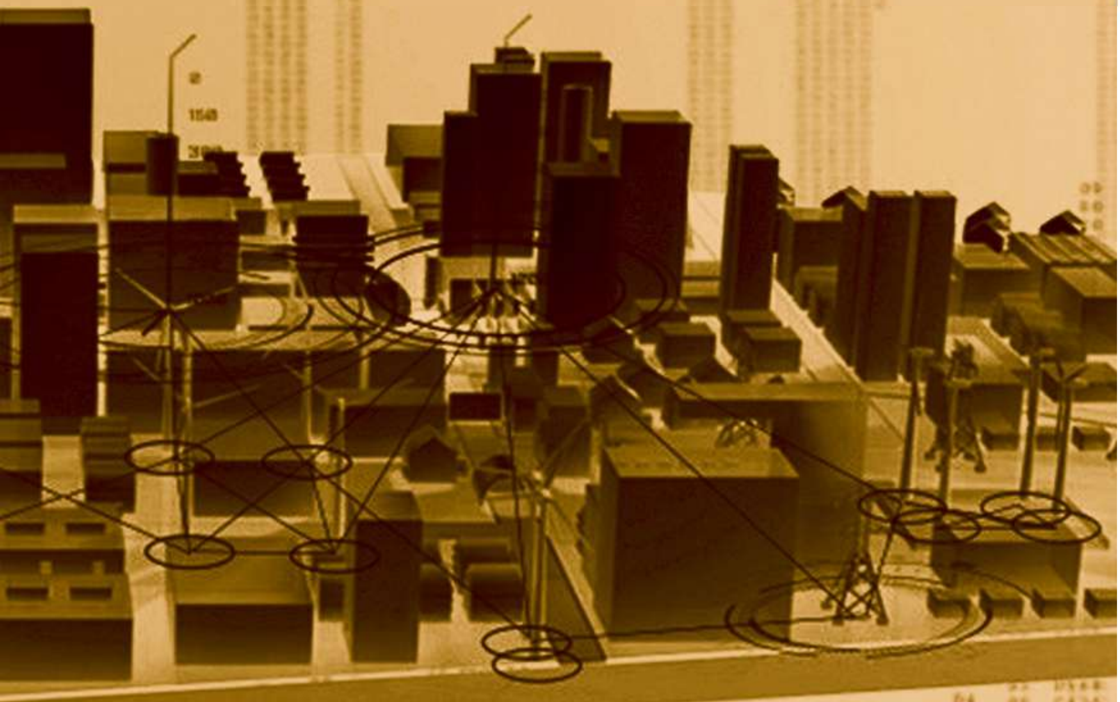
Producing Project

edited by

MASSIMO LAURIA
ELENA MUSSINELLI
FABRIZIO TUCCI

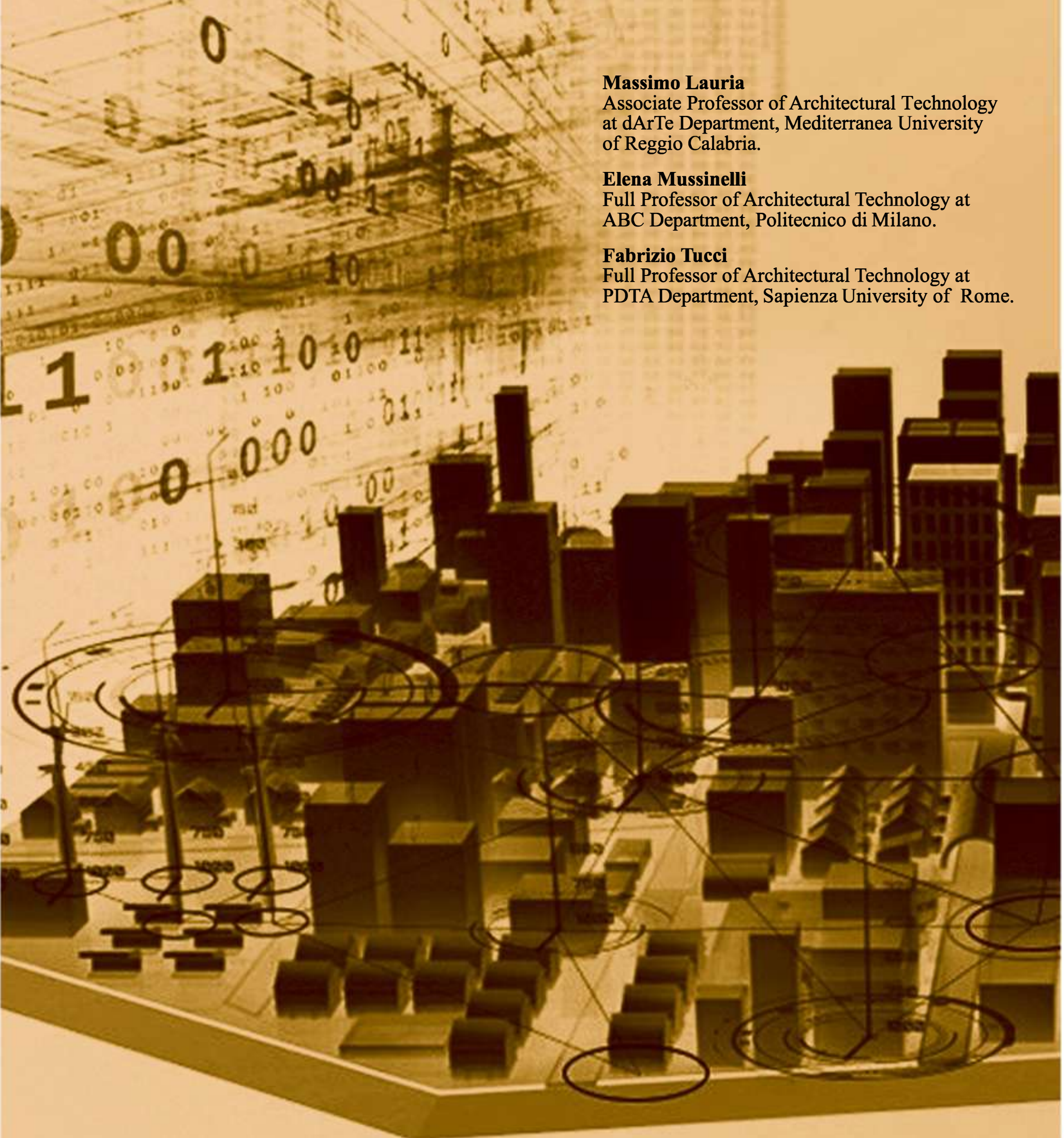


MAGGIOLI EDITORE

Massimo Lauria
Associate Professor of Architectural Technology at dArTe Department, Mediterranea University of Reggio Calabria.

Elena Mussinelli
Full Professor of Architectural Technology at ABC Department, Politecnico di Milano.

Fabrizio Tucci
Full Professor of Architectural Technology at PDTA Department, Sapienza University of Rome.



The transformations created about the design activity by the several challenges started by the economic crisis, climate change and environmental emergencies, together with the impact of the Web and ICT on social and productive systems, highlight many critical issues, but also significant prospects for updating concerning places, forms, contents and operating methods of "making architecture", at all levels and scales.
In this context, the cultural tradition and disciplinary identity of Architectural Technology provide visions and effective operating practices characterized by new ways of managing and controlling the process with the definition of roles, skills and contents related to the production chains of the circular economy/green and to real and virtual performance simulations.
The volume collects the results of the remarks and research and experimentation work of members of SIT*d*A - Italian Society of Architectural Technology, outlining scenarios of change useful for orienting the future of research concerning the raising of the quality of the project and of the construction.

Producing Project

edited by

Massimo Lauria
Elena Mussinelli
Fabrizio Tucci

MAGGIOLI EDITORE

edited by
Massimo Lauria
Elena Mussinelli
Fabrizio Tucci

editing, collection and supervision of texts by
Maria Azzalin

proofreading by
Filedelfja Musteqja
Francesca Pandolfi

This e-book has been subjected to blind peer review process.

Cover:
adaption of
Siemens digitalization tour, Siemens, 1996-2019

ISBN 978-88-916-43087

Maggioli Editore is a trademark of Maggioli SpA
Company with certified quality system ISO 9001:2000
47822 Santarcangelo di Romagna (RN) • Via del Carpino, 8
Tel. 0541/628111 • Fax 0541/622595
www.maggiolieditore.it
e-mail: clienti.editore@maggioli.it

INDEX

dedicated to
Roberto Palumbo

The new scenarios of technological design

Maria Teresa Lucarelli[*]

This publication on *Producing Project* is dense with content and interesting reflections. Its title, in its linearity and clarity, brings back to the long-standing cultural debate on the importance of new approaches to design, today urged by the increasing spread of ICT; leads back to the issue of the feasibility/buildability of the project and the need for a critical confrontation with the renewed needs of a constantly changing society. Transformation that, in the last decade, has undergone major structural changes following serious economic and environmental events, only partly foreseeable.

In particular, it references to the financial crisis of 2008 and the housing bubble that hit the construction sector and significantly reduced the project activity, aggravated by new scenarios induced by climatic changes and social emergencies. Phenomena all in rapid evolution and complexification, which are forcing us to rethink the "project" both on a cultural and technological level, also through new operating practices. However, the challenges that arise face emerging alongside significant critical issues, as Elena Mussinelli says «significant prospects for updating as regards places, forms, contents and operating methods of "making architecture"» (Mussinelli, 2018); perspectives that bring back forcefully to the centre the social and ethical role of designing which have to refer to an increasingly close relationship between design and construction. It is true, says Fabrizio Schiaffonati, that in a complex and changing reality «the project is searching for its own different identity compared to a past, even a near one, when it was placed in a sequential system where the actions downstream and upstream of its specific operating field were clear» (Schiaffonati, 2011). Considerations that place the emphasis on the slow but progressive passage of the design from a conventional, linear and sequential approach, to the integrated and interactive one of which Romano Del Nord highlights the innovative aspects, stating that «the use of sophisticated and advanced digital techniques in the development of projects becomes an indispensable imperative [...] going through the emphasis of the role of the methodological and operational

[*] Maria Teresa Lucarelli, is a Full Professor at the Department of Architecture and Territory, Mediterranea University of Reggio Calabria, Italy, mtlucarelli@unirc.it, President of the Italian Society of Architectural Technology, SIT*d*A.

techniques that have always constituted the cultural background pertaining to the Technological Area» (Del Nord, 2016).

On the theme of the project and its production, the Area of Architecture Technology has always taken an anticipatory attitude, aimed also at cognitive innovation, that is attentive to exploration and discovery, therefore to the research of which the project represents the place of experimentation and where, Giorgio Giallocosta notes, the «conception and implementation potential of architecture [...] they relate [...] to new ways of industrial production and to the growing diffusion of ITC» (Giallocosta, 2011).

A design research, therefore, that resting on deep theoretical bases and solid cultural and scientific assumptions, allows the Discipline to give concrete and innovative answers to the critical issues in progress. In this sense, the themes proposed in the publication - well centred on the problems currently affecting society, the economy and the environment - intend to represent the evolutionary framework that connotes the production of the project. The three thematic containers that constitute its structure - demand for services and supply of skills; project quality and construction quality; plan the project and invent the future through the interesting and diversified contributions presented, clearly in an osmotic relationship, highlight the current relevance of the debate, underline its continuous development, and pay particular attention to the new operating conditions introduced by "Industry 4.0".

So, retracing the structure of the text, the first major theme "Demand for Services, Offer of Competences", proposes a reflection on how we have to respond to the transformations that affect the construction sector and the construction market in our country still in serious crisis. What are, therefore, the possible evolutions in the organization of the offer and in the production of the project; what are the structures, dimensions, and skills of the design structures?

Many critical issues and opportunities can open toward new professional skills and a different entrepreneurial qualification in the sector. Undoubtedly, in the last decade, a greater attention to environmental and energy quality, safety, in particular structural safety, flexibility of spaces, maintenance of products and, last but not least, cost containment, has produced a significant transformation of demand and consequently of the design practice that calls for multidisciplinarity and specialisms, in an appropriate articulation of skills.

The contributions of this section give interesting answers, certainly not entirely exhaustive compared to a changing landscape; however, they clearly reveal the need for new organizational structures and new professionals to respond to the growing requests aimed at managing "digital facilitators"; to encourage and/or strengthen the management of processes and projects, also in consideration of the inevitable transition to a single global construction market. A new architect, therefore, able to manage the various phases of the design and construction process with greater knowledge and awareness of the potential that lies ahead.

With the second theme, “Quality of the Project, Quality of Construction”, it is clear that technological innovation, strengthened by the aforementioned digital technologies, can encourage greater “quality” in design and construction in the face of new needs. If it is true that in our country building production is still linked to a poor quality construction tradition, it is equally evident that the sector cannot escape the logic of a very competitive market, especially international, where innovation here linked, in particular, to the production and quality of the project – has to necessarily measure itself against the scenarios posed by the digital revolution and the lines of action identified by Industry 4.0, in particular in the research and development sector.

The essays presented clearly show how the use of enabling technologies is increasingly affirming in design and not only in complex projects: big data, artificial intelligence, augmented reality, digital platforms including those of IT interoperability, used effectively for advanced management and decision making processes. Innovative methods that allow you to simulate the ideational, design and construction activities avoiding errors and interferences and reducing as much as possible the waste of time and the increase in costs; at the same time improving the coordination of skills in managing the information and data necessary for the production of the project (Russo Ermolli, 2018).

It is also important to understand how the integration between various innovative technologies, including parametric design, can allow the dematerialisation of processes through simulations and virtualisations in favour of an overall improvement of the building process and to the advantage of an optimisation of the design and construction quality. In summary, as affirmed by Mario Losasso «Multiple knowledge and to be integrated, induce the strong emphasis of IT procedures both in managerial techniques related to knowledge and in the upstream and downstream integration of the project, both in the interface and interoperability of the project and process between the various actors» (Losasso, 2017).

The third major theme “Designing the Project, Inventing the Future” which continues the reasoning on the production of the project in continuity and coherence, introduces the ideation phase of the design process where the transition from theory / research to practice is certainly more complex today, however capable of predicting and optimising the potential implementation of architecture and its future prefiguration.

Within this third container, the presented reflections and research results give an account of a cultural process specific to the Technology of Architecture. Here the intertwining of art and technique, culture and science, theory and practice, undoubtedly favours an innovation of the forms of knowledge capable of governing complex decision-making processes, of identifying and implementing transdisciplinary and interdisciplinary methods with intangible collaborative forms, to respond to the main challenges of the future. The “culture of the project”, in its strategic and above all political conception; the “social innovation", more than ever urged by the need to respond to old and new emergencies; the "predictive and anticipating function of the project", indispensable to meet the needs, present and future, of an increasingly diversified; the "creativity" which underlies and enhances the architectural project, as a free expression of a cognitive process, are the four focuses developed in the last section, from which the evolution of the approach to design emerges clearly: from conventional, linear and sequential, to integrated and interactive, undoubtedly favoured by the growing diffusion of digitalisation.

The essays show a certain tendency to rely on digital technologies, the use of which however requires, in addition to in-depth knowledge, awareness of the eminently instrumental function; therefore not a fideistic acceptance but a change in the governance of the project which has to safeguard the cultural, ethical and intellectual value that underlies the making of Architecture.

Producing Project, to conclude, is undoubtedly a product of high cultural and scientific depth, which narrates a transformation, a renewed position of technological thought that does not renounce the assumptions of the disciplinary tradition, but grows in new proposals and opens up new perspectives. A reflection, therefore, on the contribution that Architecture Technology offers to promote and strengthen the design and construction quality.

One last general consideration: this publication is the latest in a series that SIT*d*A, Italian Society of Architectural Technology, promoted and supported to testify to the intellectual, cultural and scientific richness it represents. A dense text, edited with skill and attention by Elena Mussinelli, Massimo Lauria, Fabrizio Tucci to which we owe a critical rereading of the various parts and, within the three large thematic containers, an appropriate organization by topics of the products presented. A complex editorial project, also the result of the work of a Scientific Committee headed by the Company's Board of Directors, which has contributed to identifying the issues, strengthening them with their own contributions and reflections, bringing the testimony of distinguished authors, both domestic and foreign, to support the topics covered in the text.

A testament to the ability to network by promoting the sharing of results.

References

Del Nord, R. (2016), "Potenzialità dell'area tecnologica in tema di ricerca progettuale", in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto*, Franco Angeli, Milano.

Giallocosta, G. (2011), "Tecnologia dell'Architettura e progettazione tecnologica", in *Techne*, n. 2, Firenze University Press, Firenze.

Losasso, M. (2017), "Tra teorie e prassi: cultura, tecnologia, progetto", in *Techne*, n. 13, Firenze University Press, Firenze.

Mussinelli, E. (2018), in VV.AA., "Call for papers Convegno Internazionale SIT*d*A "La Produzione del Progetto", Reggio Calabria, June 2018.

Schiaffonati, F. (2011), "La finalità della progettazione nella formazione dell'architetto e dell'ingegnere", *Techne*, n. 2, Firenze University Press, Firenze.

Russo Ermolli, S. (2018) (ed), *The Changing Architect*, Maggioli Editore, Santarcangelo di Romagna.

REFLECTIONS ON RESEARCH AND DESIGN IN ARCHITECTURAL PRACTICE

Paolo Felli[*]

Dealing with the relationship between research and design in the architectural practice of recent years, three important questions emerge.

The first question: How research and design are connected today in architectural practice?

I am convinced that designing is a way of researching and researching is a way of designing. Our firm, established with Antonio Andreucci and Romano del Nord, CSPE (Centro Studi Progettazione Edilizia / Building Design Study Centre), has from the time it was established in 1976 operated with the objective and conviction of the need to merge these two aspects (research and design) into a single way of working, seeking to make a contribution through solid and sustainable design, following the path traced by our experts, from Spadolini to Ciribini, and Vittoria to Zanuso.

In all our projects we have always sought to experiment with research topics on how to address the management of complex systems, those relating to the functional and aesthetic aspects necessary to define spaces for the community and their humanisation, building construction techniques, and the productive feasibility of innovative building components.

We have shared this path with many other colleagues in Italy and abroad, but I think that this path today, present in the best experiences accomplished recently, is unfortunately becoming increasingly narrow.

To travel it an essential condition is required a priori: convergence on the common goals of the players with whom we share the construction process; therefore particularly sensitive clients and entrepreneurs with whom to dialogue, and today, in our national context, this is increasingly rare and difficult to find. I therefore wish to consider with you here what happens now in design practice with regard to these two essential players in the building process.

Among public clients today it is difficult to find openness to creativity and innovation in design. Very often the administrative machinery of public bodies, characterised for the most part by a fear of making mistakes and assuming responsibility, seeks correct but anonymous solutions.

∗ Paolo Felli, is a Professor Emeritus at the Department of Architecture, Firenze University, Italy, paolo.felli@cspe.net.

This happens, in my opinion, due to the client's difficulty in managing a professional situation in the sector of civil engineering and architecture which is absolutely out of control, which has gradually been developing in Italy in particular over the last 30 years and has now exploded in an unsustainable way. On the other side in the entrepreneurial world, given the current crisis in the construction sector (groups of traditional prestige have also disappeared in recent years), those who continue to commit themselves are forced to find operative references in countries with greater investment capacity and therefore with very little interest in investing in research and innovation that can have an impact in Italy. Today, unfortunately we must see how, with the irrepressible growth towards specialisms in both design and construction, advances in architectural practice (not that of glossy magazines but of everyday life) are very often far from the world of research and innovation. I think that the university world, our world, must discuss and reflect on the current operational reality, especially in Italy, to prepare and train young people capable of entering the productive world with the ability to renew and make design increasingly responsible.

The second question: What are the limits and advantages of the traditional holistic practices of design and what subjects and opportunities are offered by technological innovation?

I think that the skill specialization increasingly typical of the various phases and scale of the design, from security specialists to experts in fire prevention up to the various types of plant engineer and structural engineers, those who deal with the maintenance and management of what has been built, could and can find great benefit in the use of systems and methods that digital innovation allows us to adopt, with comparisons and coordination checks that were previously inconceivable.

I am referring to systems that go under the name BIM, but we cannot only consider the positive aspects, which certainly exist. We must also assess the unforeseeable negative repercussions that they can determine on the general structure of the work organisation and in design studies in particular.

The speed of transformation and the costs of the existing digital tools and those being developed (in particular programme costs) should make us reflect and we must consider that «the monarchies of today are big technology companies and we are their subjects» (from an article by Anthony Giddens in *la Repubblica* newspaper on 15 May 2019), costs and organisations that only economic power can afford. The only defence against this excessive power is our culture and our capacity to invent new forms of design bodies which otherwise unfortunately tend to be more and more validated and to become monopolies of large engineering firms, of sizes that can only be controlled by economic capacity that is not compatible with individual professional firms or small working groups.

But perhaps it is not inappropriate to reflect on another, in my opinion, important aspect arising from the use of digital systems: the exceptional rapidity, the speed that these systems permit once set up, I believe is an opportunity to reconsider praise of the "slowness", Scarpa's memory, which is our essential point of support for the same design reflection and conscious creativity.

I recently experienced first hand the sharp division between an architect (a creative designer who presents his or her ideas with free-hand drawings) and an engineering firm which translates those marks into BIM designs without managing to clearly identify who is in control of the whole procedure.

It seems to me that those who ultimately benefit from these systems are the client, in terms of the economic aspects and their immediate effect on the decision-making choices, aspects which are without doubt important, to be kept under control but which seem to take the upper hand when it comes to aspects that are not as easy to monetise such as the humanisation of the spaces, their durability over time and their beauty. Unfortunately, I think that in this context stability is very difficult to achieve for small professional bodies or individual professionals who work with holistic practices using IT systems that are increasingly critical and whose costs are difficult to sustain for a small firm.

This is why I see great difficulty for young professionals who want to test new forms of professional organisation. I think our Technology Society should reflect on these issues and make a contribution at the level of the ethical and shared values of the architectural project, and provide guidelines, indications and considerations on how to organise university education in the near future.

The third question: How are design creativity and technique in architectural and urban design combined?

If by technique we mean the set of rules that guide the design activity and that are based on experience, tradition, scientific knowledge and that are subject to ongoing evolution and innovation, there should not be any opposition but rather synergies between technique and creativity in architecture. But with regard to what I said even before about the design context today, in my view the technical capacity to innovate combined with creativity capable of inventing new solutions is in short supply today and comes with many difficulties, unless the client has a strong ethical policy desire to seek creativity and to test innovative solutions in the interest of the community. Unfortunately, at this time this is not the objective of the public client. Let us consider, to limit ourselves to one example, the role of the "RUP" (similar to a Project Manager) and reflect on this to understand whether compliance with bureaucratic and administrative procedures, certainly to be pursued, is enough in itself to ensure the quality of the project, and how the public administration demonstrates its scarce interest in travelling the difficult path that leads to innovation and creativity, save for very rare exceptions. Moreover, also the route often taken too easily by large private groups, which focus more on the self-representation of their brand and image, is certainly not aimed at seeking new and adequate responses to the issues and needs of the community but rather the goal is to increase self-affirmation. Nor can we rely solely on the archistars. Even when they bring creative and innovative ideas they represent a marginal phenomenon with respect to large building production, both in Italy and abroad, and they even serve to confine creativity and innovative experimentation to a marginal field with respect to the transformation taking place, which the culture is often barely aware of and is far removed from the creativity and needs of the community.

Reflecting more specifically on the relationship between digital technologies and creativity I think that:

- The new technologies are a tool and as such they bring advantages and disadvantages, and therefore as such they should be used with great care, above all due to the rapidity and speed they bring to the management of design and construction processes. I have already spoken about the virtue of "slowness." Speed, as for vehicles, as it gradually increases makes the route more complex and dangerous!
- Their relationship with creativity? But what is creativity? Creativity can be a simple innovative idea or an innovative decision-making process. In the first case, the "creative" is one of many specialists who participate in a linear design process, for the most part bringing an initial idea. In the second case, creativity is spread over the entire duration of the designing, from the identification of a concept through all the design phases, from the preliminary design to the detailed design and then implementation. The first way of proceeding is characteristic of large engineering companies and tends to obtain the best technical-economic result under the umbrella of an initial idea. In the second case, creativity allows the designer to make ongoing checks and controls on a participatory design process with the other players, as well as with users.
- There is one aspect of new technologies that worries me a great deal, the fact that although they enable connections with operators spread even around the globe they risk the loss of the interpersonal relationships typical of architecture firms, artisan workshops (see for example Rogers, who had to set up meeting points within the firm to ensure that his collaborators could meet each other in person after having been in contact via email for years, despite residing in the same building).

Finally, some general considerations to contribute to the line outlined in the establishment of SIT*d*A (Italian Society of Architectural Technology), remembering that it is not an academic structure but a non-profit scientific society and to also avoid the university becoming an ivory tower far from the problems of reality. I would suggest that everyone, but above all you young people, analyses, studies and makes contributions on two themes that I believe have been little investigated recently in order to avoid them being handled by other disciplines and other operators, and above all so that they are managed in the general interest and in the search for quality in architecture.

These two themes run throughout the entire process from design to construction, and they are: the relationship between the client, above all public, and the designer, and the relationship between the design and its construction and use. Today we cannot fail to wonder and research why the construction sector, particularly in Italy, is in such a crisis (public contracts have halved from 2003 to 2017) and above all we must not consider it an area of study pertaining only to administrative legal experts and economists. They know little or nothing about how the construction process develops or the variability of the surrounding conditions that continuously alter it, and instead of fiercely looking for operating practices that allow and provide for this need for continuous adaptation they block the process with unchangeable instrumental stereotypes, in a linear operating sequence (preliminary, final, detailed design) which does not permit continuous and essential dialogue between the designer and the constructor as the big names of the past taught us.

1. *Public client-designer relationship*: I am not convinced by the definition of an architecture firm as a service provider. I am fond of the origins of the word architect, as the head of builders, and I think that the architect's work is a creative and collective one. I therefore think it is impossible to design if you do not know who will produce the product and it is therefore essential to reflect and understand how the process of creating our projects in studies and at construction sites is performed today, where computer systems such as BIM will certainly be a big help.

   Even less space is given over to project timing, reflection and creativity which is not only intuition but a slow process, while we must note how the time allocated to competitions at this stage tends to be restricted (maximum 2 or 3 months) while much longer is spent, if not years, on awarding and control, which has become even more bureaucratic with the practice of tenders with (absurd) discounts, but who benefits? Certainly not quality. By way of example I wish to recall that the expenses attributed to the designer include payment of the costs necessary to publish the competition in the official journal, and to participate in a design competition the group must also pay an anti-corruption tax. In our sector it is also important to consider the procurement code, which defines the various levels of the design (preliminary, final, detailed) as perfect and sacrosanct tools while the design is a live reality like the world that surrounds it, and like all living organisms it continuously alters and transforms.
2. *Design implementation relationship*: I think it is necessary to focus our attention on the inertia that the construction world creates against transformations while not remaining unchangeable and changing its organization, both as regards the involvement of labour and the use of new tools and new construction technologies. Today the image of a business as a set of capitals managed by technicians and skilled workers is no longer a reality. The business has lost the connotations it once had and is increasingly linked to a

series of subcontracts. The role of project supervisor, which should reflect that in the musical field of the conductor of an orchestra and interpreter of the musical score, cannot take the current approach playing a mere role of control in a conflictual relationship.

To conclude, I wish to encourage reflection on the fact that for too long we have only been dealing with these fundamental relationships between project and implementation and between designer, client and business very theoretically. We need to reappropriate these issues, just like architecture technologists, starting with knowledge of the actual situation and using the tools that the digital revolution offers us, aiming them at an architect's very goals, namely creativity and beauty.

PRODUCING PROJECT

RESEARCH FOR THE QUALITY OF THE PROJECT

Elena Mussinelli[*]

The decision to promote the annual SIT*d*A Conference focusing on the "production of the project" was the occasion for an in-depth reflection within the Board of Directors.

Previous initiatives of national importance had already highlighted central topics for the research in the Technological Area: the relationship between building production, project and materials for architecture (SAIE, Bologna 2018), the resilient design (MadeExpo, Milan 2017), the relationship between architecture, memory and contemporaneity (joint initiative of Arch and SIT*d*A, Palermo 2016), the perspectives of energy efficiency and environmental quality for the existing heritage (Ferrara 2016), the knowledge of Architectural Technology for the third mission (VI National Conference, Bologna 2016), urban regeneration (V National Conference, Rome 2015), the potential role of SIT*d*A Clusters (MadeExpo, Milan 2015).

In many cases, these occasions have also resulted in publications, which have been related with the intense publishing activity of *Techne* journal (n. 16 on "Matter is Design", n. 1 of the Special Series on "Smart Cities", n. 15 on "Architectural Resilience", n. 14 on "Architecture and Social Innovation", n. 13 on "Theories Practice Design", n. 12 on "Architecture Memory Contemporaneity", n. 11 on "Infrastructures", n. 10 on "Urban Regeneration"): research products that not only record and formalise the research advancements, but that - also in comparison with inputs from other disciplinary areas - clearly identify the contribution of the Technological Area in the contemporary debate on the city and the architecture. It is important to recall this thematic path, because it highlights very well the cultural and scientific positioning of the Area, with in-depth studies and contributions of a theoretical, methodological and even specialised nature that are always related to the operational horizon of the project.

Placing the production of the project at the centre of the SIT*d*A 2018 Conference, as well as of the reflections collected in this volume, has therefore meant a precise objective: focusing on the transformations due to the changing cultural, social, technical and procedural scenarios of the design activity, in a context that highlights many critical issues, but also new perspectives of work

[*] Elena Mussinelli is a Full Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, elena.mussinelli@polimi.it.

with regard to places, forms, processes, technical contents and operational methods of “doing architecture”, at all levels and scales of intervention. Aiming at pursuing the specific cultural line that has always characterised the Area of Architectural Technology for the attention paid to the transformations that affect society, regulatory tools and the construction systems: starting from a reinterpretation of the context in which the founders of the discipline worked, through a better understanding of the state of the demand and of the supply of the project - also in light of the changing of procedural and production contexts - to prefigure the evolutionary scenarios that will characterise the future.

Undoubtedly, these undergoing changes have significant consequences on the social and ethical role of the design activity, concerning its practices, organisational models and contents. The necessity to review the cultural and technical scope of the project is, therefore, no longer just a conjunctural need, but a primary element for improving and adapting the discipline with respect to the dynamics of anthropic transformation of the territory and the contemporary city, offering adequate and updated responses to the new social, political and economic demand.

The trends seem to confirm the effectiveness of the models and approaches that have characterised technological design since its origins: the attention to the procedural and systemic dimension, the centrality of the “environmental issue”, the constant reference to the management of the building process and production innovation, the definition of methods for the verification and control of project and process quality.

Already in 2012, Fabrizio Schiaffonati encouraged to record how the transformation in progress had

> «already produced its effects, overpassing consolidated positions, traditional disciplinary contents, forms of delivery of services and skills, to redefine a design market that is very far from the conservative logic still referred to the outdated models of the liberal profession» (Schiaffonati, 2012, translated by the author)

urging the need to bridge the gap between the structural plan of the technical and socio-economic determinants that shape the building process and the scientific-disciplinary knowledge that supports and guides the production of the project.

Emphasizing again how the built environment is a terrain for experimentation and assessment

> «of a society’s difficulty in bridging the gap between possibility and capacity for change, thus, involving the entire social sphere. The project of architecture at different scales is an expression of this contradiction [...]. In such a complex reality [...] the project finds itself searching for its own different identity compared to a past, even a near one, when it was placed in a sequential system where the actions downstream and upstream of its specific field of operation were clear» (Schiaffonati, 2012, translated by the author).

The results of the reasonings, deepened and developed in the contributions collected by this publication, refer to different points of observation that revolve around three central issues: the connection between the (new) demand for services and the supply of skills, the relation between the quality of the project and the quality of the constructions and, finally, the scenarios of innovation, namely, the ability to design the project to invent the future.

References

Schiaffonati, F. (2012), "Presentazione", in Arbizzani, E., *Il progetto per costruire,* Maggioli, Santarcangelo di Romagna, pp. 9-10.

TECHNICAL CULTURE AND DISCIPLINARY STATUTES

Massimo Lauria[*]

> «Given that the phenomena that interest architecture have to do, in any way, with all sorts of social units called "organizations" and, above all, with the activities they carry out, with the motivations that are at the origin of these activities and with the performance requirements that these postulate, the architect will have not to ignore, for the exact understanding of the consequent phenomena and for their treatment, the fundamental notions of a systemic nature related to this topic. The same procedural character of the architectural facts derives from the procedural character of the organizations» (Ciribini, 1979).

The phrase "Production of the Project" joins in essence it contrasts - a term that recalls planned and repetitive industrial activities - "production" - with another - "project" - which *vice versa* refers to intellectual, if not even artistic, works whose main feature lies in being singular, original architectural and building outcomes and, therefore, not at all repetitive. Almost an oxymoron which, through a superficial analysis, could also induce us to consider its interfering and ambiguous meanings, in some cases, even elusive. But if on the one hand these meanings objectively exist and contribute in making that framework of uncertainties that has characterized the construction sector for a few decades, on the other it seems equally correct to consider - as we will try to do later in this paper - its configuration as a dyad, deeply rooted at the technical culture level, by the powerful descriptive capacity of the boundaries within which the disciplinary debate is currently positioned.

In comprising multiple meanings, this dyad, it can be said, represents the result of a long and innovative path of transformation of the statutes of the architectural project carried out in the last 50 years and to which there is no doubt that should be associated, with undisguised pride, the fundamental contribution offered by the discipline of Building Construction Production and of Architecture Technology.

---

[*] Massimo Lauria is an Associate Professor at the Department of Architecture and Territory, Mediterranea University of Reggio Calabria, Italy, mlauria@unirc.it

The interpretative and critical reading process that derives from it, leaving to the contributions that follow analysis and projections in relation to the scenarios that could be developed out the next few years, intends to highlight the thought of the fathers of the discipline who first intuited, then theorized and, finally, attempted to implement a systematic and unitary idea of the ideational, procedural and productive implications of the sector; placing in barycentric position the objective of considering as goal of the environmental transformation processes, the improvement of living conditions and the satisfaction of the needs of the communities; integrating its ideological significance with the implicit and natural complement of the implementation of the building process through the realization. «The technique turns out» will affirm Guido Nardi «an indefeasible condition of thinkability of the architectural object; an unavoidable *a priori*» (Nardi, 2001).

To try to fully understand that thought, however, it seems imperative to date back to the early 70s of 1900, when our country, which in full socio-economic evolution had bet in all its productive sectors on the great challenge of industrialization, sees simultaneously take shape two important processes of cultural renewal in the architectural and building field.

On the one hand, the Italian architectural culture developed an important theoretical reflection in support of the trends and currents aimed at overcoming the Modern Movement «incapable, in its most important component, that of rationalism, to face the profound and contradictory changes made after the reconstruction period in the 1950s, when, on the other hand, experimentations begin in many directions [...] in the field of the figurative arts, literature, cinema, costumes» (Pazzaglini, 2006) .

Mainly a renewal of studies on language and form was recorded with the technique which, conversely, remained in the background, almost always excluded from those reasonings. Different currents were asserting themselves, even very distinct from each other in terms of characteristics and inspiration. To name just a few: from Aldo Rossi’s neonationalism to Paolo Portoghesi's postmodernism; from the very first experiments of High-Tech architecture to the critical regionalism of Kenneth Frampton from which some principles of the sustainable approach will originate.

At the same time, with the enactment of the Presidential Decree 31.10.1969, n 995, which applied the Codignola law to teaching in the Faculties of Architecture, was fixed the practical and conceptual end of the school that had been driven by the provisions inspired by Giovanni Gentile in the early 1920s and by Gustavo Giovannoni.

On the other hand, returning to the disciplinary aspects, the aforementioned general reorganization of teaching, precisely through that provision of 1969 and subsequent implemented ones, ratified the transformation of *Construction Elements*, from a “service” subject for composition and architectural design into an autonomous area - the Technology of Architecture - which posed the problem of rationalizing the whole ideationing-productioning-usage process and the corresponding control instrumentation by the community, aimed at bringing together design, production and users.

At national level, several schools originated, that are remembered, not only for their numerous scientific publications, but also for the precious and detailed critical analyses proposed in contexts in which disciplinary identity is still debated (Bosia et al., 2013; Schiaffonati, 2014; Losasso, 2017).

Those *magisteri* confirm that the scope of this reform, also born from the long wave of the youth protests of 1968, will not limit its effects to a review of the disciplinary structures but, supported by the ability to view and general interpretation of the phenomena asw well as by a strongly systemic characteristic, it also had important effects on the project. And it is precisely in the design field, as well as in that of training, that from those transformations of thought and teaching practices, in fact, the terms of the still unresolved contrast are born, for then establishing themselves definitively over the following years, counterpointing the supporters of the dogma about the unavoidable need for the fragmentation of knowledge - and specialisms - and the advocates of inter and trans disciplinarity as a possible approach for the interpretation of complex phenomena. While, then, reflections were developed about architectural languages and forms, progressively increasing distances were measured between theories - based on assumptions and doctrines of very high cultural significance but which rarely have had an impact on practical actions - and the assertion, often in contrast to the former ones, of principles which assumed «construction and building production as a cycle of operations characterized by a complex process» (Spadolini, 1981).

A deep revolution in thought and technical culture.

Approaches and methods for structuring sector policies have been definitively changed, new languages were born, the lexicon was enriched with new terms and new meanings. In schematic terms, at least two different area of influence are clearly identifiable.

The first, superordinate and of the context, refers to the general strategies (national and local) of promotion and implementation of a technical policy oriented towards the industrialization of the sector.

The second, which referred to the operational aspects, concerned more closely and exactly the issue of project production.

Two dimensions none completely disjointed; rather understood as complementary.

In the mid-1980s, with their volume *Perspectives of technical construction policy*, Maurizio Costantini and Aldo Norsa took stock of the transformation process in the sector, proposing analyses of possible scenarios of technical and building policy both with reference to our country that to the practices in place in other “guide countries” (Costantini and Norsa, 1985).

This gave body and structure to the need, then strongly felt, to embed the transformation activities of the built environment as part of a concrete industrialization policy. An ambition - then, as well known, shipwrecked - and a theme in those years subject to a close disciplinary debate anticipated by Pierluigi Spadolini and Mario Zaffagnini who, along with many eminent colleagues, declined its meanings and definitions in relationship to production configuration of the sector, to the market, to the planning, to technical regulations as a contribution to the development and control of design and production processes (Spadolini et al., 1979; Zaffagnini et al., 1981).

Those experts christened the birth of the requirements-performance theory based on the identification of needs and their translation into technical requirements; they proposed the integration between the moment of design and that of production. In highlighting principles, perspectives and potentialities referring to the two most significant directions of development of industrialization processes - for closed systems and subsystems or for open components - and in particular with reference to the latter, it owns to the work by Giuseppe Ciribini, Guido Nardi and Ettore Zambelli (Ciribini, 1979; Nardi, 1982; Zambelli et al., 1985) the ability to anticipate scenarios that will occur in the following decades due to the immense growth of the sphere of influence of production of materials and building construction components, able today to condition - even heavily - project, market and implemental policies.

At the same time, Giovanni Ferracuti and Maurizio Marcelloni clearly posed the problem of the necessary renewal, to the full advantage of the qualitative aspects, of the residential building management policies, hitherto based almost exclusively on quantitative assessments (Ferracuti, Marcelloni, 1982).

Finally, almost simultaneously with the reflections on the limits of development that matured in those years (Meadows DH et al., 1972), none secondary were the intuitions of Morris Asimow who posed the question of the interaction between design and environment (Asimow, 1968) and of Thomas Maldonado who has considered construction activity within the field of ecology (Maldonado, 1970).

All these are *prolegomena* of the principles that subsequently supported the affirmation of an environmental awareness in the sector, extended to all areas of transformation of the built environment. To these principles have to be brought back the remarks of the *Milanese* school which referred to the magazine *Recuperare* and which, through the writings of Valerio Di Battista, would have theorized the concept of “project of the existing building” by giving form and substance to one of the key themes, together with the environmental one, of the century.

With the background as a cultural substrate, this wealth of propositions here only briefly introduced, and in not a completely exhaustive way, the debate in those years also addresses more purely operational issues.

The phrase production of the project will thus progressively reach its own complete definition, systematizing the numerous remarks that matured with regard to the idea of technological culture as a guide of the design process with techniques, technologies and process as the main operational tools (Crespi et al., 1985).

The relationship between techniques and design or, in other words, between technology and creativity or, again, between «post-industrial technologies and architectural object» as Giuseppe Ciribini defined it (Ciribini, 1995), thus configures one of the main relative nodes related to the future developments referring to the production of the project.

On the subject, already in the early 1980s, with refined anticipatory ability, Edoardo Vittoria argued that

> «the renewal of production procedures (from mechanization to robotization) derives substantially from the changed relationship between the use of tools and means of work and the technical and scientific knowledge. In this case, for a development not limited to the pure and simple quantitative amplification of the current ways of acting on the environment, it is essential to link more and more closely the processes of industrialization to the knowledge of the methods and technical devices that enhance the human creative value» (Vittoria, 1983).

Still in full evolutionary process, sometimes with conflicting results, sometimes decisive, this relationship, certainly neither stabilized nor accomplished, brings with itself all the enormous potential, but also the related risks, connected to the diffusion and widespread use of the modern technologies in the building constructions sector.

These currently, on the one hand, coincide with the ICT and KET technologies connoting Industry 4.0 and the European Digital Agenda; on the other, with the “invisible technologies”, as defined, already a few decades back by Nicola Sinopoli (Sinopoli, 1997).

Their importance and their current growing use are, in the various declension and potentials, well returned by this volume in its articulation in three chapters (Demand for services, offer of competences; Quality of the project, quality of the construction; Designing the project, inventing the future).

However, it should be noted that, although as we have seen, their role and the specific areas of interference with the area of the ideational phase were already clearly defined by the utterances expressed in the past, it emerges at times, also from the reading of the texts that this volume gathers together, a certain perilous logical inversion that tends to transform what could represent a solution for the growth of the sector - the availability of increasingly performing techniques and technologies - with a problem. In fact, their use takes place, sometimes with a fideistic attitude, in other cases with a kind of complacency, more and more often, placing the contents of the project only in the background.

In the context of the current statutes, it is therefore necessary to promote new agreements and new balances between the project itself and the now indefeasible process that makes extensive use of today's techniques.

Methods and tools, goals and means, which due to the repetitiveness and the purely operational value attributed to them, have for some years seemed to have led back project activity in the context of activities and operations procedural therefore substantially oriented to a solution - falling within thus, paradoxically, among the contributing factors of the current crisis of the architectural project. «Too often led by the various knowledge and methods of learning involved to dry up within easily controllable patterns, it risks either anchoring itself to a tradition now emptied of meaning, or vice versa to taking a turn towards an often purely formal technicism» (Nardi, 2001).

Some different civil and professional society portions refer with growing concern to this aspect of the project crisis, this latter transformed in many cases into a portion of the construction process to be kept under control in the same way as any other cost item relating to the production process; hoping for a renewed centrality in the construction processes and considering, first and foremost, the failures and the very high social, environmental, economic costs that its alleged margins produce.

Few conclusive considerations derive, that in the final analysis, intend to pose some of the questions which will be dealt with later in the volume.

This introductory essay, as stated, does not clearly aspire to assume the characteristics of an objective report, it does not constitute a chronicle of the time, much less a "nostalgia operation" with a flavor of cultural restoration.

Too many authors and studies not mentioned for being exhaustive. Equally unquestionable is the awareness of the real extent of the results of that season which we recognize as not very incisive results in terms of implementation, bankruptcy according to someone.

But those results do not detract from the importance of research and experiments - started, we remember it, in an almost detached way and isolated from the cultural context in which they matured - and to which are once again recognized topicality and anticipatory capacity.

A great deal about the current terms of the issues that revolve around the topic has in fact already been said and already written. Entire generations of designers and administrators - and even the current teaching class - have been formed within such a cultural context. And it is precisely for these reasons that, that lesson cannot and must not be forgotten.

It adsorbs much more often than it appears, the tools of knowledge for the recognition of the main risk factors that afflict the sector, and at the same time, the theoretical postulates and the cultural perspectives to direct the consequent actions towards growth and innovation.

References

Asimow, M. (1968), *Principi di progettazione*, Marsilio, Padova.

Bosia, D. (ed) (2013), *L'opera di Giuseppe Ciribini*, Franco Angeli, Milano.

Ciribini, G. (1979), *Introduzione alla tecnologia del design. Metodi e strumenti logici per la progettazione dell'ambiente costruito*, Franco Angeli, Milano.

Ciribini, G. (1995), *Tecnologia & progetto*, Celid, Torino.

Costantini, M., Norsa, A. (1985), P*rospettive di politica tecnica in edilizia. Produzione e qualità*, Franco Angeli, Milano.

Crespi, L., Schiaffonati, F., Uttini, B. (1985), *Produzione e controllo del progetto. Modelli organizzativi, tecniche decisionali e tecnologie per la progettazione architettonica*, Franco Angeli, Milano.

Ferracuti, G., Marcelloni M. (1982), *La casa. Mercato e programmazione*, Giulio Einaudi editore, Torino.

Losasso, M. (2017), "L'insegnamento della tecnologia dell'architettura nella facoltà di Architettura di Napoli" in Losasso M. (ed), *Temi di cultura tecnologica della progettazione. Saggi scelti,* available at: www.docenti.unina.it%2Fwebdocenti-be%2Fallegati%2Fmateriale-didattico%2F 647380 &usg =AOvVaw2NDM-dpY_-kTcmFLa-cQS_.

Maldonado, T. (1970), *La speranza progettuale*, Einaudi, Torino.

Meadows, D.H., Meadows, D.L., Randers, J., Behrens, W. (1972*), I limiti dello sviluppo. Rapporto del System Dynamics Group Massachusetts Institute of Technology (MIT) per il progetto del Club di Roma sui dilemmi dell'umanità*, Edizioni Scientifiche e Tecniche Mondadori, Milano.

Nardi, G. (1982), *Tecnologia dell'architettura e industrializzazione dell'edilizia*, Franco Angeli, Milano.

Nardi, G. (2001), *Tecnologie dell'architettura. Teorie e Storia*, Maggioli, Santarcangelo di Romagna.

Pazzaglini, M. (2006), *Architettura italiana negli anni '60 e seconda avanguardia*, Gruppo Mancosu editore, Roma.

Schiaffonati, F. (2014), "Il contesto culturale e la nascita della disciplina" in VV.AA., *La cultura tecnologica nella scuola milanese*, Maggioli Editore, Santarcangelo di Romagna.

Sinopoli, N. (1997), *La tecnologia invisibile. Il processo di produzione dell'architettura e le sue regie*, Franco Angeli, Milano.

Spadolini, P. (1981), "Progettare nel processo edilizio" in Zaffagnini, M. (ed), *Progettare nel processo edilizio. La realtà come scenario per l'edilizia residenziale*, Edizioni Luigi Parma, Bologna.

Spadolini, P., et alii (1979), *Normativa tecnica e industrializzazione dell'edilizia*, Luigi Parma, Bologna.

Vittoria, E. (1983), "Progetto, cultura, tecnica" in *Controspazio*, n. 3, Gangemi Editore, Roma.

Zaffagni, M., et al. (1981), *Progettare nel processo edilizio: la realtà come scenario per l'edilizia residenziale*, Edizioni Luigi Parma, Bologna.

Zambelli, E., Raiteri, R., Novi, F. (1985), *Costruzione facilitata*, BeMa, Milano.

REQUIREMENTS, APPROACHES, VISIONS IN THE PROSPECTS FOR DEVELOPMENT OF TECHNOLOGICAL DESIGN

Fabrizio Tucci[*]

To comprehend the impact of the challenges and characteristics of our time on the regulation of Technological Design and to imagine the possible directions, orientations, and visions in constructing future development scenarios, we must start from the full awareness of the original identity of the Technology of Architecture. It is a discipline inspired by the characteristics of openness, process, systematicity, connectivity, relatability, and experimentation, committed to overcoming the apparent form/function dichotomy with a profound interest in investigating the need/performance aspects of designing, the relationships between innovation and permanence, and the more fertile relationships among materials, components, systems, techniques, and morphologies of spaces. This discipline is aimed at reasoning in terms of organized, interrelated, and complex systems; at grasping the necessary, ineluctable association between unity and diversity; at effectively exercising the role of unifying the process/design moments with moments of production/construction/development; and at carrying out the role of intermediation with reality, while holding together the epochal triad of environmental, social, and economic demands.

It aspires to be an expression of a culture of design thought capable of carrying out the complex direction of technical and functional aspects, logical and morphological aspects, aspects of the behaviour and performance of architecture, as well as of narration to the users and of involvement, at various levels, of the various parties – customers, operators, designers, stakeholders, users. In a word, it interprets the profound connotation of the expression "technological culture of design," at all times animated by an anticipatory and visionary spirit.

Our time is marked by questions that push towards defining it as the "era of crises and uncertainty" – questions in which Technological Design is a potential protagonist in the experimentation of innovative ways of designing in new contexts and new conditions, in the attempt and desire to provide some responses to the main challenges of the future, which means: designing in a time of "crisis" (cultural, social, and economic); designing in "emergency" conditions (environmental/climate, humanitarian, housing); designing in a state of

[*] Fabrizio Tucci is a Full Professor at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, fabrizio.tucci@uniroma1.it

"scarce resources" (material and immaterial); designing in conditions of "uncertainty" (wholly cutting across the previous ones).

But it is also the *digital and digitalization era*, the time of revolution in the ways of accessing information; of continuous mobilization of skills; of the expression of an intelligence that is widespread, connected, and coordinated in real time; of the apparently unlimited possibility for consulting, using, and exchanging data. It is the era marked by the creation and self-endowment of Information and Communication Technologies and of Key Enabling Technologies, with leading roles played by, among other things, the, internet of things, big data and open data, simulation and modelling systems, digital fabrication, computational design, virtual reality, augmented reality, analysis and exchange data, and generative systems. Reflection is therefore needed on the possible innovation of approaches, requirements, and visions of Technological Design – in certain aspects in progress for some time, in others being set up, and in others still, wholly to be investigated – in the prospects of a future marked by the era of crises and of digital developments.

The questions to be raised – essentially three in number, although strongly interrelated in non-linear fashion with one another – are by necessity to be developed in a consequential manner for logical and narrative needs: What requirements do we expect to be met by technological design in a renewed evolutionary construction of the discipline in dealing with epochal challenges? What approaches are characterizing and will characterize production in order to be able to respond and give substance to those requirements? What visions may be imagined in recounting and building a future in which some responses marked by those requirements and supported by those approaches can be offered?

The following are some points for reflection, developed starting from the extraordinary wealth of viewpoints present in the contributions of the 125 authors of this important (in our opinion) volume, and from the expanded basin of dialogue with a part of that scientific and disciplinary (but also extra-disciplinary) production that, in these years, has taken differentiated positions on the questions in play.

Requirements

The essence of the change in the contemporary condition of "design production" and of its prospects for evolution in future scenarios hinges not so much, and not only, on the instrumental ways in which the design process develops – also, as we were saying, through the availability of systems that may be related to the expression "Industry 4.0" – but in the very way in which the *requirements* that "inform" the approach to design are identified and employed; these requirements, if they are the expression of profound technical knowledge and the ability to give voice to creativity and imagination, can characterize the entire range of process phases and guide the behaviour, the performance dimensions, and capacities to make real contributions to Dwelling, to Society, to the Environment, as never before in the past.

From this perspective, new *requirements* for a new mode of approaching the production of design have been taking shape during these years, and others are turning to the scene of experimentation. Among the most innovative, we may mention those of:

- "liminality" of the conditions for developing design, always poised (in the sense of "in a dialectic relationship") between the search for quality (technical, morphological, housing, social, environmental, spatial, etc.) on the one hand, and the need to verify the efficiency and effectiveness in performance (performance-related, functional, energy-related, ecological, economic, etc.) on the other (Buchanan, 2011);
- disciplinary "a-scalarity" and "transversality" of design production, whose fulcrum lies in gaining awareness that it is impossible to identify a single, privileged scale of application of the system, overcoming the traditional linear/hierarchical vision of a proceeding in space and time, from the large to the small scale, and that the true task of design lies in valorising the disciplinary interactions among and within its various possible levels (Herzog, 2010);
- "vitality" of the designed morphological/technological system, always ready to be cast back into doubt, open for development, able to prove itself sensitive to the consideration of the specific socioeconomic / cultural / geographic / climate characteristics of the object of the transformative action – a key requirement also for relaunching the central importance of the figure of the architect (Schiaffonati, 2017);
- "self-organization" and "replication capacity," which is to say the capacity for self-conservation (replication in time, renewal) and for re-production (replication in space, multiplication) of the design intervention system (Schumacher, 2011);
- "stochasticity," which is to say the capacity to combine a *random* component with a *selective* process in such a way that only certain results of the random can persist synergistically in the designed intervention system (Haken, 2013);
- "tolerability" of a certain margin of error in the design intervention process, in keeping with the theory of *Fehlerfreundlichkeit*, which may be translated into "serene awareness of the possibility for error or malfunction" (von Weizsäcker, 2010), which has its counterpart in the subsequent two requirements of:
- "correctibility" and "controllability" of intervention actions and of the components and systems with which they are actuated (Vidal et al., 2016), with the awareness of the need for continuous adjustments, in progress, of the temporary design outcomes;

- "circularity," "durability," and "cyclicity" of resources and of systems introduced into the processes of designing and transforming the built environment – essential requirements in the designing hope for a more sustainable future (Dierna, 2011);
- "flexibility," "adaptivity," and "resilience" of the development and management processes, diachronically and synchronically, of design (Lucarelli, et al., 2018);
- "multivalence," "reactivity," and "porosity" of the conditions, *infra* and *in-between*, at the boundary/border of the technological systems characterizing the designed intervention – systems willing to lose the anisotropic and invariable nature of the structure (Angelucci et al., 2015) to become open, permeable, capable of playing roles of mediation/regulation in urban metamorphic processes;
- two-way "connectivity" and "interactivity" with and among resources, information, data, and systems that are the object of design production (Hensel, Nilsson, 2018);
- "inclusiveness" and "shareability" as key requirements, on the level of social impacts, in order to implement, in the different phases of designing, the main objectives of the inclusive and participatory processes of users, beneficiaries, and citizens, in the vision of design for social innovation (Bologna et al., 2017; Perriccioli, 2017);
- "agreeability" and "accessibility" of the models of behaviour and use ("behavioural modelling"), for a supply and sustainable management of future-proofing services, and for a social extension of user requirements, of efficiency, and of the benefits to all potential users (Del Nord, 2016);
- "iterativeness" and "reflexiveness," which hinge on the so called *collaborative thought* in constant dialectic with the concept of connective intelligence, bearers of that "active citizenship" that is being founded upon the basis of the vision of a Sharing Economy for a Collaborative City (Manzini, 2018);
- "simulability," "modellability," and "computability" of the information's data, both of the conditions of the *ex ante* context and of the *ex post* configurations and arrangements, as impressed by the design process, also with reliance on smart systems, big data, and open data (Russo Ermolli, 2018);
- "interoperability" of the systems put in place in support of the representation of the architectural and urban complex in the processes of design production (Antonini et al., 2017), a requirement that is the linchpin of a recursive/interactive vision that seeks integrations, interconnections, interrelationships – in a word, the most profound dialogue – among elements and factors that are the object of transformation, for a valorisation of the intrinsically heuristic nature of design.

Approaches

These requirements, in the attempt to reconstitute the certainly not comprehensive framework as sketched out above (also because it is constantly in progress), are – in their reciprocal collaboration (prevalently with the quadrangulations to be set out below, parenthetically) – the "vital apparatus" of the possible Approaches in a perspective of developing design production.

Among the main ones, the following appear particularly interesting for some of the future scenarios of Technological Design (referred to with the English-language terms most recurrent in international settings):

- *Generative-interactive approach*, which dialogues with the *Collaborative-iterative approach* and the *Social innovation approach* (whose main requirements of reference are inclusiveness, shareability, interactivity, porosity). These approaches involve a renewed systemic conception typical of the technological culture of design, which may lead to the affirmation of "generative" and "collaborative" processes of designing (Losasso, 2019).
  The tendency is towards the ability to generate interactive exchanges, multiple non-linear relationships, and interface with the complexity of the social realities of living for an "active city," in which the central player is also the sharing and dynamic interdependence among multiple factors acting in the same environment, in the constant search for points of synthesis and balance in accordance with the theory of *Fließgleichgewicht* (von Bertalanffy, 2004).
- *Infra-disciplinary approach* (the main requirements include those of vitality, stochasticity, a-scalarity, liminality, an approach that leads those governing design production to move within the boundaries "between" disciplines that our own disciplinary forebears always sought (Bosia, 2013; Campioli, 2016): beyond a collaboration and integration of knowledges (multidisciplinary), beyond a profound exchange of viewpoints and a synthesis (interdisciplinary) (Reuter, 2013), also as a proof of osmotic interaction performed by the places, all to be explored, set within the *infra*-discipline limits (or in the points of contact, depending on the point of view).
- *Dynamic-responsive approach* (whose main requirements are those of reactivity, adaptivity, resilience, interactivity), an approach by which the renewed traits of design will have to be capable of enabling environmental, urban, and architectural systems to respond to constant interactions with the changes taking place, in a way that is at once synergistic, dynamic, and reactive/resilient (Eilenberger, 2018); a management of the built environment, of the economy underlying it, and of their interactions – the most natural and least costly of resources that exists – that is based upon the specific capacity of the technological characteristics of the designed system to react and to "dynamically reorganize" (Cantrell, Holzman, 2016).
- *Cognitive-perceptive approach* (main requirements of reference: liminality, reflexivity, multivalence, shareability), an approach that starts from the ab-

sorption and re-elaboration of the teachings of the neurosciences (Pallasmaa, 2011), in the awareness, by the designer and researcher, of the centrality of the cognitive and perceptive processes that are actuated in the user/citizen immersed in the spaces of inhabiting sources of these stimuli (Giachetta et al., 2019). Design today can implement them by putting into play the innovative modes of simulation of these processes, which may be integrated into conceptual and design development.

- *Simulation and modelling approach, Computational approach* (requirements of reference include: interoperability, simulability, connectivity, modellability), approaches that represent a methodological condition of important work – in the future, a virtually mandatory passage – for the refinement of the knowledge-cognitive apparatus of the de facto state, and for the more correct simulative prefiguration of the behaviour and the performance of the design state (Auer et al., 2017); this dimension of method and operativity makes it possible to trigger virtuous *ex ante* simulation processes – modelling – and an *ex post* simulation of which an important integral part is constituted by repeated moments of feedback.
- *Self-reliant approach* (main requirements: reflexivity, self-organization, inclusiveness, iterativeness), an approach for which the built environment, its architecture, its relationships, must become "autopoietic" systems (Ireland, Zaroukas, 2015) capable of ensuring themselves an uninterrupted existence, also through a sequential and functional self-regeneration of their components, which are aggregated and split, leaving the intensity of the processes at all times in harmony with the system's unity and with the identity of its organization.
- *Error-friendliness approach* (reference requirements include: tolerability, correctibility, flexibility, adaptivity), an approach that involves being "well-disposed towards errors," which is to say not just "tolerance of errors" but also "flexible and friendly cooperation" with them, which produces, from error to error, a progressive "adaptive hardiness" of the system (Minati, Pessa, 2018). It has been seen that, in the very theory of the evolution of the species, the processes of evolution never involve eliminating errors and failures which, in fact, are an indispensable element of it (Nachtigall, 2015): a design factor that must become essential also in a renewed vision of the future performance behaviour of the technological systems of architecture and of the built environment.
- *Green Building approach,* which dialogues with the *Ecosystemic approach*, the *Light Resource approach,* and the *Life Cycle approach* (the main requirements include: durability, circularity, adaptivity, hardiness, resilience); a complex approach animated by the objectives of environmental, social, and economic sustainability, upon which it introduces, and appropriates, the demands of the Green Economy and of its Circular Economy pillar (SGGE, 2017).

It is an approach that directs the dimensions of *Designing* and of *Building* onto the strategies of green requalification and regeneration of the existing elements, of land protection, of the capacity for resilience, adaptation, and mitigation, of energy and bioclimatic efficiency, and of the circularity of resources (Tucci, 2018); by promoting, in the renewed ecosystemic conception of *Dwelling*, an ecological and green conversion of the cities, of architecture, and of ways of living, producing, and consuming (GCN, 2018); and by incentivizing an active role of all the players in these processes, from public administrators to the customers, designers, businesspeople, and final users: for a full affirmation of the most advanced technological and environmental culture of design.

Visions

We have built certain elements, in terms of key requirements and approaches of method, in order to attempt to provide a response to the final question: What does it mean, for a design animated by a profound technological culture, to build, looking forward, a vision for a more desirable future? I will try to answer in ten points, in the awareness that the following work outlines are less comprehensive than ever of the many possible lines of development:

1. it means having the courage to reacquire – albeit in conditions, for this reason, of "weak-statute" discipline – the role as "linchpin" in the complex process phases for understanding, guiding, and planning natural, behavioural, and organizational phenomena, in accordance with the spirit that, on the international level, animates the action, among other things, of the sectors of *Architectural Technology*, *Baukonstruktion*, *Technologie de l'Architecture*, *Construcción en Arquitectura*, which, in the various contexts, do not represent only a disciplinary setting (moreover, always highly multidisciplinary, interdisciplinary, and recently also infra-disciplinary) but also the logical and cultural dimension in which the complex articulations and the different design features are coordinated;
2. it means conceiving architecture in a multi-scalar and transversal sense, transcending the presumed "specificities" of the dimension of scale that have always encouraged a separation of design moments, from the detail to the component, building, neighbourhood, city, territory, and landscape, in order to reappropriate a holistic vision that has always been behind the conception – spontaneous or aware, informal or morphologically conceived, intrinsically inherent or scientifically instilled – of Quality and Sustainability in the design of the transformations of the built environment;
3. it means promoting the level of "ecosystemic efficiency" of the environment in which the intervention is made, in a global, widespread, and local sense at the same time, fostering its increase also of the degree of "ecosystemic effectiveness," or of the quality, quantity, and rapidity of exchanges that the trophic factors establish among themselves and with the other ele-

ments in the system, with respect to the resources put into play to implement them;

4. it means valorising the ability of the designed systems to adapt and interact, just as a real living organism does, with the variations of the external material and immaterial factors, augmenting the degree of stability – or, better, the ability to continuously construct new stabilities – in the dynamic processes of the constant interaction of architecture with its biophysical and environmental surrounding;
5. it means promoting the degree of safety and production of the designed system, which entails the dual need of "low vulnerability" (or a low degree of the system's damageability by an outside event) and of "high resilience" (or a high capacity of the system to recover from the damage suffered, and to restore the environmental and ecological balances);
6. it means maximizing the degree of "consonance" and accord between built environment and human requirements, also – aided by the neurosciences – in cognitive-perceptive terms, and, in the constant search for a biological balance, calibrated sensory stimulations, proper physical/bodily and psychological/mental functions, with respect to a framework of priorities of the needs of people in their inhabiting and building activities, a framework is to be placed among the focal aspects of design;
7. it means raising, as much as possible, the degree of "consistency" by which the form and availability of space, of means of communication, and of equipment of a habitat respond, in an ergonomic, anthropometric, and proxemic sense, to the intertwinement and the quality of actions that people normally make or are about to undertake; or the level of flexibility and of adequacy of the environments for present and future behaviours and activities;
8. it means promoting the degree of "justice," which is to say the way in which social and environmental costs and benefits are distributed among all the components of the dwelling system, and the way in which, conversely, they can access and exploit the goods and services produced. And, in a broader way, it means becoming promoters of arrangements of behaviours and interactions in society that programmatically and methodologically place more and more importance on the demands of participation, sharing, and inclusion of the users of the designed spaces, the users of the services and of the delivered performance, but also: of the customers which will have to be supported in defining the demand; of the regulators and public administrators who are to be accompanied in their guidance actions; and of the operators (producers, builders, maintainers) as potential protagonists of an important part of the achievement of an effective quality and sustainability in delivering the services and in implementing the design production processes;
9. it means optimizing the "ecological productivity" of the dwelling system that is the object of design transformation, which is to say the ability to pro-

duce and transform matter, energy, and information not only into *input*, but also into *output*, while at the same time maintaining firm the principles of reducing the resource consumption, maximizing the durability of materials and components, reuse, and recycling, and minimizing harmful emissions, or reducing them to zero; and to tend towards a circular arrangement of design, attentive to valorising its life cycles, and aimed entirely at enhancing its qualities of the ecological compatibility of materials, components, and technological/morphological systems employed – aspects that may at the same time lower its ecological footprint and raise its value and range of environmental quality;

10. lastly, it means, also in a complementary relationship with the previous point, arriving at a renewed vision – more responsible towards quality of life and more aware of the ecological/energy/environmental questions – in which technological culture appropriates all the demands of the future and destiny of the Environment, of which it becomes not only a support but also a bearing element; and in which the perception of the elements characterizing the balanced contribution to an improved life and environmental quality is based upon such concepts as reduction, separation, conservation, reuse, requalification, and regeneration, in antithesis to the dominant principles typical of the city and of "non-responsible" artificial settings: increase (in consumption, population, density), saturation (of spaces, of the built area, of services), dissipation (of energy, of resources, of the economy), and waste (of materials, of refuse, of primary resources).

It means above all not considering the ten visions above as factors unto themselves, separate from one another, but rather conceiving them as active parts of a strategic project that sees them as co-participants in the definition of future scenarios in which the processes of transformation of the built environment are informed, nourished, and characterized with the contribution of all those visions that the conditions of context and the surroundings will allow to be put into play.

In concluding this focus aimed at imagining, with a look forward, some of the possible future traces of Technological Design work, it may be useful to recall the words of Salvatore Dierna when, in the introduction to his courses at the faculty of architecture in Rome, he stated that designing and experimenting with the ethics of technological and environmental culture means carrying out that difficult, fascinating "balancing act" in treading the razor thin edge between the necessary and the superfluous, the pragmatic and the utopian, the real and the dreamed.

It is a fine outline for continuing to build together – as researchers, teachers, experimenters – the future of the Technological Design of Architecture.

References

Angelucci, F., Alfonso, R.B., Di Sivo, M., Ladiana, D. (2015), *The Technological Design of Resilient Landscape*, Franco Angeli, Milano.

Antonini E., Gaspari J., Boulanger Saveria, O.M. (2017), "Multi-layered design strategies to adopt smart district as urban regeneration enabler", in *IJSDP*, 12(08), pp. 1247-1259.

Auer, T., Melis, A., Aimar, F. (2017), *Disruptive Technologies. The integration of advanced technology in architecture and radical projects for the future city,* Wolters Kluwer, Milano.

Bologna, R., Rogora, A., Cafiero, G., Annunziato, M. (2017), "Salvaguardare il Capitale sociale e incentivare i processi di inclusione", in Antonini, E., Tucci, F. (eds), *Architettura, Città e Territorio verso la Green Economy*, Edizioni Ambiente, Milano.

Bosia, D. (2013), *L'opera di Giuseppe Ciribini*, Franco Angeli, Milano.

Buchanan, P. (2011), "Pioneering a New Paradigm", in Herzog, T., *Architecture+Technology*, Prestel Verlag, Monaco, London, New York.

Campioli, A. (2016), "Tecnologia dell'Architettura: un aggiornamento identitario", in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto,* Franco Angeli, Milano.

Cantrell, B., Holzman, J. (2016), *Responsive landscapes. Strategies for responsive technologies in landscapes architecture*, Routledge, Denver, GB.

Del Nord, R. (2016), "Potenzialità dell'area tecnologica in tema di ricerca progettuale", in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto,* Franco Angeli, Milano.

Dierna, S. (2011), "Perchè andare verso un'ecoefficienza in Architettura", in Tucci, F. (ed), *Efficienza ecologica ed energetica in Architettura,* Alinea Editrice, Firenze.

Eilenberger, G. (2018), *Reguläres und chaotisches Verhalten Hamiltonscher Systeme. Ferienkurs Nichtlineare Dynamik in kondensierter Materie*, Kernforschungsanlage Jülich, Amburgo.

GCN Green City Network (2018), *Linee Guida per le Green City*, SUSDEF Pubblicazioni, Roma.

Giachetta, A., Novi, F., Raiteri, R. (2019), *La costruzione dell'idea, il pensiero della materia. Riflessioni sul progetto di architettura*, Franco Angeli, Milano.

Hensel, M., Nilsson, F. (2018). *The Changing Shape of Architecture,* Routledge, London.

Haken, H. (2013), *Advanced Synergetics*, Springer, New York.

Herzog, T., Steckeweh, C. (2010), *StadtWende. Komplexität im Wandel*, Jovis, Berlin.

Ireland, T., Zaroukas, E., (2015), *Actuating (Auto)Poiesis*, Bertalanffy Center for the Study of Systems Science, Emcsr Publishing, Wien.

Losasso, M. (2019), "Produrre il progetto nell'era digitale", in Mussinelli, E., Tucci, F., Lauria, M. (eds) (2019), *La Produzione del Progetto*, Maggioli, Santarcangelo di Romagna.

Lucarelli, M.T., Mussinelli, E., Daglio, L. (eds) (2018), *Progettare Resiliente*, Maggioli, Santarcangelo di Romagna.

Manzini, E. (2018), *Politiche del quotidiano*, Edizioni di Comunità, Ivrea.

Minati, G., Pessa, E. (2018), *From Collective Beings to Quasi-Systems*, Springer, New York.

Nachtigall, W., Wisser, A. (2015), *Bionics by Examples*, Springer, New York.

Pallasmaa, J. (2011), *Lampi di pensiero. Fenomenologia della percezione in architettura*, Pedragon Edizioni, Bologna.

Perriccioli, M. (2017), "Innovazione sociale e cultura del progetto", *Techne*, n. 14, FUP, pp. 25-31.

Reuter, W. D., Jonas, W. (2013), *Thinking Design Transdisziplinäre Konzepte für Planer und Entwerfer*, Birkhäuser Verlag, Basilea.

Russo Ermolli, S. (ed) (2018), *The Changing Architect*, Maggioli Ed.

Schiaffonati, F. (2017), "Per una centralità della figura dell'architetto", *Eco Web Town*, n. 16, vol. II.

Schumacher P. (2011), *Autopoiesis of Architecture*. John Wiley & Sons, Londra.

SGGE Stati Generali della Green Economy (2017), *La Città Futura. Manifesto della Green Economy per l'architettura e l'urbanistica*, SUSDEF Pubblicazioni, Roma.

Tucci, F. (2018), *Green Building and Dwelling. Approaches, Strategies, Experimentation for an Environmental Technological Design,* Altralinea, Firenze.

Vidal, R., Ma Y., Sastry, S. (2016), *Generalized principal component analysis*, Springer, NewYork.

Von Bertalanffy, L. (2004), *Teoria generale dei sistemi*, Mondadori, Milano [nuova ed.].

Von Weizsäcker, C. (2010), "Fehlerfreundlichkeit", in Kornwachs, K. (ed), *Offenheit Zeitlichkeit Komplexität. zur Theorieoffener Systeme,* Campus Verlag, Francoforte.

PART 1.

DEMAND FOR SERVICES, OFFER OF COMPETENCES

VALUES, CONTENTS AND PROJECT ACTORS
IN THE NEW ORGANIZATIONAL MODELS OF THE BUILDING PROCESS

1.1 ARCHITECTS' TRAINING AND PROFESSION: CURRENT STATUS, TRENDS AND PERSPECTIVES

Ernesto Antonini, Pietromaria Davoli*, Massimo Lauria**

Abstract

The context surrounding architectural projects in Italy is heavily influenced by the role and strategies of clients, the legal framework and the dynamics of the building sector. There are furthermore certain peculiarities that define the design market when compared to the European situation: from the number of architects to restricted overall revenues in the construction sector, from the marginal role that is usually given to design to unsolved issues in the organisation of training. The disciplinary debate posits and focuses on several critical topics that are highlighted here through a critical reading of the many contributions that have been collected.

Keywords: Architect, Project, Profession, Market, Training

Architects in Italy

One of the many factors that influence the production of a project in a substantial way is certainly that of the role of designers, main actors in the process. Their professional profile, the conditions within which their work is carried out, their workflow all have relevant effects on the features of the service they provide, namely the project itself, and, even more, the product that is the result of it – architecture. In Italy, an important source of data in regard to this is the Osservatorio "Professione Architetto" *(Observatory Architectural Profession)*, a periodical inquiry by CRESME on behalf of the Consiglio Nazionale degli Architetti, Pianificatori, Paesaggisti, Conservatori *(National Council of Architects, Planners, Landscape architects, Conservationists)* (CNAPPC and CRESME, 2016). It was last updated in 2014 and thus does not give information on the last four years, however it highlights certain tendencies that are surely useful to understand medium-term trends.

---

* Ernesto Antonini is a Full Professor at the Department of Architecture of the University of Bologna, Italy, ernesto.antonini@unibo.it.

* Pietromaria Davoli is a Full Professor at the Department of Architecture of the University of Ferrara, Italy, pietromaria.davoli@unife.it.

* Massimo Lauria is an Associate Professor at the Department of Architecture and Territory at Mediterranea University of Reggio Calabria, Italy, mlauria@unirc.it.

For a comparison at the European scale, the Architects' Council of Europe (ACA-CAE) gathers information from professionals registered to associations in the 26 EU countries and publishes yearly (Architects' Council of Europe, 2019). As elsewhere, in Italy the role and strategies of clients, the legal framework and dynamics of the construction sector heavily influence the context surrounding architectural projects. However, our country presents certain peculiar aspects that differentiate our market for design from other European situations. First of all, the number of architects: there are more than 150,000 registered architects in Italy, that is more or less a quarter of the 600,000 working in the whole European financial zone (EU countries + 5). That means that in Italy the ratio is 2.5 architects/1.000 inhabitants, compared to a continental average of 1 architect/1,000 inhabitants, which falls to 0.8 architects/1,000 inhabitants when considering just the remaining countries, Italy excluded. This spike in the number of Italian architects has occurred in the last thirty years: in 1986, with 40,000 members in the professional register (that is 0.6 architects/1,000 inhabitants), Italy was in line with the average of other European countries. The dramatic increment was registered in the following fifteen years, with a 6% yearly increase rate that led to double the number of members (thus 93,000 in 2000) and an another 50,000 units increment in the fifteen years after, with still positive trends, although less substantial (+3.4% a year in 2005-2010 and +0.8% between 2012-2015).

This dynamic was induced by both a parallel growth in the number of students enrolled in university for architecture training and of the number of architecture graduates which however, after peaks of over 13,000 enrolled per year in 2006/2007, fell by 50% in the following 6 years to 6,000 units/year in 2013/2014 and showed a declining trend in the years after. Such a substantial influx of professionals has had a significant impact on design services, pushing the quota of architects being commissioned up to 15% compared to the average European level, which is below 10%. Despite this supposedly favourable situation, the huge number of operators in the field (over 150,000 individuals and more than 70,000 studios) reduces the average yearly income pro capita to circa 19,000 euros (data 2014), which is 30% lower than the European average (29,000 €/year) and immensely less that the almost 45,000 €/year income of Dutch and German architects. Although the different scanning methodologies do not allow for direct comparisons, the results of the ACE-CAE survey in 2018 point out that there have been changes in the last four-year period: while the number of Italian architects is stable at 160,000 units, studios are little more than 41,000 (55,000 were originally registered in the 2016 ACE-CAE inquiry in 2016), and have an average yearly revenue of 35,000 € which is still however significantly below the European average of 65,000 €/year.

The contraction in total revenues for the building sector, which decreased by 35% in the decade between 2008 and 2018, dramatically exacerbated the phenomenon.

At the same time, a second peculiarly Italian phenomenon must also be taken into account, that is the presence of 200,000 other professionals (engineers, surveyors, building experts) whose roles are confused and, in many cases, largely overlap with that of architects. This leads to a hard, and at times unfair, competitive environment - also due to the absence of adequate normative restrictions in regard to the services that can or cannot be delivered – which takes a toll on the nature of earnings and adds limitations to job opportunities for architects. A coherent new set-up of professional competences in the design sector (the existing one for engineers and architects is regulated by an almost century-old law: the RD2537/1925) that would cure an evident and all-Italian paradox, has been called for many times but never seriously considered by political and institutional bodies.

Since the “Architect’s Directive” (85/384/CEE) defines the essential competences needed to practice in the EU, in this contradiction lies an inconsistency between the requirements the Directive imposes on the training courses to be EU-compliant (that is, in Italy, the degree courses within the LM4-class), and what Italian authorities expect individuals without these requirements or training to have in order to carry out almost all the activities specific to architects.

As well as their extremely high numbers and significantly lower income, the profile of Italian architects also shows further important differences compared with European trends: in Italy there are more practicing women (43% as opposed to 39% in the EU) but the average age is higher (the number of over-45-year-old practicing individuals is nearly 60% in Italy as opposed to 54% in the Europe); a quarter of Italian architects work part-time (25% as opposed to 19%) and only 67% full-time (EU average is 77%); almost all are in very small offices (1-2 people: Italy 90%, EU 84%). Given the circumstances, it is hardly surprising that Italian architects have negative expectations in regard to the development of their activity for 2019: according to the ACE-CAE survey, only 25% expect an improvement while another 25% foresee a decrease with the remaining half not expecting any significant change compared to 2018.

These predictions are in opposition to average EU data, with 32% of European architects expecting an improvement of their work volume and only 17% a decrease (mostly in Finland and the Czech Republic).

Project and training

The situation that emerges from this data suggests it is necessary to study further certain issues that have certainly contributed to – and still contribute to – the creation of several critical aspects, which have negatively influenced average architectural quality recently. Above all, the so-called crisis of the architectural project, caught between the ambition to regain centrality within the building process and the marginal role, which it is often forcefully given.

This crisis – whether it be real or only perceived, or the result of deep transformations taking place – is confronted with several factors, both external and internal, that are evidently closely connected with the role that the designer is assigned in the context of the contemporary project production process of the project. Such factors include:

- the extensively structured, unstable and ever-changing normative framework, a growing (as of today, the CNA estimates this percentage is 5% of total commissions) but yet not so common use of architectural competitions as a tool to commission projects;
- the inadequate technical capacities of clients who need to control complex processes such as the construction of demand, project validation, and manage realisation;
- the presence of powerful production companies who do not usually share their knowledge and know-how regarding the developed project, thus transferring a share of the decision process outside the architectural studio.

If the project is going through a crisis, it is also because the architect himself is living a radical change of working responsibilities. This fracture is clearly deeper than positive statistical reports reveal regarding the current professional condition. According to AlmaLaurea 2018's report, 87,3% of graduates from five-year Master courses in Architecture and in Construction engineering and Architecture are employed within 5 years of graduation, with the first job coming after 5.8 months, compared to the 7.0 month-average expected for any second-level graduate to find a job (AlmaLaurea, 2018).

These changes are related not only to statistics regarding occupation but also to fields of interest and skills. The previously mentioned Osservatorio Professione Architetto that the CNAPPC instituted with the technical collaboration of CRESME, highlights that aside from traditional activities (drafting of technical-financial reports, cost estimation documents, engineering tests, cadastres, consultancies for court authorities, occupational safety and health, fire prevention work, ease-of-access in regard to physical barriers, administrative activities, etc) innovative aspects of the job are growing, such as feasibility studies and design, project financing, facility management, design of energy technologies, energy performance certification, GIS and BIM systems, and 3D modelling. The workflow has also changed. The digital revolution as well as management and control systems have determined a radical break from traditional approaches, to the great disappointment of great architects of the twentieth century. At the same time the parallel introduction in architecture offices of finance-related and managerial work have both turned studios into service-providing companies, in line with an ever-growing tendency to consider professionals as service providers rather than for their intellectual labour. However, the provision of services implies a standardisation of processes, which, for a professional activity such as that of the designer, would seem in the opinion of many to conflict with the civic and social role that should define the profession.

Moreover, it all too frequently appears to lead to a type of competition based on the lowest bid. According to the Associazione delle Organizzazioni di Ingegneria e Consulenza Tecnico-economica (Engineering and Technical-financial Organisations' Council), in 2017 the average decline in payments for intellectual services in the public sector was around 40.7%. How hard this hits the appeal of the architect as a professional figure is hard to say. To give an idea, a first indication is the number of enrolled students on degree courses in Architecture in 2018, that showed a further decrease in comparison to the total 7,211 places available in Italian universities. Of 7,986 enrolled, only 6,779 actually took the admission test. Of these only 5,720, that is 84.38% of the total, made it to the national ranking list, as opposed to 97.95% in 2017 and 96.83% in 2016. From these statistics, it would seem there is a need for renewal, starting from the rethinking of the didactic offer. The training of an architect at a national scale, as much in 3+2 courses (L17 Architectural Sciences + LM4 Architecture) as in the 5 year-cycle (LM4 Architecture), has mostly focused on maintaining the last ten years' didactic approach toward an all-around preparation. It has left out of learning programmes the knowledge and disciplines that are necessary to train specific profiles to be ready for of working environments. The issue here cannot be oversimplified with an antithesis between specific and general knowledge. Architectural training has been deeply influenced by this dichotomy and has thus become a measure (and perhaps also a reason) for this generalised crisis in the profession's vocation. The skills mastered by graduates are seen by AlmaLaurea as insufficient. In fact, 71.6% of graduates carry on education with postgraduate training, in particular by starting voluntary collaboration with professors, experts, professionals, etc (34.5%), work placement in companies (27.3%), internships (21.6%) but also professional training courses (17.3%). In this context, the state exam for architects rightly seems to be one of the issues that should be reconsidered. An initial analysis of the offer of the educational system/expected competences and requirements/professional activities and approaches brings up several critical topics that deserve further investigation. This should also be carried out through a critical analysis of the main topics in contemporary disciplinary debate, which the many contributions collected here allow for.

Demand for services, competences supply and new professional skills: a few answers from the Technological Area

When a debate is initiated around specific topics within a scientific community, the contributions lead to a series of results that can trace a reliable and strategic sample of thought regarding the current trends and an exemplary, although certainly not thorough, showcase of the state and focal points of interest in disciplinary discussion and its reactions to the specific theme.

Such insights outline a synthetic overview of certain dynamics that can possibly be identified between the market and training in the field of project production.

In regard to the demand for design services, the first topic being the analysis of priorities, strategies, instruments, approaches and subsequent effects, there is growing interest concerning the opportunities of participated projects in the transformation of the built environment. This is a well-known approach, that today shows new features due to new models of associating specific and developed competences in order to confront specifications of feasibility and enhance the proactive dimension of the process.

A much-needed regeneration process in terms of implications and efficiency of design competitions should be aimed at creating a more effective tool in order to generate demand for services, an improved understanding of the needs of the client and to stress the relevance of competition procedures, thus seen as an undeniable element in the decision-making process and a privileged research instrument in regard to fully satisfying the needs of the community. In Italy this operative tool is struggling and constantly looking for new formulas to overcome administrative hurdles in the public sector where winning, after the hard work of those who participated, does not mean building.

With the global construction market as a context, a second topic is a further analysis of how the organisation of supply and production of projects has evolved in terms of size, layout, and competences of design organisations. It is evident from such an analysis that there is an urgent need to balance an overwhelming and often distracting focus on technical tools that runs parallel to the design process as well as a call to give new added value to intangible resources (coordination, collaboration, workflow between involved actors, etc). The result is an increased interest towards the demand and supply of rating-system competences that can produce through guided procedures new directions for multidisciplinary sustainability. As tools required by clients for general assessment, such systems are now also more efficient supporting structures to control the complexities of the project. They allow us to imagine promising achievements such as, above all, performance-based protocols that introduce requirements in terms of resilience and climatic mitigation at different scales.

The European policies encouraging Public Administrations towards Green Public Procurements, as well as the Italian norms regarding *Minimal environmental criteria* in the matter of design services and tendering of public works, open up new important scenarios.

Life Cycle Assessment, embodied energy, circular economy, products containing recycled materials, environmental certificates for products and so on, all entail a significantly specialised training of technicians-designers to speed up the promotion and checking processes that are needed to meet such requirements. The integrated and holistic supply of professional skills in the growing field of green design and green building is still totally inadequate.

The same can be said for resilient and adaptive urban design in the context of the sudden strains, as well as for long-term mitigation actions against climate changes.

Besides, the issue concerning the elaboration of projects inside Universities is still under debate. With the goal of a more incisive so-called *third mission*, many hope that academia will also be able to put its resources back into action and apply the potentials of scientific research to architectural projects, thus contributing to cultural, social and financial development through a more direct and productive link to the country and its operators.

It is therefore necessary to interrupt the current practice of university project services being offered to public institutions via anomalous, almost undercover, forms of consultancy.

The necessity to encourage the creation of a two-way technological transfer is related to this issue, given the rather weak model of collaboration in our Country. Which requires an intensified bond between second-level university education offer and both industrial production and corporate sectors. This is intended to establish systemic connections for education and work aimed at training researchers and, specifically, at the production dynamics of architectural projects.

Another aspect, regarding new professional figures, should take a relevant position: the role of the "Responsabile Unico del Procedimento", i.e. the principal manager of a procedure, for public tenders. From a merely administrative figure, as it was originally, it today must be seen as a versatile project manager, who can tackle the complexities of the actors and competences involved. This individual's role must have decision-making power in planning and in managing the development of the project and processes as a whole, through the lens of multidisciplinary management techniques.

The explosion in the number of expert BIM-system modelling and management professionals undeniably leads to a few considerations. Beside the important regulations, new fast-developing opportunities are emerging especially in the management of complex processes such as those of sanitary structures, in the reuse and regeneration of the existing heritage, and in the strategies and content of energy and environmental assessment for a project. BIM as a tool to support designs and a way to upgrade the critical decision-making skills of architects, does, instead, ring like an alarm when it is reduced to a mere instrument and ultra-specialist technical tool for informatics management.

In regard to a third topic, that of encouraging the study of the demand for new professional skills with which to feed the project process, the priority is to generate an extended and interdisciplinary sphere of competences, as has very rarely happened in the past. As most of the technical aspects can be brilliantly solved, the most interesting challenges will be at the level of transformations of organisational models that are able to influence and control the building process in new ways.

It is evident that not all the critical issues of the digitalisation process can be solved with the competences of the BIM Manager or of the BIM Coordinator, however undeniable and innovative they may be. The theme is more complex and yet to be thoroughly investigated. In particular, that of the BIM approach to design in connection to other enabling technologies, as well as that of the production of the Programmed Maintenance project 4.0 which adopts, with the goal of improving predictive capacities, the opportunities given by Big Data, by a constant sharing of information and by the Internet of Things.

References

Alma Laurea (2018), *XX Indagine Condizione occupazionale dei Laureati*, Rapporto 2018.

Architects' Council of Europe (2019), *The Architectural Profession in Europe 2018. A Sector Study*, ACE-CAE, Brussels.

CNAPPC, CRESME (2016), *Osservatorio professione Architetto 2015. Quinta indagine congiunturale sullo stato della professione in Italia*, CNAPPC/CRESME, Roma.

1.2 THE ITALIAN DESIGN MARKET FROM THE POINT OF VIEW OF THE SUPPLY

Aldo Norsa[*]

Abstract

In Italy, the design market is not properly balanced. The supply of professional services suffers for at least two reasons: clients (especially public administrations) impose low prices and limited times for the production of design documents; contractors consider these documents not enough binding and try imposing alterations to modify in their favour the contract conditions. Thus, Italian design firms need to develop into fully organised and managerial entities in order to improve their contractual strength and resist these pressures, following the example of the countries where a better organised system attracts the most brilliant Italian talents. This essay presents the "state of the art" (quantitative and qualitative) in the design industry and discusses how to strengthen it facing the global competition.

Keywords: Architectural services, Project entrepreneurship

Demand and supply

The quantitative analysis of the Italian design market is hindered by the fact that most surveys emphasise the public (better officially documented) rather than the private sector. Moreover, the national research bodies are traditionally keener on demand than on supply due to the macroeconomic and political nature of the recommendations which they derive from the analysis.

The purpose of the study presented here (a synthesis of the yearly Report on the Construction, Architecture and Engineering Industry edited by the author and published on www.guamari.it) is to fill this gap in national research: focus on the supply of A/E design services, in this essay with special emphasis on architecture (and industrial design).

Basis of the information and comments that follow is a yearly survey of the annual reports (balance sheets and statements) of the largest firms, which in Italy are officially deposited at the national firms' registry and made available online.

The top 150 firms in each category (architecture and engineering) are included in a list, completed by their addresses, which is the basis for presenting

[*] Aldo Norsa is a Full Professor at the Università IUAV of Venice, Italy, yaxmo@tin.it.

the whole array of the design industry, with special emphasis on the most internationalised firms, and discussing development trends, market positions, strategies for diversification both in services offered and in markets served.

Year after year, the quantitative evidence shows that the Italian supply of A/E design services is much more fragmented (and, especially in architecture, dominated by firms which derive from individual professional practice) than in most of the countries against which Italy competes. The evidence comes first from the national market where, according to the surveys of the architects' and engineers' national associations, less than one third of the value of public contracts is awarded to companies while more than 60 percent of this amount goes to private professionals. The fragmentation of the offer (specular to the fragmentation of the demand) is especially true of architecture (and industrial design), rarely confronted with building projects of great size, whereas engineering can count on the opportunities of large infrastructures and industrial settlements.

The size of the Italian market

As far as demand is concerned, the Italian market, according to the latest calculations of CRESME, *Centre of economic and social building market research*, in 2018 was worth 171.1 billion euros (see figure 1). However, this number refers to "production", thus including not only the amount of works performed and professional services provided but also the value of products installed. Subtracting from the total value of production the amount of works referring to the specific activity of "maintenance" (including installation of products not requiring specific design services) the market of real direct interest for the A/E services is reported by CRESME in terms of "investments" with a total value of 132.5 billion euros, which is further to be reduced to 119.3 billion euros if the investments in infrastructures, of no interest for architects, are not taken into account. Moreover, the market of real interest for architectural firms is substantially related to new building construction and, in 2018, has been limited to 31.4 billion euros (15 residential, 16.4 non-residential), much inferior to the dominating market of "retrofitting" (of interest to many technical professions besides architects), typical of a country like Italy where the median age of the building stock is in the order of 40 years!

If we estimate that on the average 10 percent of the total building investment is dedicated to architectural services, an "educated guess" would attribute to each of the 150 Italian architects members of the official professional order a yearly revenue of just some 20 thousand euros (similar to the estimates by CRESME).

Obviously, the real incomes are higher (as, for instance, other than strictly design activities, and all abroad not counted) and they are enhanced for all professionals working in companies able to provide a larger and better paid range of services. Thus, the recommendation is to develop the corporate side of the profession starting with alliances and m&a (mergers and acquisitions), betting on a national market which promises growth: plus 4.6 percent the amount of calls for bids published in 2018 according to OICE (the association of A/E companies), and even more enlarging the scope of work and prospecting further foreign opportunities.

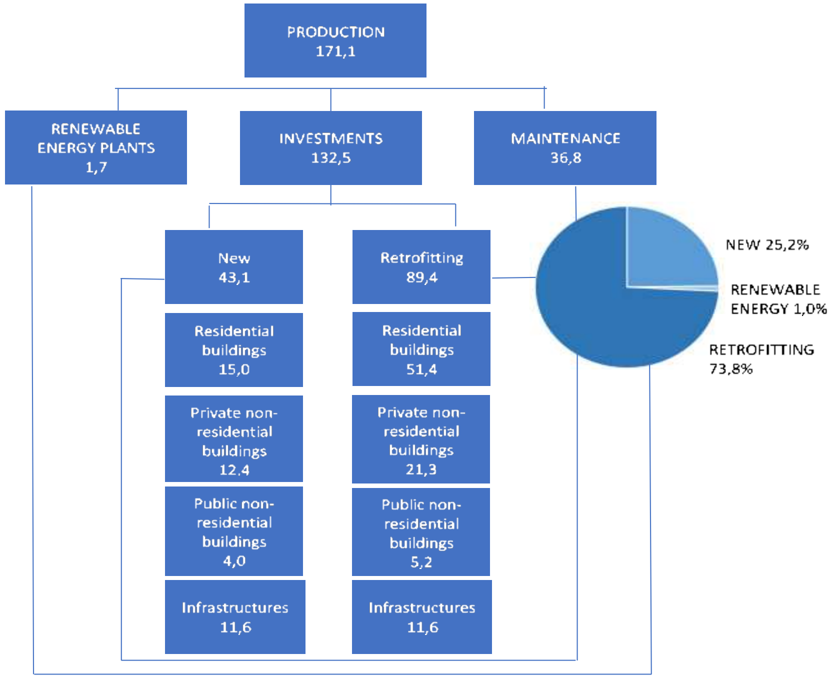


Figure 1 - The Italian market: demand (source: CRESME).

Trends and scenarios for the profession

Strengthening the Italian profession is not only crucial to win in the global market but also to fight a *brain drain* which weighs on the resources deployed in an expensive and valuable national education system. A strong supply of design services is in the interest of a country which badly needs to improve its liveability and the quality of a built environment stemming from an exceptional heritage.

Organising the profession with an entrepreneurial attitude is the right answer The better performing organisations (which should set a “benchmark” for all the others) offer services of better quality (and thus profitability) for these main reasons: 1) guarantee clients when projects are especially large and complex; 2) favour interdisciplinary cooperation; 3) can afford bigger investments (for instance in digitalisation); 4) can promote “external growth” combining complementary skills; 5) aspire to become “export champions” through projects promoting “made in Italy” especially in interior contracting. How the top Italian players succeed in these endeavours is discussed in the following paragraph.

The top players in architecture

The sum of the 2017 turnover of the top 150 Italian engineering firms (including the most important active in industrial besides construction markets) and the top 150 architecture (and industrial design) firms (limited to the building market) is 2.5 billion euros: dominated by the engineering firms which declare a total turnover of 2.1 billion. This turnover is 8.7% higher than in 2017 and includes approximately 1/4 of services sold all over the world: with 57 top engineering firms and 41 architectural firms declaring operating through foreign subsidiaries. Separating architecture from engineering services, the top 150 Italian engineering firms declare a total 2017 revenue of 2.1 billion euros, 8.5 percent up from 2016 thanks to a share of more than one fourth of international turnover. EBITDA is 15.2 percent higher than the past year and net profit is confirmed 76.4 million euros (with just 12 firms showing a net loss). Net debt amounts to 62.7 million while 2016 was marked by a net cash of 52.1 million. As far as equity is concerned, it has grown by 17.4 percent. However, the size of the Italian competitors remains severely inadequate to the international competition: the revenue of the national leader, Italferr, is 46 times smaller than what declares the world champion, the American Jacobs!

The top 150 architecture (and design) firms are more than six times smaller than the engineering ones with just 348.2 million euros revenues (plus 9.9 percent and 21.6 percent abroad) but they look generally healthier in economic and financial terms (not thanks to a less competitive environment but due to the better possibility of keeping costs under control). EBITDA and net profit show important increases: 16.9 percent and 34.2 percent, net cash is confirmed but decreases by 7.7 percent and equity grows by 13.7 percent.

Reversing to a combined analysis of the supply of project services, the geographical distribution (figure 2) shows the dominance of the two “capitals”: Rome and Milan, the latter especially for architecture (and industrial design), adding an interesting concentration of engineering firms in the region of Veneto, while Southern Italy has practically no major firms.

Figure 2 - Geographical distribution of Top 150 Engineering Firms and Top 150 Architecture Firms (Source: Report 2018 on the Italian Construction, Architecture and Engineering Industry).

Professional highlights

Limiting the analysis to the market of architecture intellectual services, unlike the engineering sector (spanning through infrastructures and industrial facilities), the firms which are studied operate in the realm of building, with occasional attention to the larger scale (urbanism) or the smaller (products and interiors). Out of 150 listed (with a minimum 2017 turnover in excess of 700 thousand euros) the main distinction is between firms that rely on recognised, “creative” authors and those which choose an anonymous brand (although creativity generally remains a distinction and marks a competitive advantage). A glance at the “top ten” (accounting for one fourth of the top 150 output) shows how “designed in Italy” has achieved international importance. For the second year One Works is the Italian leader with a size (21.5 million euros) more than thirty times that of the last firm in ranking. Founded by Leonardo Cavalli and Giulio De Carli, it has made a reputation starting from the sector of transports (especially airports) with important contracts in the Middle East. Second is Rpbw (Renzo Piano Building Workshop) which develops the intuitions of the world most famous Italian architect: it would rank first (61 million euros) if its balance sheet took into account the production (45 million euros) of the two main offices outside Italy (in France and in the USA) which is four times as important. Third is Lombardini22 (first in terms of domestic turnover: 11.5 million euros) specialising in office architecture, with a special emphasis on interior design (with the brand Degw, originally British but now fully Italian) and in association with Cibic Workshop, a creative brand. Fourth is Progetto Cmr (founded by Massimo Roj) which has grown at the fastest pace also thanks to a diversification in the design and build activity. Fifth is Cremonesi Workshop (Crew), the firm which, so far, adds most engineering content to its building design, very successful in the Middle East and recently bought by Italferr. Sixth is Giugiaro Architettura, the first of three major firms (followed by Pininfarina, in the process of rejoining the exclusive auto brand, and Bertone) originating from the specialty of car design renewed focusing on buildings (namely interiors). Seventh is Archea Associati, founded by architect Marco Casamonti. Eighth is Hydea, a firm highly specialised in retail design with an important branch in China promoting the "Italian style". Ninth is Gpa, another example of firm where engineering services go hand in hand with architectural ones, especially active in luxury and fashion facilities. Tenth and eleventh are Citterio Viel Interiors and Partners, two author driven firms with the same property, specialising in design and architecture at the top level, known for its emphasis on "liveability": their combined 2017 turnover amounts to 12.5 million euros. The remaining firms in this list often bear the names of famous Italian architects and designers and shine for their "glamour" well above their size. In decreasing order of revenues, we find Patricia Urquiola, Matteo Thun, Mario Cucinella, Michele De Lucchi, Piero Lissoni, Marco Piva, Stefano Boeri, Alfonso Femia, Carlo Ratti, André Straja, Massimiliano Fuksas, Massimo Iosa Ghini, Gianmaria Beretta, Paolo Garretti, Cino Zucchi, etc. When, on the contrary, the authors prefer to "hide" behind anonymous names of firms, generally chosen to appeal to fantasy, the "pecking order" is: Piuarch, Open Project, Archilinea, Genius Loci, Ipostudio, Design to Users, Leonardo, Open Building Research, Gruppo Thema Progetti, etc. As far as foreign famous architects are concerned, only the British David Chipperfield, among the "starchitects", is still active with an Italian office not to mention the French Jean-Michel Wilmotte, whose subsidiary is too small for our ranking. Others have closed their offices preferring to work from their home base: notably, the British Norman Foster and the late Zaha Hadid, the American Daniel Libeskind (from whose office the firm Sbga – Blengini Ghirardelli was born), the French Jean Nouvel. In addition, an important role is played by two subsidiaries of British firms: Chapman Taylor Architetti and Design International. It is also worth mentioning Andrea Maffei Architects, representing the Japanese Arata Isozaki.

Other comments refer to added skills to the core activity of architecture which can be found in a number of firms in the top 150 list. Starting with the array of engineering services (and management) which are offered by firms in closer contact with contractors and developers than it is traditional for architects: the already mentioned Crew, Hydea, Gpa, Starching, General Planning, Tekne, J+S, Archest, Aegis Cantarelli, etc. Another field of interest is much less common than abroad: landscaping. Only two firms stand out in our list as entirely specialised: Land Italia, Ag&P Greenscape. Finally, a field of specialisation which is developing in its own right is the conception of hospitals; from the architecture perspective stand out: Binini Partners, Ipostudio, ATIproject, Valle 3.0, Cspe, etc. Finally, m&a are not yet common among architectural firms with a very few exceptions: Lombardini22, after incorporating Degw, has allied with Cibic Workshop, J+S was born from the merger of Jps and Sering, H&A Associati was created by Hyd Architettura and ArkaAssociati, etc. For its importance, a recent development stands out, the acquisition of the majority of Crew by the engineering (and procurement) firm Italferr, belonging to Fs Group (State railways).

Architecture Groups

When examined in the international competition, it is better to assess the real size of the few Italian groups operating through significant foreign branches (adding the relevant turnovers of firms under their control when officially consolidated financial reports are not available). This particular unofficial list sees Rpbw at the top thanks to the turnover declared by its Paris office (including New York). One Works is second thanks to its success in the Middle East, Citterio-Viel, adding to the architecture and interiors activity the work of its branch in New York reaches the third place and Lombardini22 is fourth. Other firms operating with more brands are: Progetto Cmr (active in China), Lissoni (with Lissoni Architettura, Lissoni Associati, Graph.X and a New York branch) and Matteo Thun (Matteo Thun & Partners and Mtlc). While Crew and Hydea are the only two firms in this particular list releasing balance sheets which consolidated subsidiaries respectively in the Emirates and in China.

Specific “niches”

The Italian scene is appreciated worldwide for a number of renowned (industrial and interior) design firms, which are the real “engine” of supply of an array of consumer goods, often exported in “turn-key” contract solutions, by firms having developed from manufacturers to “fit out” contractors.

If the majority of exported goods is furniture with all related furnishing, buildings (starting with offices, hotels and residences) are not the only destination: for instance, structures for leisure and shows; yachts and ships are also an important target.

A list of the top 20 creative design firms (bearing in mind the width of the above-mentioned markets) successful in consumer-oriented, fashionable and "trendy" facilities is also published: their total 2017 turnover amounts to 41.1 million (1.8% more than in the previous year). In furniture and interior design Citterio Viel is followed by Patricia Urquiola, Design Group Italia, Lissoni, Baciocchi (formerly participated by the fashion group Prada), Retail Design, Simone Micheli, Paolo Badesco, Bertone Design, Emme Elle, Design International, Sadler, Studio Cerri. A particular "niche" is lighting with only one major specialist: Metis, while Hangar is focusing on brand design and Giò Forma on stage design. The conception of yachts and ships (engineering the exterior and designing the interior) is the common expertise of Zuccon International, Francesco Paszkowski, Officina Italiana Design, Hydro Tec, etc.

Conclusions

If the pace of growth of the Italian top architectural firms will continue at least at the average 10 percent a year recorded in our Report, the prospects for the Italian young generation of professionals will improve (also considering that the peak in the number of graduates was reached some three years ago) as they will be able to develop their skills without having to expatriate. The performance of the Peninsula will be enhanced by further internationalisation and by a long-awaited trend of mergers, acquisitions and diversifications. Architectural firms will be able to better drive Italian exports having the size and the qualifications for more sophisticated and value-added projects.

1.3 THE PROFESSION OF THE ARCHITECT IN THE VUCA SOCIETY

Paolo Mezzalama[*]

Abstract

Today's society is composite, shifting, fluid and chaotic. If, as we believe, architecture is a reflection of society, as such it must express society's full complexity. Observing other fields, such as those of high tech, economy, medicine and design, teaches us that hybridisation between different spheres of knowledge produces innovation.

Keywords: Architecture, Profession, Hybridisation, Society, Evolution, VUCA

A group of researchers from the Zoological Society of London recently travelled to Panama to study the social life of local bees, using innovative technology to trace and monitor the movements of 33 different colonies over a period of 6,000 hours. Their discoveries put paid to the centuries-old stereotypical beliefs about the habits of these social insects. For example, the possibility that worker bees might cross the boundaries that separate one colony from another, leaving the beehive of their birth to move to another hive, was considered an incongruous idea, because the native bees in the new colony would quickly drive away the stranger bee, killing it should it refuse to leave. This conviction had never before been called into question.

Recent technological innovations used to trace both the movements of single bees and their system-making using different disciplines, have made possible a change of paradigm, generating a way of monitoring the traces of traffic between one hive and another. There was no lack of instruments to answer the question: it was the question itself that was lacking, that could be made through the overlapping disciplines and technological innovation. It was discovered that 56% of bees change hive over the course of their life, and do not simply move to other colonies as temporary visitors, marginalised, but as members of the adoptive community, gathering food and tending to the honeycomb like the indigenous workers themselves. The hives that were subject to the research were found unexpectedly to be mixed populations, with native insects and immigrant insects living together, becoming, at least to the human observer, indistinguishable from each other if it were not for the electronic identifiers.

---

[*] Paolo Mezzalama is a founder member of the architectural studio It's, Roma, Italy, paolo.mezzalama@its.vision.

This social model is being studied by researchers evaluating potential applications within the regulation of migrant flows in the international civil society (Bauman, 2007).

Such a tale illustrates the potential of overlapping disciplines for technological innovation and the hybridisation of knowledge, capable of generating radical changes of perspective on unexpected themes and creating new living models for contemporary society.

Premise

Today's society is composite, shifting, fluid and chaotic. If, as we believe, architecture is a reflection of society, as such it must express society's full complexity. Observing other fields, such as those of high tech, economy, medicine and design, teaches us that hybridisation between different spheres of knowledge produces innovation. At the moment one of the businessman who most personifies the path of hybridisation is Elon Musk: the man behind Paypal (online payment), SpaceX (aerospace), Tesla Motors (automobile industry), Solarcity (solar energy for buildings), Halcyon Molecular (biotechnology in medicine) and Hyperloop (transport). For example, he designed a car battery designed to be used in the house as well.

Architecture and the construction supply chain cannot but be influenced by these changes.

The world of construction is one of the few sectors not to have made significant progress in the last fifty years. If we look at other sectors, evolution is striking: the basic rationale of telecommunications has been overturned several times in a period only a few years: today new generations chat rather than talk and an application such as Snapchat bases its success on the speed of communication derived from the evolution of technological networks to the extent that text, images and videos are viewable for a matter of seconds only.

Uber, in the transport services sector, has wiped out many accepted systems with considerable consequences on the world of employment: responding to the needs of people who require part-time or temporary jobs, without the necessity for particular qualifications.

At the basis of Uber is an application that very quickly rendered obsolete the entire management system of traditional taxi services; forcing the latter to address the problem by adapting themselves to the market with innovative working tools.

The automobile industry in the post war years still had a marked artisanal component that today, thanks to automation, has practically disappeared.

If we look at these changes, we see that many have occurred by means of the integration of know-how from apparently different areas.

Today FCA, Fiat Chrysler Automobiles, is collaborating with Google to produce a self-driving car: a carmaker has hybridised with a company whose core business is the search engine with the aim of revolutionising its own product and launching (as a joint venture) a new business model: a Waymo self-driving taxi service (Biondi, 2018).

On closer inspection, this mix of knowledge, the integration of different disciplines, is causing and will increasingly cause a further market evolution, in other words the passage from a product economy to a product-service economy. To return to the example above, it is the business model of FCA and all the big automobile manufacturers. Automotive does not aim at car sales alone but at all the associated services. Not by chance has the company created its own bank, the FCA Bank, not only to manage purchases by means of financing and leasing but also long-term hiring and a full package of further services including insurance and personalised services aimed at the client etc.

The principle is straightforward: if I hybridise different sectors, not only does the product evolve but it sets off a chain reaction that results in the creation of a vast number of innovative and *tailor made* services to meet the needs of today's society.

The construction sector

The construction sector has not changed its modus operandi a great deal in recent years. There have been changes in some tools and technology, and certain countries are more advanced than others, but today the city is designed and built more or less as it was in the sixties, years when the Western world saw the growth of speculation and cities expanded very fast indeed. If we look at what has happened in other sectors it seems clear that building is also due to undergo radical change. Over the next few years, the construction world must confront different market requests. With the exception of some large cities, property prices are no longer in constant increase and the purchasing power of 80% of the population in the West is in sharp decline. This translates into the need to optimise the supply chain and call into question the principle by which a traditional developer buys an area with a particular designated use, carries out the project and then puts it on the market; the operation concluding with the purchase of the property. Today we must rethink building projects and work towards new business models. New generations are no longer able to buy unless at a very low cost. What is more, new generations are mobile; they move or tend to move more frequently, and their requirements will change. In western societies (but not only) we must also adapt ourselves to provide for a generation of people who will live longer and must deal with a part of their life when their costs are high but their professional income is low because they have retired.

What product and services can I offer these people?

New players in the property sector

It is interesting to observe how today some figures that are apparently external to the traditional property supply chain are entering the world of real estate with economic capacities and hence notable investment.

To give an example, Ikea no longer purely offers products for the house but sells the houses themselves and lately has forged links with developers in India and China to build low cost residential areas aimed mainly at millennials who buy products from the Swedish company. Added to which, Ikea - again by setting up alliances with big real estate groups - has moved into the business-to-business market, producing ad hoc pieces of décor and furniture to meet local demand (Tandon, 2018).

Another interesting example is Airbnb. The American company recently launched the project Backyard: using its know-how about short lets, drawn from the client data gathered over the years, today it is putting forward new living models destined for the lettings market, optimised both from the point of view of product and services (Gibson, 2018).

These are the first visible signs of a radical change of approach to the housing supply and it is interesting to note that they do not come from the traditional property business but from companies that have a different core business: Ikea sells furniture and Airbnb has created a platform to manage short lets. Once again, we are faced with an example of hybridisation between apparently unconnected sectors.

The impact of digital data on the construction industry

Many of the transformations that involve our society today are based on digital data and the new tools deriving from the digital revolution.

These transformations obviously involve the construction world. The use of digital tools is already quite widespread when it comes to optimising construction costs and the industry value chain. One of the tools that is having a significant bearing on the system is BIM, Building Information Modelling, to cite one of the changes that have been most talked about in the last ten years. But today the phenomenon is marginal and in our sector the passage from product economy to product-service economy still meets resistance, underlining the fact that the sector is in absolute terms one of the most conservative.

The role of the architect’s profession

Today architects are once again at a crossroads: a possible option is that of closure and self-protectionism.

This tendency is widespread in the field and in recent years has already led to a loss of power for our profession. In Italy in particular, the profession no longer influences the country's strategic decisions, or the planning of a real policy of urban development, and no longer manages to impose the necessity of building high quality and popular architecture.

On the other hand, the alternative approach is to embrace the social changes that are taking place, make room for the new requirements of citizens, study the new models of economic development that are becoming established and put forward solutions that can have an effect on the real estate supply chain in its globality. This latter route, although complex, is the only feasible one if we want to avoid delegating the development of our territory to large multinationals like Ikea and Airbnb.

Conclusion

In order to re-invent a sector, we need to look at what is happening in other disciplines and establish exchange relations with them that can be profitable on both sides. Hybridisation is an opportunity for growth. And hybridisation is also an important key to reading today's society, which tends increasingly to eliminate the barriers between different fields of knowledge and consequently between the various sectors of the market. In the 90s it was the world of High Technology that ran with this idea, resulting in new forms of product that melded contents and container: the iPhone being the icon par excellence. By means of the first smartphone on the market, Apple created a product that was able to receive and manage services.

If the architect's profession wishes to survive the evolution of society and steer development policies for our territory, it must absorb the abovementioned changes and once again position itself at the centre of the transformation, like the conductor of an orchestra, ready to manage a chain of construction that will become ever more complex.

Side note

Coined in 1987, the acronym VUCA was used to describe general conditions involving Volatility, Uncertainty, Complexity and Ambiguity, as part of the language of American military academies in the post Cold War world.

Today, for many organisations belonging to military and educational fields but also business in general, VUCA describes the ability to read and understand the context in order to put forward innovative solutions that are coherent with current social changes (Wikipedia, 2019).

References

Bauman, Z. (2007), *Le vespe di Panama*, Laterza, Bari.

Biondi, A. (2018), "FCA rafforza l'alleanza con Google", *Il Sole24ore*, 18 January, available at: https://www.ilsole24ore.com/art/finanza-e-mercati/2018-01-30/fca-rafforza-l-alleanza-google-215654.shtml?uuid=AENf8UrD (accessed December 2018).

Gibson, E. (2018), "Airbnb's Backyard initiative to roll out house designs in 2019", *Dezeen*, 4 December, available at: https://www.dezeen.com/2018/12/04/airbnb-backyard-initiative-samara-housing-prototype/ (accessed December 2018).

Tandon, S. (2018), "IKEA has a plan to get Indians to actually buy its furniture", *Quartz India*, 15 October, available at: https://qz.com/india/1419410/ikeas-india-plans-include-tie-ups-with-real-estate-developers/ (accessed December 2018).

Wikipedia (2019), "Volatility, uncertainty, complexity and ambiguity", available at: https://en.wikipedia.org/wiki/Volatility,_uncertainty,_complexity_and_ambiguity (accessed February 2019).

1.4 THE DEMAND FOR QUALITY IN ARCHITECTURE: PROJECT COMPETITIONS

Valeria Ciulla, Alberto De Capua**

Abstract

The necessary condition for a good architecture is the support of an adequate procedural framework. The organisational modalities of an Executive Project and the planning tools that put the project competition in place are of particular importance. Currently, public architecture is the result of administrative decisions: pivoted on economic criteria, these decisions often result in construction interventions whose quality is close to zero. With a rigorous methodical approach, the shift from the planning phase to the actual project are analysed in their procedural and operational aspects; legal and normative aspects are also taken into account. Therefore, the competition procedure is proposed as an effective method of planning-project.

Keywords: Quality of Architecture, Planning, Project competition, Innovation

La qualità della domanda nel progetto

The construction of a public building, the changes that it provokes in the urban fabric, the implications it produces in the ecosystem, its ability to meet the social needs of its time, are all expressions of the evolution of a society in a given context. Bernard Huet believes that "since public spaces must have a regulating function, their shapes cannot depend on an isolated concept, or on a subjective creation" (Huet, 1999). Architecture should be the expression of actual needs, and call therefore for a conscious commission from the part of public administration. Already in 1945 Pier Luigi Nervi wrote:

> «it is more than justifiable to consider the building activity as the most significant expression of a people's ability, and the most relevant element to judge its spirit and its degree of civilisation. It is clearly impossible to elevate the building activity to the point that every construction becomes a work of art. […] Set it would be of great moral, economic and social importance to orient our architecture towards the fulfilling of the following characteristics: a good economic performance, seriousness and aesthetic

* Valeria Ciulla is a PhD at Mediterranea University of Reggio Calabria, Italy, valeria.ciulla@unirc.it.

* Alberto De Capua is an Associate Professor at the Department of Architecture and Territory at Mediterranea University of Reggio Calabria, Italy, adecapua@unirc.it.

> rigour, technical correctness; we are way too often far from this ideal today. In order to address our architecture towards such goal it is indispensable to make the client (especially if it is a public administration) understand the importance and delicacy of their function and their implicit co-responsibility in the final result» (Nervi, 1945, translated by the authors).

Though it was formulated in a cultural and historical period determined by social and urban needs which are radically different from our own, Nervi's proposition surprisingly fits the contemporary scenario. The international debate over housing quality and the requalification of urban peripheries have strengthened the idea that new organisational models are needed in the building process, and that the public administration and the actors who side it have a transversal role in every phase of the process. Within the demand cycle the client, as an organisational entity, has the following duties:

- to clarify in a correct and detailed way it needs and the expected performance levels of the intervention;
- to verify the congruence of the architects' and firms' response to such needs.

The project in fact, as a central productive event in the building process, is the final result of a decisional process: more precisely, it is the moment in which the demand is formally converted into the offer of services. Similarly, due to the importance of the project as a crucial determinant of the quality of the intervention, the management of this phase (i.e., of the formalisation and expression of demand) and of the subsequent phases of monitoring, directing and valuation, are fundamental in ensuring the correctness of the project itself, and the social and environmental value of the resulting architecture (Clemente, 2000). The concept of project quality in the building process has changed over time: while, initially, quality concerned primarily outcomes and outputs, today it pushes towards the qualification of productive organisations themselves. The shift from product quality to the qualification of project and management processes calls for the mediation between the client and the different actors that partake in the project itself and that determine its quality. Moreover, the client needs to consciously address the complexity of the contemporary building process, in order to properly exert its directing and monitoring functions: this need is reflected in its duty to formulate the demand for quality with definitional effectiveness, by codifying it in clear and exhaustive planning documents. These matters have always characterised industrial projects and planning, that is of design, where the success of the product has always been determined by the right answers to right questions[1].

In the specific sector of architectural project and planning, it is therefore necessary to activate an innovative discussion over the identification of demand.

---

1 See, in this respect, Nicola Sinopoli's and Attilio Nesi's interventions in Tatano, 2007.

The opportunity of competition procedures

The physical configuration that is to be produced after a demand is not the duty of the technical bureaus of administrations; quite the reverse, it has to be handled by the architects, especially through dialogue and mediation among different project proposals in the context of competition. Since the client/administration often lacks the adequate competences to define more than one project solution at a time, a path of planning/decision/project/actualisation need to reconsider the utility of competition procedures, provided that it aspires at pivoting the decisional process on the project.

The project competition often provides alternative solutions, whose level of detail is that of a preliminary project (a technical and economic feasibility project); by doing so, it pertains to the planning activity, and is clearly a modality of demand formulation which is based on an ex ante valuation. In addition, the competition modality promotes architectural quality as it stimulates professional improvement, competitive updating, and the search for innovative solutions[2]. Moreover, this particular historical moment is particularly favourable for reconsidering competition among the so-called "good practices". The Framework Law on architectural quality acknowledges the architectural competition as an adequate tool to tackle the physical, functional, social and environmental decay of the built environment. Article 1 of the aforementioned Law states that:

> «As a fulfilment of Article 9 of the Italian Constitution, the Republic promotes and protects the quality of architectural ideation and realisation, as it recognises its particular public relevance, also for the purposes of landscape safeguard, sustainable development and improvement of the urban environment's liveability and of the quality of life. […] Public administrations, in the context of their respective competencies and the ordinary resources that are devoted to such aim, pursue the following goals:
> - to promote the project quality and the quality of the architectural work;
> - to promote architectural competitions, especially in the form of competition of ideas and of project competitions, for the planning and project of interventions;
> - to promote the participation of young architects to architectural competitions» (translated by the authors).

The architectural competition has been practiced for a long time. Ever since the Renaissance era, in Italy, the competition of ideas among architects has allowed the realisation of many important buildings and architectural complexes.

In 1401 a competition was called for the realisation of the door of the Florence Baptistery which marked the debut of Brunelleschi in the world of architecture.

2 See, in this respect, the "trilogy on architectural competitions", referred to in the "References" sections and consisting of the following volumes: Giannello et al., 1999; Pizzolato, Varagnolo, 1999; Missori, Varagnolo, 2000.

This practice was subject to a decline until, in the past decades, it almost entirely disappeared, because of the crisis which has characterised the architectural sector in Italy; this has led to an architectural culture almost entirely centred on economic criteria. In the context of public works, in facts, the normative framework – developed through the political scandal known as "Tangentopoli" – has limited competitive procedures to a narrow range of interventions: this was not meant to satisfy the architectural quality of buildings, but rather to respond to the need of the Public Administration to contrast corruption and speculation phenomena through rigidly normed procedural aspects. For this reason, procurement contracts were preferred to architectural competitions; the former, in facts, selected the best project manager/architect and the best economic offer, while the latter selected the project directly and without mediations. Similarly, the old "De Lise" Code allowed different procedures to entrust the project, and it set two economic criteria, that of the most advantageous economic offer and that of the lowest price, as the criteria for establishing the winners of competitions in the form of open and restricted procedures, and of competitive dialogue. Currently, the Legislative Decree n. 50 of 18th April, 2016 (Code of Public Contracts, updated by the Legislative decree n.56 of 19th, April, 2017 – the so called Corrective Code) updates and regulates the competitive procedure in articles 152, 153, 154, 155 and 156. Regarding competitions, the European Community has emanated the EU Directive 18/2004, stating that "Project competitions are procedures aiming at providing the client with a plan or a project in the sectors of territorial planning, urban planning and architecture". This dictate asserts in an unequivocal and decisive manner how competitions *are* – rather than *can be*, or *are among* – the procedures for attributing projects. From what has been stated above, it is clear that the administrative and political praxis in Italy still has not fully understood this statement.

The competition procedure can play a significant and decisive role in placing the "building programme" into being, and in providing depth to its contents – the building programme being the final, dialectic and fundamental moment of the project. What is relevant here is an approach to competitions as an important part of the decisional process, that is a substantial insight in planning choices and, subsequently, an ordinary procedure with a strong innovative vocation for the actualisation of transformative interventions. In particular, it is necessary to synergistically combine a place's tradition and peculiarity with actions that are strongly innovative from a twofold perspective: from the environmental and the landscape perspective, and from the perspective of the architectural language. This is to be achieved with a constant attention to the public interest of places and spaces, since project way too often result from compositional exercises that are totally extraneous to communities' needs in both languages and functions. The competition procedure, reversely, allows for qualitatively satisfying results, which are aligned with the requalification of public space and of architecture in general, as they are claimed by the citizens: research is an intrinsic feature of competition, as it results from the mediation and dialogue of different professional expertises; as such, it can be a great opportunity (Gallione, 2008). Differently from what has occurred in recent history in different European Countries, where competitions have progressively become not only a legal prescription but also a cultural choice, in Italy competition is still thought of as a costly and complicated procedure. In order to favour competition practices in public interventions different actions have been put in place, which aspire at mitigating local Administrations' difficulties in handling the competition procedures. Among such actions is the programme "Qualità Italia – Progetti per la qualità dell'architettura"[3], created by the Ministry for Cultural Heritage and Activities and Tourism (MiBACT), and the platform Concorrimi, developed by the Association of Architects of Milan.

From the Preliminary Document of Planning to the Document of Project Management

In the context which has just been outlined, criticalities lie in the absence of a tool able to transfer programmatic choices to the architectural choices: something which translates in the project phase the urban and architectural quality that are outlined in the planning phase, the latter being the weak node of the building process. An updated and renewed Preliminary Document of Planning (DPP hereon) could serve the purpose. DPPs, in facts, are the fundamental tool to bring the planning activities to completion, while aptly setting the subsequent project phases. DPP, together with «every document that is necessary to the drafting of the project»[4], helps the client communicate with the architects and project managers, providing guidelines on how to operate to develop the intervention drafted with previous feasibility studies. Therefore, DPP is a planning tool whose elaboration calls for an accurate selection of the information emerged throughout the planning phase, and which is therefore able to condensate the indispensable elements for a good understanding of the project needs and actualisation. Moreover, it is a "plural", evolving document, which indicates "what" and "how" the process of a project ought to be done; as such, it can be considered a project in itself (Gallione, 2008; chapters 2 and 3). The update of DPP, which has long been used by public Administrations, is a necessary and inevitable step: first, for what concerns the contents of the documents; second, because of the communication modalities and the definition of the document itself (Bedrone, 2004).

---

3 The programme, resulting from a joint action of the Ministry and Regions, aims at spreading the practice of project competitions as a guarantee and a place for dialogic encounter to realise quality public works. Moreover, it aspires at providing local Administrations with financial and technical support throughout the actualisation of competitions.

4 Article 14 of the Regulation of Legislative Decree 163/2006.

Recently, the aforementioned Legislative Decree n. 50 of 2016 has introduced some relevant innovations regarding DPP. The reorganisation of the planning and project phases has determined a revision of the contingent documentations. More specifically, in order to "satisfy the needs of communities", the scheme of the regulative decree introduces the "Framework of exigencies". Such Framework aims at "ensuring the correspondence between the planned interventions, the needs of communities, those of the administration and of the users", while allowing the architects and project managers to be fully aware of these needs, of the project goals and of the tools to achieve them. Article 3, comma 1 of the draft decree states that the institutions which call the competition are in charge for elaborating the Framework of Exigencies, as indicated by article 23, comma 3 of Legislative Decree 50/2016, to be published on the institutional sites of administrations. Article 3, comma 2 of the draft decree highlights different aspects which the Framework needs to feature: the general objectives to pursue; the needs the project aims to address; the specific qualitative and quantitative needs to be satisfied; possibly, the potential project alternatives. Article 3, comma 4 of the draft states that the administrations calling the competitions need to craft the Document of Project Management (Documento di Indirizzo alla progettazione, DIP hereon) which need to specify the features, requisite and project documents that are necessary for defining the different project levels, in accordance with the Framework of Exigencies.

The DIP should clearly state: the state of places, the objectives to be pursued, the technical requisites that the intervention should satisfy, the possible project guidelines, the financial limitations to be respected, the realisation system for the intervention; the selection procedure of the competition, the selection criteria, the type of contract.

> «The Framework of Exigencies and the DIP, therefore, orient the project management in order to ensure the quality of the process and of the project, concerning the technical rules, the safety principles, the economic and environmental sustainability, finding the balance between global costs and benefits of the building, maintenance and management […] and with reference to the lifecycle costs of the intervention» (article 3, comma 1, translated by the authors).

As a consequence, both documents implement the interrelation between planning and project that is necessary to the pursue of architectural quality. The decree further enumerates sustainability among the principles to be followed. The update achieved by the Decree has furthermore eliminated the professional role of the "Planner", which had been introduced by the De Lise Code, but was never truly used, thus delegating to the Responsible of Procedures (Responsabile Unico del Procedimento, RUP hereon)

> «the task of drafting the executive and definitive project in its technical and economic feasibility. External entities can be identified as supporting roles to the RUP in their coordination and monitoring activities over the project, without prejudice to the exclusive pertinence of the project to the architect» (Guidelines n.1, implementation of the Legislative Decree of 18th April, 2016, n.50, "General guidelines on the dele-

gation of services in the domain of Architecture and Engineering, Translated by the authors).

The "Planner" could have operated throughout the whole process, mediating between the language of architects and that of the Public Administration; it could have provided technical, historical and cultural insights on the processes of competitions (since the "Planning and programming and project management of public works – Title III of the Code of Contracts), and to subsequently shift to the specific management of competition processes. The role of RUP, as it has been outlined by Legislative Decree of 18th April, 2016, n. 50, will have bureaucratic control over procedural praxis. As indicated by the State Council, new modifications will have to be put in place in the new code, especially concerning the Title III - Planning and programming and project management of public works. It will be necessary, for instance, to elaborate the Framework of Exigencies according to an "analysis of needs" which will also be able to provide guidelines for the drafting of the "Document of feasibility of the project alternatives" (Gallia, 2017). In conclusion, in this historical moment, in which an important normative update is occurring, what is here proposed is to reflect on the complexity of the management of decisional fluxes, and on the necessity of a correct codification of the normative reference framework for a good project production.

References

Bedrone, R. (ed) (2004), *I concorsi di architettura. Manuale di programmazione*, Alinea, Firenze.

Clemente, C. (2000), *La progettualità della committenza. Ruoli e attività di assistenza per la qualificazione del processo edilizio*, Edizioni Kappa, Roma.

Gallia, R. (2017), *Programmare e progettare. La fattibilità tecnica ed economica delle infrastrutture*, Legislazione Tecnica, Roma.

Gallione, M. (ed) (2008), *Il manuale di buona pratica per le opere pubbliche e il concorso di progettazione*, Di Baio editore, Milano.

Giannello, M., Piazza, A., Varagnolo, M. (eds) (1999), *Obiettivo concorsi l'Architettura della qualità*, EdicomEdizioni, Monfalcone.

Huet, B. (1999), *Tre questioni a proposito della forma urbana*, Alinea, Firenze.

Missori, A. Varagnolo, M. (eds) (2000), *Concorsi di Architettura. Decalogo Nazionale*, EdicomEdizioni, Monfalcone.

Nervi, P.L. (1945), *Scienza o arte del costruire? Caratteristiche e possibilità del cemento armato*, Edizioni della Bussola, Roma.

Pizzolato, G., Varagnolo, M. (eds) (1999), *L'Europa dei concorsi prassi e proposte normative in architettura*, EdicomEdizioni, Monfalcone.

Sinopoli, N., Tatano, V. (2002), *Sulle tracce dell'innovazione. Tra tecnica e architettura*, Franco Angeli, Milano.

Tatano, V. (ed) (2007), *Dal manuale al web. Cultura tecnica, informazione tecnica e produzione edilizia per il progetto di architettura*, Officina Edizioni, Roma.

1.5 THE IMPACT OF SOCIAL DEMAND ON THE PROJECT: THE INCLUSIVE LIVING FOR VULNERABLE PEOPLE

Genny Cia, Marzia Morena*, Ilaria Oberti*, Angela Silvia Pavesi**

Abstract

The Law 112/2016, "Dopo di Noi", includes measures to allow parents to deal with the future of their disabled children. To support the implementation of the legislation, Senator Annamaria Parente, rapporteur of the law, with Foundation for the Innovation of the Third Sector (Fits!) promoted the creation of Officina Dopo di Noi Committee, in order to raise awareness of legal instruments, including housing. In the Law, the housing theme is central both as instrument for the implementation of independent life projects, by social housing, and for human and social experience, that are represented by living. In this project, in order to identify the best housing solutions for the different inhabitants' needs, it was necessary to restart thinking about living.

Keywords: Disability, Life project, Social housing, Collaborative living, Social manager

Overview/Foreword

A detailed picture of the disability phenomenon is provided by ISTAT through a survey on health conditions, which showed that individuals with disabilities are about 3.2 million, of which 2 million and 500 thousand are elderly[1]. In 55.5% of the cases people are severely disabled, of whom around 30% are under 65. As regards assistance and aid received, about half do not receive aid from public services, do not use paid services, nor can they count on the help of non-cohabiting family members. The burden of assistance is borne entirely by cohabiting family members.

---

* Genny Cia is a PhD Student at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, genny.cia@polimi.it.

* Marzia Morena is an Associate Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, marzia.morena@polimi.it.

* Ilaria Oberti is an Associate Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, ilaria.oberti@polimi.it.

* Angela Silvia Pavesi is an Associate Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, angela.pavesi@polimi.it.

1 ISTAT (2017), Note on the Law "Dopo di Noi". Much of this information were presented to the Social Affairs (2014) Committee of the Chamber of Deputies and Labor, Social Security (2016) Commission of the Senate as a support for the discussion of draft laws on the subject.

Focusing on the approximately 52,000 people who live alone, always with less than sixty-five years, 23% use public assistance (health care and socio-health care) and 15.5% pay for home care. This is the context in which the Law n. 112 of 25th June 2016 is inserted, containing «Disposizioni in materia di assistenza in favore delle persone con disabilità grave prive del sostegno familiare» known as "Dopo di Noi". The law aims to promote well-being, full social inclusion, emancipation from the family and the autonomy of people with severe disabilities, without family support, and offers resources and incentives to encourage support paths for residents in houses or group of apartments able to reproduce the housing and relational conditions of the family home. It also aims to implement innovative residential interventions for people with severe disabilities without parental support (Faiella, 2016). The law provides for public and private tools: borne by the institutions, a Fund which offers the severely disabled without family support, the resources for interventions aimed at avoiding institutionalisation; to families, tax incentives to plan a life path and allocate resources to disabled people, including through trust instruments, restrictions of destination and philanthropic funds. In reference to housing autonomy, the Fund has the purpose to activate and to strengthen the programmes to increase awareness and develop skills for managing daily life activities and achieving the highest possible level of autonomy. It is necessary to underline that the data currently available, deriving from both administrative sources and statistics, do not allow to identify with precision the audience of beneficiaries of Law, not only in quantitative terms, but above all in qualitative terms: disability, also that, even when serious, is presented as aggregate data. It is essential to distinguish the different forms of disability in order to delineate the areas of application of the law, for experimenting life projects for "Durante e Dopo di Noi" through appropriate interventions supporting living services, pushing research towards collaborative models that can adequately satisfy even the most vulnerable users. During the legislative process, it has been hypothesised that most serious disabilities affecting the 65 year-old population is determined by aging and/or senility-related diseases and that parents over sixty-five have greater difficulty in supporting the care and assistance activities. These hypotheses have led to the inclusion in the audience of the potential beneficiaries only the serious disabled people under the age of sixty-five who live alone and live with elderly parents, considering a total of about 127,000 individuals. Subsequently, an estimate was made based on the hypothesis that the life expectancy of people with disabilities is the same for the rest of the population, with the same gender and age. Therefore, it is estimated that in the five years 2016-2021, about 12,600 individuals will lose the possibility of being assisted within their own family unit. The Fund for assistance to people with severe disabilities without family support, whose budget for the two-year period 2016-2018 is over 180 million, is aimed at creating and strengthening an adequate "Dopo di Noi" service infrastructure for these people.

"Dopo di Noi": collaborative living as an opportunity for inclusion and social housing as an instrument

In the "Dopo di Noi" Law, the house theme is central both for implementation of social housing projects: open, inclusive and widespread in the territory, and for the human and social experience of living. The sense and the feeling of belonging to community became objectives to be achieved through living and places like home and the neighbourhood; they are incentives to experience collective belonging. The needs of a specific user must be able to become collective, just as it is important that the process for the construction of the living space provide for the inclusion of the individual project in the overall size of the city (Martinotti, 1993). These social dynamics reopen the discussion about the meaning of living and housing policies. Therefore, a new semantics of living and social housing emerges and introduces among its prerogatives the generation of social value (Housing Europe, 2003). The unprecedented demand for housing is composed of a variety of needs and types of residents that requires not only differentiated responses, but also an integrative and inclusive social context (Zaccaria et al., 2018). In this historical period, housing policies shall relate to social policies in order not to generate exclusion and the intensification of economic and social poverty (Morena, 2014).

In Italy, the current response to housing demand is the evolution of a centralist welfare model. It was generated by a regulatory framework, started in 2008, and triggered a profound change in the social housing sector, using private economic resources in order to provide a "service of general interest".

The definition of social housing construction (in Italy, it is defined as Edilizia Residenziale Sociale - ERS) began to take shape, by amending the Anglo-Saxon rules and meaning. The Italian social housing underlines a paradigm shift from the past and emphasises two main aspects: what is the purpose of social housing? who is the service of general interest addressed to? Social housing includes all interventions realised by the joint between public and private subjects and satisfies the social right to housing of individuals and house-holds that are not able to access the free market. It is a new path that integrates the quantitative (requirements) and qualitative (needs) approach, with an emphasis on the forms of cooperation between public, private and third sector, according to the project financing model. In this context, Italy is experimenting the Integrated Fund System, a form of Private Public Partnership (profit, non-profit and third sector organisation). By adopting project financing logic, it triggers a process of privatisation (off-balance sheet investments of the public sector), financialisation (ethical real estate funds) and socialisation (design and technical-social management) of the interventions in the residential sector (Lakatos, 2018). A new culture originated, representing an important experimentation of inclusive housing (simple/light, assisted, co-housing, housing community) for disabled people, because of the Design for All approach, which proclaims the human right of all to be included (Oberti, 2017).

There is a need to rethink the housing typology, which must no longer be governed by the search for a productive uniformity identifying social equality, but oriented towards a plurality of design and management approaches that respond to needs formulated by users with articulated and different characteristics, summarising the concept of social inclusion.

The repercussions on the design process are identifiable in the transition from a design method focused on the residential product to participatory design processes focused on support services for the customisation of building and context (Niemeijer et al., 2010).

This principle defines the profile of the community and generates the premise of maximum flexibility and adaptability of housing solutions, especially in the presence of vulnerable users.

By overcoming the antithesis of mass production and mass customisation, the process of sustainable development and management of housing stock becomes "suited" to social impact. The new processes underway highlight the transformations that affect three particular classes of stakeholders and relationships that are established between them with respect to the macro areas that define the quality of living: the methods of use and ownership (property), the support services (facility) and the dimension of sociality and social inclusion (community).

The first interlocutor, probably the most relevant in strategic terms, is represented by financial actors, such as social housing funds, which through a mix of public and private resources have accumulated a "patient" capital to make sustainable housing projects to respond to a double need.

On the one hand, the inclusion of vulnerable people, as they are part of the increasingly large "grey area" that is neither part of the market supply nor of public housing, on the other, social cohesion is an integral part of the housing project both in structural terms (e.g. by providing common spaces and the adaptability of houses to the changing needs of their inhabitants) and in the management of the social component by enriching the offer of services and the methods of use.

From this point of view, the low profit and/or impact approach and the medium/long term orientation of the financial lever represent the conditions of sustainability so that the value chain of social housing is able to incorporate on a stable and continuous basis objectives of inclusion and social cohesion (Zaccaria et al., 2018). From here, an in-depth analysis emerges, related to both the need to build production strategies that have as their fundamental basis the maximum cooperation between the various figures involved in the process, and to the importance to be attributed to the maintenance phase of the residential assets on the part of users. Not least, the issue of identifying the levels of customisation that can be implemented, from the apparently simpler ones that make the home more "intelligent" thanks to the introduction of equipment and systems capable of performing partially or completely autonomous functions, to those that have impacts on the construction process, to adapt and integrate construction elements, components, if not systems (Di Sivo, Angelucci, 2012).

In order to better direct and coordinate customisation interventions, the “technical-social advisory” activity in the start-up phase of both the community and the construction process, and the “social management” activity in the phase of accompaniment to living and long-term management, both of the community of inhabitants and of the built environment (requiring therefore figures with specific skills), assume a role of absolute importance.

“Dopo di Noi”: already started residential experiences

In the design of new forms of housing for Lifetime and “Dopo di Noi”, the configuration of housing did not only come from technical or health factors, but also from assessments on living space quality. Among the factors that support living in conditions of fragility, the context can have a strong impact on the success of the project (Liat et al., 2018).

For people with disabilities, in fact, it is not enough to have a house, but a context to promote autonomy and emancipation is needed, such as the provision of services, the liveliness of the neighbourhood, the presence of inclusive territorial contexts (Owen et al., 2006).

The OASI project, generated by the collaboration between the company USL Distretto di Bologna, the Public Company for Personal Services (ASP City of Bologna) and the Municipality of Bologna, offers housing opportunities that enhance the autonomy of people with disabilities, guaranteeing equal opportunities, dignity and confidentiality.

The ASP City of Bologna has made available an entire building, consisting of seven apartments and common areas that can be managed in a way shared by the inhabitants. The cohousing project makes use of the educational support of AIAS (Italian Association of Spastic Assistance).

AIAS has mainly the task of putting together the resources and needs of the different people involved in the path, activating customised solutions and promoting virtuous paths, in a housing experience based on the optimisation of welfare resources as well as environmental and energy. The project was launched in 2016 with an inter-institutional agreement, then took shape with the search for people with disabilities who could be able/wanted to live in the same building in a form of co-housing.

Some of these people work, and therefore have an income, others have an accompanying/retirement allowance. “Oasi” is a new experience capable of going beyond mere logic of welfare and institutionalisation, integrating the urban environment and the frailest people: through the support of services, the associations of the third sector, and mainly of the community.

Another example of collaborative living is represented by the social housing intervention “Cenni di Cambiamento” in Milan, which gives children with disabilities the opportunity to create independent life paths.

The project is known and represents the first social housing project in Italy (Ferri, Pacucci, 2015): inaugurated in 2013, it is highly innovative from many points of view, including the technological one[2].

Inserted in a monofunctional urban context and with a limited presence of aggregating poles, the complex consists of 123 rooms of different sizes, in energy class A, and a series of collective welfare services and recreational and cultural spaces, with the aim to create the optimal conditions for the formation of a network of good neighbourly solidarity relations. The architectural project, strongly oriented by the community project, is based on an idea of mixed development and on the consideration that a typological variety of housing may correspond to a social variety. The value of the public space as a ground on which to build relationships is the basis of the intervention: a green space, a symbol of sustainability intended not only as an objective to be pursued, but also a cultural value to be shared and an element of aggregation and development of services to live. The continuity between the private dimension of the accommodation and the public dimension of the open spaces is well expressed in the terraces and loggias, elements of plastic characterisation of the volume, but above all the expression of a relationship between inside and outside, between the life of the individual and that of the community. The recipients of the intervention are new families, both singles leaving the family of origin, and young disabled people, placed in a highly inclusive context.

Another multi-stakeholder project born to meet the needs of autonomous life is “Palestra autonomie” in Reggio Emilia, created with the collaboration between Mountain Union of Municipalities of Reggio Apennines, the associated educational social service of Reggio Apennines - disabled area adults, Coopselios, the Foundation “Durante e Dopo di Noi”, ENAIP (Ente Nazionale ACLI per l’Istruzione Professionale), the social cooperative Il Ginepro and Kilowatt (incubator and facilitator). These subjects have started a year-long participation path aimed at promoting the self-sufficiency of adults with disabilities and their inclusion in public life[3]. After a first phase of individualised knowledge and planning, conducted by a multidisciplinary team, a plan of interventions was formulated where all the actors were involved in a common path towards the autonomy of the recipients of the project. The building process in this case goes beyond the social project and is managed by a subject present throughout the activation process of formal and informal collaboration networks throughout the territory. Through the development of shared working practices and methodologies, we want to overcome the concept of assisted living, for a light living supported by mutual exchanges with the community of reference.

2 It is, by size, the largest residential project built in Europe with a system of load-bearing wooden structures made of cross-laminated panels.

3 The project started thanks to the support of the Regional fund for non-self-sufficiency of Emilia-Romagna Region and the contribution of the Ministry of Labour and Social Security through the Fund for non-self-sufficiency.

The multi-stakeholder network represents an expansion of the construction process chain and communicates with the designers in a dynamic and non-predefined way. A benchmark model in terms of both scalability and inclusion for people with severe motor disabilities is “Orbassano 2” in Turin, promoted by the Cooperative Giuseppe Di Vittorio with the “Group to help and support the housing problems of people with serious disabilities”. It is financed by a public-private partnership: Fondo Abitare Sostenibile Piemonte; Investire Sgr; CDP Investimenti Sgr e Compagnia di San Paolo (VV.AA., 2018). The project includes 96 accommodations, 74 of which are permanently leased and 22 for sale and includes 10% of the apartments specially designed for users with motor disability problems. Compared to the functional and social mix, there is a further specialisation of users, with a double challenge: that of the total use of space and the sustainability of a tailor made project. In the project team, the financial subjects, the designers, and the cooperative of inhabitants as the social manager have collaborated in an integrated manner, since the advisory and metaproject phase. The result is well represented by the functional-spatial project: the complex includes areas for re-educational activities and technological “islands” for micro-laboratories of art and music; disabled accommodations include rooms for support staff. The complex takes on the dimension of the inclusion of disabled people at the neighbourhood scale, in a place conceived totally without barriers, obstacles and separations. The project foresees collective places of relationship and common activities such as terraces equipped with urban gardens, a multipurpose space with co-working area, a video room, and a gym for physiotherapy rehabilitation. This intervention, like “Cenni di Cambiamento” in Milan, makes use of the figure of the social manager: the same cooperative of inhabitants Giuseppe Di Vittorio, promoter of the intervention, carries out the building and facility management activities for the maintenance of the built heritage and community management activities, organising neighbourhood collaborations, small jobs of social utility such as the care of gardens and vegetable patches, the provision of after-school services or purchasing groups for small commissions. These projects are useful for outlining some typical aspects of new forms of collaborative living, where the design approach changes significantly: in fact, we move from a top down design, typical of a welfare orientation, to a shared design. The idea of the “home forever” is also changed, with its project defined and characterised by fixed links with the surrounding area, in favour of a design “in the making”, subject to constant changes from a spatial point of view and morphological so as to adapt to the changing needs of users. Attention to flexibility requires the prefiguration of the technical methods both in the implementation phase and in the subsequent operating phase, so that management and maintenance are easily implemented and economically sustainable. These interventions also experimented with technological solutions with a high content of innovation, in a residential market still dominated by traditional and often inadequate building models, materials, technologies, systems and type-morphological organisation.

“Dopo di Noi”: future developments on the convergence between supply and demand for collaborative living

With the entry into force of Law 112/2016, the “Dopo di Noi” Committee was set up, promoted by Senator Annamaria Parente, rapporteur of the law, with Banca Prossima Foundation for Innovation of Third Sector (Fits!). Its aim is to disseminate the contents of the law, in collaboration with institutions and family associations, and to monitor and support its implementation.

The Committee consists of an Advisory Board, a Management Committee and the Commissions Law, Finance and Real Estate, Taxation, Person and Health and Housing, in which professionals and experts, teachers, researchers and social workers commit themselves pro bono for the realisation of this initiative. The goals are to monitor the implementation of law 112/2016 and the derived decrees of the Regions; to play a proactive role towards legislative and administrative bodies, at national and community level; to support the cooperation between institutions, professionals, bodies and subjects (also financial) operating in this area (support administrators, mutual societies and insurance companies, trust companies, community foundations and philanthropic intermediation); to promote the knowledge and dissemination of the regulatory instruments for the protection of disabled person, to deepen the economic sustainability of the initiatives, studying the most effective combination of financial sources (donations, crowdfunding, national and regional European funds, credit, bond issues) (Pavesi et al., 2018).

The aim of spreading knowledge about the law, working on the dissemination of good practices and developing sustainable models, requires a strengthening of collaboration with universities and scientific research[4], particularly for the service’s configuration and the production of the project.

In this framework, the Committee is active in promoting multi-stakeholder networks for the feasibility of collaborative social housing projects throughout the country. In this context, the Officina Dopo di Noi Committee is developing an observatory for social housing projects with a share of housing intended for the life project for “Durante e Dopo di Noi”. Starting from the observation and classification of the projects, a guide document is being prepared for preliminary design, to direct the construction process in the most appropriate way with respect to end users. Among the monitored projects, “Orbassano 2” in Turin will be a model for the development of a scalable methodology on the national territory, to be extended, with the appropriate criteria, to different types of mental disability.

---

[4] Angela Silvia Pavesi, founding member of the Committee and vice-president of the Advisory Board, has favoured the stipulation of a Framework Agreement between the Committee and Politecnico di Milano to promote research and scientific innovation in support of disability. The authors of the paper participate in various ways in the Officina Dopo di Noi Committee; Genny Cia is the Committee’s research manager and coordinates the Finance and Real Estate Commission.

Conclusion

In the law 112/2016, the housing theme is central for the implementation of independent life projects: the housing sector represents an industry that has rapidly evolved in supply capacity in terms of construction technologies, in the field of inclusive facilitation and, finally, the dimension of the supply of welfare services. Social housing introduces significant changes in the approach to the demand for housing because its definition contains an extension to the sphere of services and collaboration, opening to the needs of specific users and offering itself as a dynamic welfare system. The demand for housing is expressed by subjects organised in public-private partnership (including third sector organisations) which ab origine influence social housing forms.

Typically, these subjects take a non-profit or limited profit legal form and are based on solid participatory bases for their functioning, in the sense that the inhabitants are adequately represented within them and, if possible, they are also involved in the creation and management of services.

The social management of the interventions is based on the combination of housing administration, social accompaniment of the community and involvement of residents in the community life organisation, in the care of spaces and in the creation of collaborative processes of mutual help among inhabitants (Del Gatto et al., 2012).

In order to adhere to housing projects with an explicit social dimension, such as that of disability, it is necessary to acquire skills and knowledge. These are necessary to manage different aspects concurrently, such as people needs and wellbeing aspirations and the supply of contributions (economic and financial but also donations) that, to be sustainable, must be structured over significant time horizons. In this sense, the general criterion of effectiveness is to consider both the effects on the direct beneficiaries and the whole plurality of involved actors, not only in terms of the final evaluation of the intervention, but as a guiding

References

Del Gatto, M. L., Ferri, G., Pavesi, A. (2012), “Il gestore sociale quale garante della sostenibilità negli interventi di Housing Sociale”, *Techne*, n. 4, Firenze University Press, Firenze.

Di Sivo, M., Angelucci, M. (2012), “Il mass customization process per l’Housing Sociale. Potenzialità, nodi critici, linee di ricerca”, *Techne*, n. 14, Firenze University Press, Firenze.

Faiella, M.G. (2016), “Disabili - È legge il «Dopo di noi» Quando i genitori non ci saranno più”, *Corriere della Sera*, 14 June.

Ferri, G., Pacucci, L. (2015), *Realizzare housing sociale. Promemoria per chi progetta,* Bruno Mondadori Pearson Italia, Milano-Torino.

Housing Europe (2003), *Breaking down the barriers. Social Housing for people with disabilities in Europe*, Carmichael&Co, Brighton.

Lakatos, E. (2018), *A Mid-Term Analysis of the Impact of Structural Funds on Public, Cooperative and Social Housing in 2014-2020. The Implementation of the European Structural and Investment Funds for Housing Projects in the European Union*, Housing Europe, Brussels.

Liat, R., Corubolo M., Gasmbarana, C., Omegna, E. (2018), *Cohousing. L'arte di vivere insieme. Princìpi, esperienze e numeri dell'abitare collaborativo in Italia*, Altreconomia, Milano.

Martinotti, G. (1993), *Metropoli. La nuova morfologia sociale della città*, Il Mulino, Bologna.

Morena, M. (2014), *Le strutture socio-assistenziali e residenziali per anziani e disabili. Esperienze e modelli innovativi*, Maggioli, Santarcangelo di Romagna.

Niemeijer, R.A., de Vries, B., Beetz, J. (2010), "Designing with constraints - Towards mass customization in the housing industry", in Timmermans, H.J.P., de Vries, B. (eds), *10th International Conference on Design & Decision Support Systems*, Eindhoven.

Oberti, I. (2017), "La progettazione partecipata per un progetto inclusivo", *Rivista Italiana di Ergonomia*, vol. 14.

Owen, C., Rutherford, V., Jones, M., Wright, C., Tennant, C., Smallman, A. (2006), "Housing accommodation preferences of people with psychiatric disabilities", *Psychiatric Services*, vol. 47, issue 6.

Pavesi, A.S., Cia, G., Del Gatto, M.L. (2018), "Il Gestore Sociale: dalla finanza d'impatto al Real Estate Management", *FMI Facility Management Italia*, n. 36.

VV.AA. (2018), *Bilancio Sociale Cooperativa Di Vittorio – Edilizia convenzionata*, available at: www.coopdivittorio.it/wp-content/uploads/2019/01/DV_BilancioSociale2017.pdf.

Zaccaria, R., Ferri, G., Pavesi, A. (2018), *Cambiare l'abitare cooperando. Il gestore sociale cooperativo infrastruttura dell'housing sociale e del welfare urbano*, Mondadori, Milano.

1.6 CIRCULAR AND COLLABORATIVE: TWO TERMS OF THE PROJECT CULTURE IN THE ERA OF INDUSTRY 4.0

Mariangela Bellomo, Antonella Falotico**

Abstract

Circular *and* Collaborative *are recurrent terms in the culture of contemporary design, which relate to the new role played by industry and production in the revolution brought about by digital culture. Regarding circular, this term is becoming a paradigm of project practices that consider not only environmental limits and resource scarcity, but also and above all new models of social innovation and sharing. As for collaborative, this term refers to the logic of open innovation and, in this sense, takes up the challenge presented by Industry 4.0, which transforms the factory and strongly conditions the dialectic established between technology and architecture, between creation and practice, between manual skills and trade.*

Keywords: Circular, Collaborative, Industry 4.0, Open source, Digital culture

Project and Industry 4.0 (by M. Bellomo)

The relationship between the architectural project and the production system relies on the features and specific aspects that define both terms over time.

If the architectural project has always been a creative act aimed at envisioning a desirable future, its formulation is related to the economic, normative, procedural and technical system of a particular historical, environmental and social context; likewise, the productive structure is strictly connected to technical possibilities - both hard and soft - offered by every community.

In industrialised countries, the aforementioned pair is included in a complex design process where various components, organisation, design, implementation and management impose a dialogue between numerous operators.

In every historical moment, this dialogue unfolds either through technical and scientific progress, or as a result of technological innovations connected to fabrication or "making".

* Mariangela Bellomo is an Associate Professor at the Department of Architecture of the University of Naples Federico II, Italy, bellomo@unina.it.

* Antonella Falotico is a Researcher at the Department of Architecture of the University of Naples Federico II, Italy, antonellafalotico63@gmail.com.

Today, it confronts a phenomenon that may substantially modify the life of individuals in the near future, but which is currently undergoing development and definition in the various fields of human action: digitisation. The current phase of transition from computerisation to digitalisation attributes to the "dialogue within architecture" new spatial, temporal and instrumental dimensions, which must nevertheless meet old and new living requirements. When we talk about digitisation and architecture, we refer to complex phenomena involving the management and analysis of a considerable data, to the governance of the man-machine touch interface, to the elimination of physical distances, to document digitalisation, to the "real rendering" of everything that was virtually designed, controlled, and previewed, which demand the introduction of new professional figures related to new or revisited processes, projects, products, and services. These are largely unknown territories that combine human and exact sciences, in a context that poses new challenges and consolidates recent ones.

Circular. A new yet ancient paradigm of the design process[1]

(by M. Bellomo)

As an adjective, the term "circular" serves to describe relations between the design process and the production world, allowing a reflection on various issues, some already debated and some yet to be explored. At first, the term refers to the geometric figure in which all points, set at an identical distance from the centre, recall the concept of balance and harmony; every point is at the same time the beginning and end of the whole, and is systematically and periodically traversed should one travel around the circumference to which it pertains. Hence the concepts of recursive and cyclical that make the circular theory, like the linear one, an interpretative model of reality adopted by classical science[2]. The recent economic, social and environmental crisis has placed the concept of circularity in opposition to that of linearity.

From an economic standpoint, the linear growth and development model - based on the production-consumption-waste sequence - stood on the objective value of the goods produced; from an environmental standpoint, it stood on the presumed endless supply of natural resources, and the unlimited bearing capacity of the planet; lastly, from the social point of view, it stood on the idea of progress and well-being guaranteed by the positivistic and unconditional trust placed in technology.

---

1 The title is a clear reference to *Le nuove radici antiche*, by Guido Nardi, whose thinking (philosophy) and action (techniques) are closely related to reflections on some innovative aspects of an atavistic process: to build places to live.

2 We refer to the Greek culture, based on the concept of circularity/cycle (cycle of the seasons, constellations, etc.) to which the Jewish/Christian culture opposed based on the concept of linearity (evolution of man from sinfulness to salvation).

Starting from the observation of natural processes without «unemployed resources or even waste, where all elements perform a task, and one's waste becomes other's raw material in a waterfall like system where nothing is discarded» (Segré, 2012), the circular model defines as virtuous any closed, self-regenerating, and integrated systems, the elements of which are reusable, recyclable and repairable.

The Cradle to Cradle theory, elaborated by Walter Stahel[3]; is closely connected to the concept of circularity; the idea of preferring services to products; industrial metabolism as an integrated approach between usually distinct industries, which activate exchanges of materials, energy, resources and products (Chertow, 2000); social metabolism, involving transformation processes of matter and energy by individuals, and their environmental impact. One particular aspect of this scientific field regards the attribution of cultural value to the matter and energy flows between nature and society, that is to say, the social community becomes the connecting and relationship hinge between culture and nature (Giuntarelli, 2017).

In fact, we move from the Green economy to the Blue economy[4], from the "linear economy" to the "circular economy"[5] in an interpretation typical of contemporary science, which introduced the concept of complexity via so-called complex systems. The latter feature network structures, interact with the environment, provide and receive feedback, and exhibit non-linear relationships.

Downstream of these key concepts of contemporary culture, it can be argued that it is precisely the theory of complexity that makes circularity possible: the implementation of closed, self-regenerative systems, with cyclical and recursive phases, can exclusively occur by adopting operating methods that envisage open and collaborative organisations, knowledge sharing, crowdfunding, sharing economy, and process optimisation.

---

3 W. McDonough later founded MBDC, whereby the Cradle to Cradle approach becomes a certification of virtuous production processes.

4 The blue economy is one of the cornerstones of the circular economy. In the blue economy, a concept theorised by the entrepreneur and economist G. Pauli, the goal of reducing CO2 emissions down the certain limits is exceeded, reaching nearly zero emissions, as a premise for green processes.

5 The most accredited definition of circular economy in the scientific field is the one formulated by the Ellen MacArthur Foundation, which provides for the development of methods and tools to allow a practical regeneration of the two circuits: that of biological materials, which must return to the biosphere at the end of their life, and that of technical materials, which must be reintegrated into the production system without ever coming into contact with the biosphere. https://www.ellenmacarthurfoundation.org/.
The first discussion on the circular relationship between economy and environment is proposed by K. Boulding in the article The Economics of the Coming Spaceship Earth (1966). Ten years later, W. Stahel and G. Reday present the report The Potential for Sub-Instituting Manpower for Energy, in which the circular economy is understood as the possibility to activate virtuous processes of resource saving and waste reduction.

In this view, the heuristic phase of modern projects attempts again to hybridise and contaminate concepts pertaining to consolidated research areas and new methods, finding in their multi and cross-disciplinary nature the indispensable prerequisite for a new and necessary science of sustainability (Bologna, 2008); when formulating ideas, open source and open innovation criteria reign supreme; when defining technical choices, consolidated processes undergo a drastic review to uncover resources in what is presumably waste. In essence, it involves the activation of technological metabolism processes, which can be implemented through design based on usage cycles, energy recovery, versatility, disassembly and reassembly of materials and components; the reconciliation of global with local elements, which may mean multiplying and intensifying the meshes of large-scale networks; the adoption of unconventional and even untested technologies (Vittoria, 1988), i.e. technologies that stray from safe, consolidated methods, as a way to attain a desirable future. Finally, one last meaning of circularity refers to the significance and role of *teknè*,

> «an essential part of the creative process. Working in a circular way between idea, technique, construction and idea again, the technical gesture reclaims centre stage, restoring thus its dignity, and everyone remains relevant in this circular motion of the creative process» (Piano, 2000).

Collaborative. Multitude vs solitude (by A. Falotico)

Collaborative is a term profoundly connected to the professional and intellectual figure of the designer as a thinker and implementer. It also concerns the role of digital technologies and the new forms of dialogue among different figures of the building process, a dialogue that pushes back the boundaries, modifies established practices and opens up to collaboration. This mainly refers to how business organisations develop, how people work together to create products or services (co-creation of value), and relate to the terms co-production, co-working, co-design, emerging from contemporary culture.

The prefix "co" refers to the idea of connection, and therefore of the network, relationships and interactions, qualities that today are attributed to the digital revolution and to aspects concerning social innovation.

Social innovation is one of the major change agents of modern day, as a tangible and widespread manifestation of a new form of economy, one that is "circular", "collaborative" and regenerative, in line with the ecological demands of contemporary societies (Webster, 2015).

An innovation no less powerful and fast than technological innovation, with which architecture has been confronted with shifting fortunes for at least two centuries, proposing new types of relations between production and consumption and which takes environmental and energy themes as change agents.

A form of innovation that has found in new digital platforms a fundamental support for spreading and extending the influence of new social practices, combining two seemingly opposite principles: identifying specific aspects of targeted interventions, often of a local nature, and the possibility of building extended social networks (Perricciolі, 2017).

Digitisation is therefore the new challenge, an innovative one that is rekindling the old debate between ideas and manufacturing, which is identified with the terms “immaterial” and “virtual”, and that alters the traditional categories of time and space, going beyond the three dimensions. «In this context, the digital dimension has transformed the rational spatiality of the industrial age and the great certainties of the twentieth century, turning immaterial what was traditionally material» (Sacchi, Unali 2003).

A new era of “constructible thinking” opens up before us. By their very nature, digital natives can simultaneously portray virtual and real spaces, transforming a set of pixels into something material, tactile and usable; they have the sense of collaboration, and can manufacture the production tools. Something is happening to the culture of contemporary construction, something closely resembling the operative condition that inspired most of pre-industrial production, when “the architect-man” and “the mason-man” were one and the same, and when technical skill and reason merged together at the building site. The “building activity” takes on the dimensions of a “collective enterprise” (Hannes Meyer) and the architect becomes “choral” (Ratti, Claudel 2014).

In this context, the design activity is caught in its complex dimension, where teamwork plays a fundamental role, the integration of various, constantly expanding skills and collaboration, which have always been prerequisites for a quality process in opposition to isolation and self-referencing.

The complexity we are discussing refers to the huge number of operators and emerging professional figures that characterise the design process and its regulation, which requires an expansion of strategic and relationship skills, information sharing, coordination, and dialogue; all these terms are not new to the technical discipline of the project and its systemic vision, and can be assumed as project materials as Vittorio Gregotti understands them[6]. A project that should be able to find its reasons in collective operation, in collaborative spirit, in the lack of competition.

Without a doubt, the digital revolution has produced physical devices and software suitable to favour even complex interoperability processes, interactive and virtual platforms, real “scaffolding” that “sustains” massive information flows whereby operators communicate, and through which the collective intelligence theorized by Pierre Levy “materialises” to becomes a project and, at the same time, the ability to formulate hypotheses alongside “open” and diversified solutions that can evolve and change.

[6] The term is used as V. Gregotti understands it (“content”, “element” of the project). Cf.: “Elogio della tecnica” (1982), *Casabella*, n. 480; *Questioni di Architettura* (1986), Einaudi, Torino.

There is a conception of information as a public good, the value of which lies in accessibility and sharing and the idea of a virtual space of possibilities: a space where, with little effort and at a low price, everything is possible (Manzini, 1990). A space in which ideas and matter are one, where potential modifications occur without ever leaving it, and in which the virtual model, whether this is an object or a building, becomes a sort of data bank that enters the "production channels" to reach its realisation. In this way, distances between design moment and production moment are eliminated. Project, factory and building site become the "subject of ideas", while the quantity (of knowledge, data, calculations, control, possibility of modification in real time) becomes the quality of the future project.

Circular and Collaborative in the project culture

(by A. Falotico)

The reasoning on the terms "Circular" and "Collaborative" has opened up reflection scenarios on three major challenges of the project culture as to the relationship between production and the new sense of "doing" in architecture: respect for the environment and awareness of resource limitations; the importance of teamwork and the value of the community; the instrumental potential of digital culture in governing process complexity. These terms, whilst referring to the socio-technical culture of the contemporary project, have always been connected to the construction activity, and especially to some foundational paradigms of material culture. In this culture, the collective sharing of technical acts legitimises the nature of the choices and constructive actions mainly related to the respect of places, productions, identities, knowledge, human and intangible capital, networks, values and territorial resources, which together conform project constraints, requirements, and goals. If, from an instrumental perspective, the terms have been dealt with separately, their treatment intended to find interweaving and convergences.

As a result, the reference to the "circular" nature of project solutions, combined with the "collaboration" and the multi-disciplinary and cross-disciplinary dialogue favoured by virtual platforms, alongside the now complete transition of the digitalisation of production processes, has led to the progressive abandonment of a traditional approach to doing and thinking, one that favoured a strong ability to craft visions and manage the complex paths of future projects. These paths, however, are no longer linear, absolute, unidirectional, but variable, changeable, predictable and tailor made, measured on what men wants and on what the planet can "sustain". In this context, we may identify certain paradigms, suitable not only for the traditional but also for a radically new construction activity, which become reference drives when imagining the possible qualities of the future habitat project.

Construction/Deconstruction: Ability to imagine an artificial cycle of products that respects the natural process and that can be composed of systems, but also decomposed, entering new cycles of utility.

Variability/Customization: Possibility of referring to diversified and programmable production cycles that orient the production towards made to order / measure products.

Optimization: Simplification process that is linked to the organization, the rational use of resources and the appropriate use of elements regarding the function that must be performed in the system, as to ensure the cost efficiency of the work from its ideation phase.

Governance: Strategic component that brings people together and engages them in dialogue to implement a different project approach, more collaborative, open, and relational.

References

Bologna, G. (2008), *Manuale della sostenibilità. Idee, concetti, nuove discipline capaci di futuro*, Edizioni Ambiente, Milano.

Chertow, M.R. (2000), "Industrial Symbiosis: Literature and Taxonomy", *Annual Rewiew of Energy and Environment*, n. 25, p. 314.

Giuntarelli, P. (2017), "Paradigmi e modelli della sociologia dell'ambiente", in Augustoni, A., Giuntarelli, P., Veraldi R. (eds), *Sociologia dello spazio, dell'ambiente, del territorio*, Franco Angeli, Milano.

Manzini, E. (1990), *Artefatti. Verso una nuova ecologia dell'ambiente artificiale*, Domus Academy, Milano, p. 52.

Perriccioli, M. (2017), "Innovazione sociale e cultura del progetto", in *Techne*, n. 14, Firenze University Press, Firenze, p. 25.

Piano, R. (2000), *La responsabilità dell'architetto*, Passigli Editori, Firenze, p. 102.

Ratti, C., Claudel, M. (2014), *Architettura Open Source. Verso una progettazione aperta*, Einaudi, Torino, p. 33.

Segrè, A. (2012), *Economia a colori*, Einaudi Editore, Torino, p. 35.

Sacchi, L., Unali, M. (2003), *Architettura e cultura digitale*, Skira, Milano, p. 129.

Vittoria, E. (1988), "Le tecnologie devianti dell'architettura", in Guazzo G. (1995), *Eduardo Vittoria, L'utopia come laboratorio sperimentale*, Gangemi editore, Roma, pp. 136-139.

Webster, K. (2015), *The Circular Economy: A Wealth of Flows*, Ellen Mc Arthur Foundation, Chicago, p. 69.

1.7 PROJECT AND CROWDSOURCING: PHENOMENON MAPPING AND FUTURE PERSPECTIVES

Timothy Daniel Brownlee [*], *Valeria Melappioni* [*]

Abstract

Crowdsourcing is becoming increasingly affirmed, placing itself as a dis-intermediation process, even at a high level of specialisation and with creative types of contexts. The use of the new technological networks and its implementation of the relationship with the stakeholders, highlights a metamorphosis in the way of working, even in the "making architecture" places. The era of global interconnection puts us in front of new challenges of sharing, requiring at the same time faster and more effective responses and a growing attention to diversified specialised complexities. The paper investigates the project's role in the emerging context of architecture "uberisation" phenomena, as a platform capable of placing designers in a world of global customers.

Keywords: Crowdsourcing, Uberisation, Online contest, Cocontest, Arcbazar

Introduction

In a scenario of a whole range of online and collaborative phenomena, we can observe how some of these practices introduce discontinuity elements that are capable of undermining the stable system in which they are placed (Manzini, 2015). Those users that employ online and collaborative instruments obtain a new efficacy that stems from the benefits that that particular practice generates, with global and accessible potentialities.

Today we can find how the widespread diffusion of web platforms enables an immediate relationship between users and particularly between private users and freelancers. Among the ongoing phenomena we refer also to ordinary daily life processes that concern the purchase of material goods, the political representation, the diffusion of knowledge but also the purchase and supply of specialised intellectual services. Often the rapidity of these relationships makes the intermediary role obsolete, since it can be easily replaced by a crowdsourcing platform.

---

[*] Timothy Daniel Brownlee is a Postdoctoral Fellow at the School of Architecture and Design Eduardo Vittoria, University of Camerino, Italy, timothy.brownlee@unicam.it.

[*] Valeria Melappioni is a PhD candidate at the School of Architecture and Design Eduardo Vittoria, University of Camerino, Italy, valeria.melappioni@unicam.it.

In other words, supply and demand can meet directly, according to the rising disintermediation phenomenon[1].

The implementation of this approach to architectural practices raises questions about the use of new collaborative platforms in relation to design activity, and to the potentialities in generating value and *win-win* results[2].

Crowdsourcing

As is common knowledge, the crowdsourcing phenomena, which is different from the open-source[3], one, was described by Jeff Howe in 2006[4] as a fusion of the crowd and the outsourcing concepts, in order to outline a collaborative practice that could be opened to a more or less large number of people involved in a particular task. Howe declared that «the amount of knowledge and talent dispersed among the human race has always outstripped our capacity to harness it. Crowdsourcing corrects that».

The concept refers to the sociological theory that James Surowiecki (2005) expressed in the book "The wisdom of crowds", according to which a mass of inexperienced individuals would be able to provide a valid answer to a specific question more than experts would do. As a matter of fact, considering that groups «are remarkably intelligent, and are often smarter than the smartest people in them», the crowd is (re)considered as holder of a new collective knowledge. According to the integrated definition that Estellés-Arolas and Gonzales-Ladron-de-Guevara give, crowdsourcing can be described as:

> «a type of activity in which an organisation, an institution, [...] proposes to a group of people with various types of knowledges, a free and voluntary fulfilment of a task, through a flexible and open announcement» (Estellés-Arolas, Gonzales-Ladron-de-Guevara, 2012).

Referring to the on demand economy model, the crowd is exactly available in the required quantities, it is on demand and just in time[5] (De Stefano, 2015), and it can be considered as re-sizable actor. The openness level of the announcement can vary: it could be opened to a crowd of non experts, it could have controlled participants, or it could be limited to a community with a specific knowledge.

---

[1] According to the Treccani encyclopedia, «the disintermediation phenomenon had a great impulse thanks to the spread of internet and electronic trading. […] The d. affected particularly the services market and the intangible assets».

[2] The expression indicates a result that is good for everyone who is involved in a given situation.

[3] It indicates a value system that promotes an open exchange, the development of the Community, the enhancement of a service, and does not provide economical rewards or fees.

[4] The term appears for the first time in Wired Magazine. Howe J. (2006).

[5] Terms commonly used in the language of digital economy to define the demand's characteristics of immediacy and instantaneousness.

The possibility of outsourcing even only the critical aspects of certain projects by activating a collective intelligence that interacts sharing knowledge, might be beneficial for those who easily know how to use the network. Users can actively participate from the first development stages by externalising their wishes and experiences (Alsever, 2007). Applying this model to different thematic areas, several heterogeneous phenomena might come out, all based on the desire to generate value by the means of an active crowd in a community[6]: we refer specifically to the crowdcreativity cases, that means crowdsourcing for creative practices[7]. These online structures, that collect contributions in the fields of visual communication, photography, design, fashion, music and even architecture, are presented as democratic tools, capable of overcoming geographical obstacles and enhancing intellectual work. The unexpected channels of relationship, dialogue and proposal, generate a renovation of the production processes ideas, as well as new roles for the creatives themselves.

Talking about the creation of platforms for the market demands the acquisition of architectural design services; one wonders if indeed architecture can be crowdsourcing, if there are some potentialities in the union between gig economy[8] and architecture, if a "design thinking" mode can accommodate and not undergo the new network promoted processes, if it is possible to enable a virtuous interacting between the interconnection instruments and the traditional *modus operandi* that architects have.

The data concerning the situation of the architectural profession in the European[9] context and in particular in Italy become relevant:

- 600,000 architects in Europe (of those 1/4 are in Italy, that has the highest ratio of architects per 1,000 inhabitants);
- 72% of European offices are made up of only one architect and Italy is among those countries with the smallest structures;
- In Italy, the number of part time architects went from 8% in 2008 to 20% in 2016 (highest percentage in Europe);
- average gross income in Italy is about 18,000 euros per year.

In addition to this:

- Italy is considered the fourth biggest construction market in Europe, but architects are responsible only for a small part of it (Sacchi, 2017);
- about 70% of the construction works concerns the private residential sector, mainly renovations.

---

6 It refers to crowdfunding, crowdtesting, crowdvoting, crowdmapping, etc.

7 Among the pioneers of crowd involvement, we cite the competition that Mattei carried in the early 50s, in order to launch the new "Supercortemaggiore" petrol and that led to the famous "six-legged" dog-dragon logo.

8 It refers to an economic model in which one works only when there is a specific service demand.

9 Data from the Architects' Council of Europe 2016.

The figures reveal the need to question how to carry out a profession that appears exclusive (Abis, Airoldi, 2018) and far from actual needs, perhaps by allowing more space to those changes that are already taking place, opening contact networks in a transnational market through the redefinition of project approaching paths (Crosbie, 2014). Maselli and Fabo (2015) highlight how some attractive and immediately accessible platforms are used as a means of advancing in professional career for those with limited resources, given the difficulty especially for young people, to enter effectively the freelance market work. Imdat As, founder of the Arcbazar platform, speaks about a gap: it is «as if architects gave up parts of their fees» related to small sectors to which they do not pay attention (Keslacy, 2018). The Industry Report conducted in 2011 by the IBISWorld (Carè, Colurcio, 2016) in the USA, confirms what As expresses estimating the extent of this non-collection at 40% of the total potential of the services.

Is it possible to speak about new forms of project production, if the design process is articulated through virtual and shared environments?

There are two types of online platforms for architectural services:

- service marketplaces connect bidders and searchers, according to demand and supply processes (Houzz, Habitissimo, Bam);
- competition marketplaces promote solutions through the use of competitive mechanisms. Arcbazar and CoContest (Gopilar) are the best known.

The study focuses mainly on the second category which involves the use of design processes. The input begins from a customer who proposes a call for a specific design question, thereby activating the platform. The call might be opened to a crowd of users that participate even without necessarily being enrolled on a professional register. The competition data, the deadlines and the prize amount are defined right at the beginning. After the delivery of the projects, the prizes are awarded according to an evaluation phase, usually in an anonymous form, managed by a jury of experts, or more often by the client himself. The designers might ask questions to the client through an open chat that is visible to all the participants. Therefore, the designing process is lightened by the ease of contact between the involved figures; however, is there any risk that during its implementation, the recursive interaction, that is typical of the continuous dialogue between professional and client, might be cancelled? For the future of crowdsourcing design, is there any chance of evolving the current limit of a silent type of dialogue?

Although some platforms suggest the caller to establish a relationship with the winner, in fact the implementing designing phases that should follow the competition phase are not contemplated. Therefore, the competitions aim exclusively at the acquisition of a preparatory project or of a concept.

One wonders about the ability that platforms have to respond effectively to design complexities, as a synthesis of a dense exchange work, with multifaceted and specialised visions. How can one guarantee that projects are responsive, as a minimum, to the construction regulation of a given site's country? How to ensure that designers take on professional responsibility of what they propose if they are not required to incorporate specific regulations to their projects?

There are also a series of deontological and labour law questions that concern the rights of smart workers[10], and the effects of a possible deregulation of the profession. The history of the Co-Contest platform, born in Rome in 2012 from the idea of three recent graduates, has been at the centre of an intense debate, becoming, on the one hand, an example for those that seek innovation[11] in Italy and on the other, the object of a Parliamentary question and an antitrust complaint. The accusation concerns the violation of laws that regulate the relationship between client and professional, the enslavement of unpaid intellectual jobs and the facilitation to develop projects without any check of feasibility.

The founders declare that among their aims they want to: bring people closer to the project by putting it at the centre of the whole process, explaining that it must be paid in advance, and giving it the value it deserves. On CoContest you pay only for the design, or better, for the concept. The competition is a transparent selection method and therefore you choose an architect not with the usual "connections methods". In order to participate you must have developed skills and it is not enough just to know how to drive a car like Uber[12].

A streamlined design process or a reduction of intellectual work to a mere instrumental service?

Some authors[13] point out that the interactive crowdsourcing process that generates "co-creation" of value, at the same time could foster the development of "co-destruction" of that value (Ambrosini, Bowman, 2009): an improper use of those resources that are placed in the web might impoverish those who participated actively and therefore disperse the generated value.

---

10 See the article by Tucci C., 2017. "Smart working, sono già 250mila. Identikit del dipendente da casa", in *il Sole 24 ore*, May 14th 2017;

11 Forbes Magazine has nominated Federico Schiano di Pepe, one of the founders, one of the youngest under 30s influencers in "e-commerce".

12 We refer to the "uberisation" concept of work: highly digitised business platforms that revolutionise the way to deal with customers, developing algorithms, dialogue interfaces and continuous feedback. Alessandro Rossi, co-founder, on: www.youtube.com/watch?v=afks8myLgz4.

13 In particular, Jeff Howe (2006) concludes his definition of the concept by saying that the amount of knowledge and talent dispersed among the human race has always outstripped our capacity to harness it. *Crowdsourcing* corrects that but in doing so, it also unleashes the forces of creative destruction.

In Arcbazar and CoContest all of the projects become public at the end of the competition (and at the same time the creativity and competence values that designers express in them), in some way they become acquirable by any subject and therefore usable even without a shared and collaborative purpose. «The value is dispersed and it is not captured by those who generated the interaction, but possibly by external actors» (Carè, Colurcio, 2016). If it were possible to monitor the terms of intellectual property and the correctness of competition procedures, would that implicate the direct access to these tools? Would ethical regulation be necessary in order to set a first qualitative evaluation factor? Other and more developed crowd-creativity areas work in this direction[14].

Is it possible to outline new collaborative forms in the web immateriality[15]?

The designing process that was used in 2014 to realise the 17 John Skyscraper Hotel NY was established by an online contest in order to develop the project of some key-spaces of the intervention. According to the founder of the company, the traditional and trusted architects might become judges of crowdsourcing competitions and therefore curators of the whole project, summarising "the wisdom of the crowds", overpassing those boundaries that normally one designer or one team of designers have, in terms of knowledge, skills geographical limits[16]. Massive open online course (MOOC) proposed an online contest to develop a prototype for a natural disaster resistant school that could be used as a community shelter, commissioned by the Philippines Government: the winning project was presented at the United Nations in New York and it was developed by virtual and interconnected colleagues, from Italy, India, Arab Emirates and Canada[17]. In 2012 several Somerville (USA) citizens, published a competition on Arcbazar, for the concept project of a school building in their city that remained unused for ten years. The renovation project of the building, called Powder House Community School, attracted 80 designers from all over the world. In a second phase the winner was involved in an offline mode in order to work with local architects on the executive project (currently in the realisation phase). The World Bank believed that this kind of competitive crowdsourcing mode could be useful as a collaborative motor for socially and economically complex locations as well (Angelico, As, 2012), allowing the relationship collective intelligence architects' expertise, to move towards innovative forms of social collaboration.

---

[14] Since 2013, the AIAP, Italian association of visual communication design, works to evaluate crowdsourcing work and to set up shared guidelines.

[15] Expression used by L. Sacchi in 2017, in *Il mestiere dell'architetto: prospettive per il futuro*.

[16] Refer to: www.archdaily.com/rodrigo-nino-in-defense-of-crowdsourcing-and-crowdfunding.

[17] See the article: www.ong2zero.org/blog/crowdsourcing-fare-progetti-2-0/.

When crowdsourcing and crowdfunding are combined together, a bottom up project approach becomes even more incisive, fully exploiting the needs that come bottom up[18]; moreover, in those circumstances in which the crowdsourcing phenomenon is linked to an open source availability of drawings and development project prototypes[19], is it possible to prefigure a scenario made of opportunities, linked to a network based on interdisciplinary skills, culture of sharing and processes of social innovation? This opens up a field of study that still has to be explored and built, which concerns a new developing culture, related to an interconnected project in which the complexity and the set of problems linked to the changing of the qualifications that architects have, connects to the ability to innovate the project production forms in new collaborative, flexible and immaterial environments.

References

Abis, M., Airoldi, A. (2018), "L'immagine sociale dell'architetto e dell'urbanista. Rapporto finale". *VII Congresso nazionale degli architetti PPC, Roma 5-7 Luglio 2018*.

Alsever, J. (2007), "What is Crowdsourcing?" available at: https://www.cbsnews.com/news/what-is-crowdsourcing/, (accessed 17 January 2018).

Angelico, M., As, I. (2012), "Crowdsourcing Architecture: A Disruptive Model in Architectural Practice", Synthetic Digital Ecologies, *Acadia Annual International Conference*, pp. 438-443.

Colurcio, M., Carè, S. (2016), "Co-creating value design with the crowd: a crowdsourcing practice for the interior design sector", in *Arts, Cultural and Creative Industries 2016 Symposium*, 23-24 September 2016, Torino, Italia.

Crosbie, M. J. (2014), "Crowdsourcing Design: The End of Architecture, or a New Beginning?", available at: www.archnewsnow.com/features/Feature448.htm (accessed 17 January 2018).

De Stefano, V. (2015), "The rise of the just in time workforce: on-demand work, crowdwork and labour protection in the gig-economy", *Conditions of Work and Employment Series*, n. 71, International labour office, Geneva.

Éstelles-Arolas, E., Gonzales-Ladron-de-Guevara, F. (2012), "Towards an integrated crowdsourcing definition", in *Journal of information Science XX,* pp.1-14.

Fabo, B., Maselli, I. (2015), "Digital workers by design? An example from the on demand economy", *Ceps working documents,* n. 414.

Howe, J. (2006), "The rise of crowdsourcing", in *Wired Magazine*, Issue 14, June 2016, available at: https://www.wired.com/wired/archive/14.06/crowds_pr.html.

Keslacy, E. (2018), "Arcbazar and the ethics of crowdsourcing architecture", *MIT's annual Thresholds Journal*, 46, pp. 300-317.

Manzini, E. (2015), *Design when everybody designs, an introduction to Design for Social Innovation*, MIT Press, Cambridge, USA.

Sacchi, L. (2017), "Il mestiere dell'architetto: prospettive per il future", *Op.Cit.*, n. 160, pp. 5-18.

Surowiecki, J. (2005), *The wisdom of crowds,* Anchor Books, USA.

---

18 In this regard, the process that led to the construction of the "Luchtsingel pedestrian bridge in Rotterdam (2012)" might be an interesting case study.

19 In 2016 Aravena A. and the social enterprise Elemental SA decided to make available on open source several social housing projects in order to allow people to use them, as a replication or as a re-elaborated version.

1.8 THE DIGITAL TRANSFORMATION OF THE AEC SECTOR: INNOVATION OF PROCESSES, ORGANISATIONAL MODELS

Marcella Bonanomi, Cinzia Talamo*, Giancarlo Paganin**

Abstract

The digitalisation of the Architecture, Engineering, and Construction (AEC) sector is transforming the way buildings are designed, built, and operated, leading to significant changes in the way practitioners work and collaborate. The study herewith presented is based on the hypothesis that AEC firms must shift from silo-based processes and organisational structures to collaborative workflows and integrated networks to draw full benefits from digital innovation. The research objective is to propose investigation methods useful to lead digital transition and outline risk-response strategies to manage the changes of processes, organisational structures, and relationships between professionals (traditional and new ones).

Keywords: Digitalisation, AEC Sector, Change management, Design and Construction Process, Organisational structure

Introduction

Digital technologies represent an enormous potential for the transformation of the Architecture, Engineering, and Construction (AEC) sector, which remains among the least digitised ones (McKinsey, 2016). In addition to the low levels of digitisation, design and construction processes are typically managed with a sequential and silo-functional approach. This means that the many stakeholders involved in the design and construction process usually get their work done only developing their discipline specific workflows and without creating valuable cross-functional relationships. Furthermore, traditional organisational models of AEC firms closely resemble the structure of a functional hierarchy in which power flows vertically and upward along to formally recognised reporting chains and information is transferred downstream.

---

* Marcella Bonanomi is a Postdoctoral Research Associate at the Department of Civil, Environmental and Geomatic Engineering at ETH Zürich, Switzerland, bonanomi@ibi.baug.ethz.ch.

* Cinzia Talamo is a Full Professor at the Department of Architecture, Built Environment and Construction Engineering at Politecnico di Milano, Italy, cinzia.talamo@polimi.it.

* Giancarlo Paganin is an Associate Professor at the Department of Architecture and Urban Studies at Politecnico di Milano, Italy, giancarlo.paganin@polimi.it.

On the contrary, the recent development and application of digital technologies creates a demand for more collaborative and iterative work relationships, as well as for more dynamic and networked business models (Deloitte, 2018).

Despite the need for a systemic approach to digital innovation, very little has been done to investigate how also business models and processes, in addition to software and tools, should change for achieving a successful digital transformation. There are little methods and approaches for managing the associated process related and organisational changes, even if many studies have been performed to investigate the implementation of new digital methodologies, such as in the specific field of Building Information Modeling (BIM) (Eastman et al., 2011). However, the digitalisation of the sector goes well beyond BIM because it should be analysed, understood, and managed as a systemic innovation of practices, processes, and organisational models supported by the change of technological infrastructures. Starting from these considerations, the main research objective is to identify analytical methods and risk-response strategies (risk identification, analysis and response development) for managing the process-related and organisational changes required for a successful digital transformation of the AEC sector.

From sequential and silo-based towards iterative and collaborative processes

Regarding the conventional approach to project management processes, there are two main problematic issues in the AEC sector that could be overcome by the digitalisation:

- tasks are usually managed as functional silos rather than as cross-functional systems. This means that the deliverables of the different project phases are transmitted from one party to another right after completion and with poor levels of iteration;
- relationships are typically defined by transactions rather than by interactions. This translates in different stakeholders advancing in the process only after the conclusion of the previous phases. This practice outlines a weak interaction throughout the phases of the project delivery process.

This lack of iteration and interaction plays a critical role in determining a low sector performance in terms of process efficiency and product quality. Considering these problematic issues, as well as the emerging demand for more integrated and digitally enabled work environments, the evidence suggests that a paradigm shift should drive process innovation in the AEC sector. It is the shift from silo-based and sequential to collaborative and iterative design and construction processes (Poirier et al., 2015). The rationale for this paradigm shift can be more easily understood analysing some strategies that digitally mature firms are already implementing, namely:

- design with data – this strategy is about considering the development of design processes recognising the role of data and moving from the use of only 3D data (three-dimensional simulation as a tool for knowledge and evaluation) towards an approach that we could define D3, i.e. Data-Driven-Design. The D3 concept indicates the use of data throughout the entire project life cycle as a valuable input in relation to the possibility of iteratively evaluating project alternatives through the management of significant amounts of relevant data to look for measurable solution sets that are more satisfactory in relation to multiple parameters;
- network approach to stakeholder management – the network concept aims at acknowledging the complex nature of the relationship system in which AEC firms are embedded into. The goal of this innovative approach is to improve process efficiency and product quality shifting from chains to networks, from relationships to partnerships.

From functional-hierarchical towards dynamic and networked structures

As processes are going through a paradigm transformation from silo-based and sequential to collaborative and iterative workflows, so organisational structures must do (The Boston Consulting Group, 2016). There are multiple risks associated with overlooking the emerging need for innovative organisa-tional and operational models in the context of the digitalisation of the AEC sector. These risks can be associated to the following categories:

- Knowledge creation, diffusion, and utilisation – in traditional and hierarchical organisational structures, employees are often rigidly organised in departments and information is transferred downstream in functional pipelines. This organisational model can create problems of communication, information sharing, and decision-making. For example, employees, who are doing similar work in different departments or projects, may not be networked and informed of the parallel activities going on, thus losing the possibility of sharing experiences and business know-how. In summary, hierarchical structures do not always facilitate a cross-functional and interdisciplinary knowledge integration, which is rather one of the goals of moving toward collaborative and iterative digital processes (Deloitte, 2018). Furthermore, without an effective knowledge distribution network, the possibility for digital experts to contribute to the innovation process is limited.
- People performance and satisfaction – employees’ roles and responsibilities can change a lot when AEC firms transition towards integrated digitally enabled work environments. If the organisational structure does not formally recognise new roles, skills, and responsibilities associated with digitalisation, people could start to feel frustrated since their work, done informally, is not officially acknowledged. This condition may also be associated to a

potential flight risk. In other words, digitally skilful and trained employees, who are unsatisfied with not getting the appropriate recognition for the work done, are more inclined to accept a work proposal from another firm.

- Business process efficiency – another risk associated with overlooking new roles and responsibilities is the danger of overload. While transitioning to digitally enabled work environments, digital experts often report to supervisors that are not familiar with innovative ICT (Information and Communication Technologies) methods and tools. This condition is not a problematic issue for the business efficiency and effectiveness, if the organisation is able to seize the opportunity to look at the definition of new roles that are able to support process improvement/change with digital skills. If not, the misalignment between operating modes associated with innovative digital processes and traditional organisational models may end up in poor business performance, conflicts, and inefficiencies because different operators individually perform digital tasks.

Therefore, a systemic approach to both process innovation and organisational structure reconfiguration should be promoted to enhance the digital transformation of AEC firms. As processes digitally mature, organisational structures should change accordingly towards dynamic and networked models (Picon, 2016). Some ideas for change can be grasped observing, for transfer, the strategies which firms that are working within other digitally more mature sectors already implement:

- Dynamic network of teams as innovative business ecosystem – the rationale of this approach is to leverage network effects by shifting from functional hierarchical organisational structures to dynamic and networked ecosystems. In this setting, AEC professionals could operate as cross-functional networks of teams to respond quickly and systemically to the need for constant knowledge updating and temporary skills aggregation in relation to specific market demands. A recent article published in the Harward Business Review (2016) focuses on this latter issue arguing that a sort of "platformisation" is reconfiguring the traditional hierarchical pattern of organisational structures. This new structure allows for dynamism and flexibility within the overall organisational structure. Furthermore, the implementation of this "network of teams" can help firms to achieve a high degree of empowerment, to improve communication, and to respond to market changes.
- Visual analytics as a new approach for improving performance management – recently, digitally-mature firms have started to understand the benefits of capturing, recording, and combining data about various aspects of design and construction processes through the adoption of Business Intelligence (BI) platforms and advanced data analytics tools. The collection and integration of data coming from multiple sources aim at improving process performance, as well as providing decision-making support for the optimization of workflows and workforces.

Methods for managing process-oriented and organisational changes

The following strategies can be used as a reference for managing the changes associated with digital transformation:

- developing new organisational models in response to the emerging paradigms of change transferrable from other fields: platforms and networks;
- outlining innovative processes that can answer the need for a more iterative and collaborative approach to project management;
- defining new roles and responsibilities in accordance with innovative digital processes by either acknowledging, hiring, or training people at both strategic and operational levels;
- complementing internal business knowledge through early involvement of third parties specifically by networking with clients and suppliers to strengthen the relationships with the entire value chain.

AEC firms that are willing to undergo a digital transition should start from the analysis of their existing processes and organisational structures. First, the purpose of these preliminary analyses is to get valuable information about the organisational context, which means the business structure in relation to the specificity of its reference market.

Alongside this type of investigation, it is also important to analyse the digital maturity of both the firm’s internal resources and its supply chains (Price, Chahal, 2006).

Strategies for change can be diverse, but the changed management approach based on the cycle “assess/learn/implement” should always be applied. To apply this approach in the AEC field, the research has performed analyses of the process and the organisational structure in two multidisciplinary design firms according the following three levels of investigation:

- “as-is” that means the analysis and representation of the current situation (processes and organisational structure) before the digital transition;
- “transition”, which is the analysis and representation of the situation during the transformation;
- “to-be”, in other words the analysis and representation of the envisioned setting to be achieved after the transitional state is completed;

Regarding the approaches to understand, analyse, and visualise the changes occurring while in a digital transition, the research project has identified three different methods: Process mapping; Stakeholder mapping; Social Network Analysis (SNA).

In the herewith presented study, each of these methods have been applied, tested, and validated in an organisational context. Specifically, an Italian multidisciplinary design firm (medium size < 250 employees) has been selected to apply process mapping and stakeholder mapping as methods for understanding and managing the process-oriented changes required for transitioning to digitally enabled work environments.

A Canadian multidisciplinary design firm (large size 250 employees) has been rather used as a ground where to implement Social Network Analysis to understand and manage the organisational changes occurring while in a digital transition. The following reasons can be used to justify the choice of multidisciplinary design firms in the Italian and Canadian context:

- both countries cannot be included in the category of early adopters regarding digital technologies and methodologies. They shall be rather understood as evolving scenarios transitioning toward a full digitalisation of the AEC sector;
- both the Italian and Canadian construction industry's workforce is mainly made up of small and micro businesses.

In both the case studies, the application of the proposed analysis methods, deployed at the three investigation levels (as-is, transition, to-be) has allowed to validate the hypotheses of this research and to answer the following questions:

- What process-oriented and organisational changes are occurring?
- How do they unfold in context and according to the different maturity levels of the firm and its supply chain?
- How to draw and calibrate a change management strategy according to both the context of change and the digital maturity level?

Final considerations and future directions

The digitalisation of the AEC sector has the potentialities to radically transform the way buildings are designed, built, and operated, leading to significant changes in the way practitioners work and collaborate. Today, the technological aspects of these changes are creating great interest, while instead less focus is put on the challenges concerning organisational and process-oriented changes. It is therefore important to focus the attention of researches and experimentations on paradigm shifts, methods, and strategies to be implemented in order to set up innovative digital work environments. The introduction of digital technologies, in fact, is changing people skills and process requirements. The opportunity this may present is not just to redesign jobs, but fundamentally to rethink "work architecture". This translates in decomposing project activities into their fundamental elements – for instance, assessment, production, problem-solving, communication, supervision – to analyse and test new combinations of enabling technologies and human work in relation to the specific features of the AEC sector. To recognise and capture the full benefits of possible changes, AEC firms must undergo a deep business transformation by both re-engineering processes and re-configuring organisational structures. This transformation can take as a reference a scenario made by collaborative and iterative processes managed by a dynamic network of teams and underpinned by integrated digital technologies platforms.

Regarding this scenario, the operators involved in the digital change can avail themselves of methods for system analysis and risk management and find valid support in a set of investigation activities and applied research, such as:

- collection and analysis of benchmarking data by investigating more and more case studies;
- interpretation of digital changes through the deepening of investigations on best practices;
- analysis and comparison of organisational strategies for the digitalisation of the AEC sector in relation to different market situations and diverse contexts (economic, regulatory, social, etc.).

References

Deloitte (2018), “The rise of the social enterprise”, available at: https://www2.deloitte.com/insights/us/en/focus/human-capital-trends.html (accessed 18 September 2018).

Eastman, C.M. et alii (2011), *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*, 2nd ed. Wiley, Hoboken, NJ.

Harward Business Review (2016), “Instead of Optimizing Processes, Reimagine Them as Platforms”, available at: https://hbr.org/2016/12/instead-of-optimizing-processes-reimagine-them-as-platforms (accessed 18 September 2018).

McKinsey (2016), “Imagining construction’s digital future”, available at: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future (accessed 18 September 2018).

Picon, A. (2016), “From Authorship to Ownership”, *Journal of Architectural Design*, vol. 86, n. 5, pp. 36-41.

Poirier, E., Staub-French S., Forgues, D. (2015), “Embedded contexts of innovation: BIM adoption and implementation for a specialty contracting SME”, *Journal of Construction Innovation*, vol. 15, n. 1, pp. 42-65.

Price, A.D.F., Chahal, K. (2006), “A Strategic Framework for Change Management”, *Journal of Construction Management and Economics*, vol. 24, n. 3, pp. 237-251.

The Boston Consulting Group (2016), “Digital in Engineering and Construction. The Transformative Power of Building Information Modelling”, available at: https://www.bcg.com/ publications/2016/engineered-products-infrastructure-digital-transformative-power-building-in formation-modeling.aspx (accessed 18 September 2018).

1.9 THE DIGITAL CHALLENGE FOR THE INNOVATION OF DESIGN PROCESSES

Alessandro Claudi de Saint Mihiel[*]

Abstract

The context of design research appears today increasingly characterised by networks, platforms, clusters and districts for sharing, interchange, knowledge transfer. The new drivers of the contemporary project are inevitably connoted by the proliferation of information technologies. The era of these technologies has stimulated several challenges concerning both the methods and the ways in which we design cities, architectures, objects, which directly invest the ways of producing and building, living and inhabiting. The digitalisation of the construction sector, already interpreted as the most tangible expression of the fourth industrial revolution, is destined to radically condition the design processes, both in the contents and in the processing methods, not intended as representative techniques but as the decision-making processes of a design nature that they underlie.

Keywords: Digitalisation, Information, Knowledge, Innovation, Enabling technologies

Introduction

It has been clear - within the disciplines of Architectural Technology - for more than 30 years that information technologies and project information are at the base of a complex planning thinking and therefore are not relegated to pure instrumental aspects.

In *Il Governo del Progetto* (The project governance) of 1987, a text that anticipated by 30 years the current phenomena linked to the role of information technology in the sphere of the architectural project, it is underlined that «since the first industrial revolution, and even more in the recent phase of the great technological innovations and beyond, the project is extended to the new spaces of theoretical and operational research, of calculation. From openness to broader perspectives, to potential alternatives offered by automatisms and computer processing» (Zanuso, 1987, translated by the author).

The theme of the relationship between information and project constitutes and has constituted a central element in the search for a balance and a new relationship between information systems and design practice. In this sense - again

[*] Alessandro Claudi de Saint Mihiel is a Researcher at the Department of Architecture of the University of Naples Federico II, Italy, alessandro.claudi@unina.it.

in the volume mentioned above - we see how «the culture of old manuals replaces a new information culture, proposed by the telematic era [...] an immaterial, underground transformation that involves the entire social and physical system, implying radical methodological and instrumental changes for the management of the architectural project and its quality» (Gangemi, 1987, translated by the author).

These preliminary considerations are aimed at understanding the key to interpret the theme of the conference session "Quality of the project, quality of construction. Technological innovation and ICT for the building process": in order to guarantee the quality of the project, the quality of the information that underlies the project must be guaranteed.

Scenario

As highlighted by the former Minister of Economic Development Carlo Calenda, the digitalisation of production processes in general represents not only an opportunity for the economic growth of the Country, but it is also and above all a change of epochal scope that cannot be avoided, «facing such profound changes, you are a protagonist, or you are overwhelmed»[1].

In order to respond to the new Open Innovation challenges, the technological frontiers of Industry 4.0, the digitalisation of the construction sector, interoperability and "real and virtual" performance simulations, I think we should strategically focus on training, an ongoing formation which in the current historical phase coincides with processes of permanent innovation and in which knowledge plays a decisive role in industrial, economic and social development. The framework that is looming today, and around which all the strategies of the countries competing with ours revolve, «is that of a market in which the digitalisation of the sector, already interpreted as the most tangible expression of the fourth industrial revolution, is destined to radically condition the design processes, both in the contents and in the processing methods» (Del Nord, 2016, translated by the author). However, Del Nord does not mean in the representative techniques but in the decision-making processes of a design nature that they underlie. Ultimately «it is not about doing old things in an innovative way: it is about doing new things in new ways»[2].

More generally, it is necessary to review the current training model to ensure the availability of (not only digital) competences that are coherent with the new context; «and the goal of a training process today can only be the construc-

---

1 Carlo Calenda, Minister of Economic Development, parliamentary hearing on the issues of Industry 4.0, Chamber of Deputies, Rome, 15 June 2016. Translated by the author.

2 Carlo Calenda, *ibidem*.

tion of cognitive maps that allow us to orient ourselves in the informative universe in which we are immersed» (Campioli, 2016, translated by the author).

It is clear how the quality of knowledge determines the quality of the information of the architectural project, establishing its constructability and compliance with the current requirements of safety, energy efficiency and resilience.

What is knowledge? It is certainly not easy to give an effective synthetic definition. The economists Lundvall and Johnson, in a 2006 paper entitled “Science, Technology, and Innovation Policy” highlight four dimensions:

- *know what* it concerns the possession of information or the knowledge of “facts”; it is information that can be transmitted and disseminated with the help of data-bases;
- *know why* it concerns the principles and laws that govern the phenomena. It is the theoretical knowledge that is the basis of scientific and technological research that allows the innovation of processes and products;
- *know how* it is linked to the individual and shared working experience in the different groups united by homogeneous practices, it constitutes the human capital of a company and of the various social networks;
- *know who* it identifies people who can find solutions to complex problems. This element of knowledge makes it possible to construct networks in a perspective of broad and intense interactivity.

We use knowledge to attribute meaning to a specific situation: knowledge interprets information about a situation, to decide how to manage it. For this reason, as affirmed at the international conference “The Changing Architect” held in Naples in May 2017, it becomes relevant the aspect linked to the advanced training of figures capable of «integrated management of decisional, planning and construction processes through knowledge and, therefore, the appropriate use of new digital methodologies in a strategic vision that, respecting the chain of responsibilities, preserves the cultural, ethical and intellectual value that underlies the planning and construction, and therefore of making architecture» (Lucarelli, 2018, translated by the author).

The new scenarios, inevitably connoted by the proliferation of information technologies[3], are connected with obsolescence in the construction chain.

In sharp contrast with other sectors, the construction industry - despite being one of the major flywheels of the world economy - is among the most reluctant to technological innovation, presenting a minimum level of digitalisation of the sector. Defined by Mark Bew, in the report on the digital future “Built Environment 2050” as “the last bastion of the analogue world”, the building sector is affected by the resilience of a system based on traditional methods, not accustomed to change and characterised by extremely slow changes.

---

3 The growing connection between computers, actuators and sensors available at increasingly low cost is associated with an ever more pervasive use of data and information, of computational technologies, of new materials, components and intelligent systems of production that are fully digitised and interconnected: internet of things and machines.

As it is known, the field of Information Communication Technology (ICT) sets a system of tools for the technical control of interventions and the different performances of the building, in order to define innovative methodologies and develop integrated strategies and decision support tools. Among the ICT tools, definable as the set of technologies that allow to process and communicate information through digital media BIM (Building Information Modeling) applications are contributing to the AECO sector (Architecture, Engineering, Construction, Operations)[4]. The principles of Building Information Modeling should be seen in the context of Industry 4.0, referring to the role that the project can have if linked to Key Enabling Technologies. «The new enabling technologies allow the activation of a circular process of production and analysis of data, simulations, models, re-configurations and corrective actions. In this process BIM prefigures methodologies and tools that allow the implementation of a new integrated system that is completed in broader chains through the governance of continuous circular processes» (Losasso, 2018, translated by the author).

We must not therefore make the mistake of concentrating on the tool but on the centrality of the information that must be managed by these tools in terms of constructability and organisation of the process. So when we talk about BIM without going into its 8 "dimensions" (Visualisation, Time, Cost, Energy, Facility management, Safety) and the different meanings of the letter "M" (Model, Modeling, Management) «it is important that "M" assumes the highest status of semantic memory storage» (Argiolas, 2015, translated by the author).

However, it can be seen that the practices consolidated by the actors of the building process use the potential of BIM and ICT tools as if they were traditional CAD tools. As pointed out by Andrea Campioli[5] it is not a problem of three-dimensional modelling, the centrality must be identified in the production and management of information related to the products that must be used and the actions that must be performed throughout the life cycle of an artefact.

It is equally evident, however, that it is not only a problem of quantity and correctness of the exchanged information, but above all of their interpretation and the meanings associated with them. «There is the difficulty of interpreting the needs of a society in continuous transformation, which consists in the incapacity, if not the impossibility, of only one or a few subjects to interpret the totality of new needs and to elaborate appropriate design solutions» (Carrara, 2017, translated by the author). In this sense, an interesting research in the BIM area concerns the configuration of a digital knowledge platform BKM - Build-

[4] The digitisation of the ACEO sector requires and will require ever more substantial economic investments aimed at a rapid adaptation of training processes to respond to the growing market demand. We need to invest more and more and orient our educational system towards skill empowerment, with particular reference to STEM disciplines (science, technology, engineering and math) and technical and professional training.

[5] Intervention during the "Incontri dell'Annunziata" Study Days, Ascoli Piceno, May 2017.

ing Knowledge Modeling - able to bring together, in addition to information, the knowledge of the individual actors.

This requires a correct understanding of the information associated with the design solutions. However, the different cultural formations and the different specialist technical skills create what Carrara himself defines a “symmetry of ignorance” as a barrier, sometimes insurmountable, to mutual understanding, which prevents a correct and effective design interaction. The central innovation of the BKM project is the definition of an open, modular and scalable collaborative environment, capable of formalising and exchanging information of a high semantic level (concepts and not just data, as it currently happens), typical of multidisciplinary project actions, allowing mutual understanding between agents (human or software) belonging to different disciplinary fields.

The Net brings connectivity into the community. It transfers to each of us a hypertextual dimension. Not only, therefore, the communicability of the individual elements as a fundamental characteristic of the new medium, but the possibility offered for the creation of a cognitive artefact.

In conclusion, we could hazard a comparison of the various BIM-BKM specificities, with the differences between “collective intelligence” and “connective intelligence”[6].

Perspectives

The aim of this contribution, without pretension of exhaustiveness, was to frame the phenomenon of the digitalisation processes of architecture in general and of BIM applications in particular. In this cultural field one cannot ignore that the goal of the training processes can only be the construction of cognitive maps to orientate in the universe of information - and related connections - that characterise the contemporary project.

It would be risky, to say the least, to include the BIM as an integral part of the training paths, without starting from this assumption.

First, because the enthusiastic diffusion of these tools can undermine the awareness that these will bring about a radical change in the design practice.

Secondly, because a possible all-encompassing assumption of this instrumental dimension underlies a deterministic view of the architectural project by renouncing the heuristic dimension that also incorporates the creative aspect as a prefiguration of hypotheses to be measured and scientifically validated.

---

[6] Recalling the theory of Collective Intelligence by Levy, Derrick de Kerckhove, a Canadian national sociologist from Belgium, assistant to Marshall McLuhan and professor at Federico II of “Sociology of digital culture”, in his book *Architecture of Intelligence* has updated and adapted it to the technological context of networks, aiming at connecting intelligences as a synergistic approach and meeting of single subjects to achieve a goal.

The role of the designer must not be flattened into a simple application of already codified solutions. Otherwise, the design would be reduced to a determinological, therefore uncritical activity with respect to the purpose of a continuous interpretation of reality[7].

In addition to the identified risks, it is clear the difficulty of setting up a theoretical tool that can align itself with the new digital tools, creating a valid assumption on the training plan. Rather and very often «the theoretical reflection is limited to chasing information technology in its mad rush, losing itself in the comprehension-reconstruction of manuals related to various software applications, in a dispersive and labyrinthine proceed to the search for know-how, not always of high epistemological profile» (Ricci, 2006, translated by the author).

We need to know how to manage information that is increasingly present, interactive, and available in real time, with fewer and fewer boundaries between the different fields. It is necessary to understand whether «this revolution highlights, once again, the crisis of modernity or rather marks a phase of it in which the fragmentation of functions, typical of modernity, is replaced by simultaneous synchronisation, by an integrated system of information that allows us to create unified experiences» (Sacchi, Unali, 2003, translated by the author).

In conclusion we can affirm that the elements of the future are on the mat. The technological development with which the project is called to confront imposes choices, it is a question of whether the project should aim at controlling technological evolution by using it in an instrumental dimension, or if the project and the new technologies should be rather seen as a unitary and indivisible place of creative elaboration.

Personally, I share this second vision.

References

Argiolas, C., Prenza, R., Quaquero, E. (2015), *BIM 3.0 dal disegno alla simulazione: nuovo paradigma per il progetto e la produzione edilizia*, Gangemi Editore, Roma.

Campioli, A. (2016), “Tecnologia dell’architettura: un aggiornamento identitario”, in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano.

Carrara, G. (2017), “Complessità e crisi del progetto, collaborazione e conoscenza”, in *Techne*, n. 13, Firenze University Press, Firenze.

---

7 Thomas Maldonado spoke about these “drifts” in an interview entitled “Web: if there is a spider web, there must be a spider” of 1997 motivates the title of his latest book *Critique of Computer Reason* stating that «Technology is not a determining factor, but a conditioning factor of cultural processes. I believe that, indeed, there is an exaggeration, an exasperation of a certain vision of society; according to this interpretation, the company has undergone a radical change only due to new technologies. New technologies are important, they can have a significant impact on our daily lives. But, once again, the emphasis makes us forget a series of open questions on which we must reflect».

Del Nord, R. (2016), “Potenzialità dell’area tecnologica in tema di ricerca progettuale”, in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano.
Gangemi, V. (1987), “Progetto e informazione: manualistica e tecniche esecutive”, in Gangemi, V., Ranzo, P. (eds), *Il governo del progetto. La Tecnologia per la formazione dell’architetto*, Luigi Parma, Bologna.
Losasso, M. (2018), “Presentazione”, in Russo Ermolli, S. (ed), *The Changing Architect. Innovazione tecnologica e modellazione informativa per l’efficienza dei processi*, Maggioli, Santarcangelo di Romagna.
Lucarelli, M.T. (2018), “Presentazione”, in Russo Ermolli, S. (ed), *The Changing Architect. Innovazione tecnologica e modellazione informativa per l’efficienza dei processi*, Maggioli, Santarcangelo di Romagna.
Ricci, G. (2006), *Itinerari narrativi tra realtà e simulazione*, Liguori, Napoli.
Sacchi, L., Unali, M. (2003), *Architettura e cultura digitale*, Skira, Milano.
Zanuso, M. (1987), “La cultura del progetto: dal meccanicismo all’organicismo”, in Gangemi, V., Ranzo, P. (eds), *Il governo del progetto. La Tecnologia per la formazione dell’architetto*, Luigi Parma, Bologna.

1.10 New management models for design and construction: the Solar Decathlon ME 2018 experience

Antonio Basti[*]*, Michele Di Sivo*[*]*, Adriano Remigio*[*]

Abstract

This text explores the application of BIM in architectural design. In particular, it looks at the potentials offered by this methodology in the prefiguration and management of the diverse phases of construction. Specifically, the text describes the participation of the team from the G. D'Annunzio University of Chieti-Pescara in the Solar Decathlon Middle East 2018. Based on the creation of a BIM model for the solar house designed for the competition, this study led to the conceptual identification of a BIM based digital supports, useful to guide operators (decathletes, skilled workers, technicians) during the assembling and disassembling activities, and to make as easy as possible the verification of quality and the correspondence between what is designed and what is built.

Keywords: BIM, Architectural Quality, Technological Innovation, Construction Management

Introduction

The application of BIM (Building Information Modelling) technologies to architectural design, nowadays represents an ineluctable reality as confirmed by the recent application experiences, as well as by recent laws and regulations.

Referring to the Italian context, it is sufficient to consider the issuance of the UNI 11337 standard on digital management of construction works (Italian Authority for Standardisation, 2017) and the integration of BIM within the new Public Procurement Code (Italian Government, 2016).

Recent studies highlight the opportunities linked to the use of BIM methodologies to manage the physical and spatial elements of a project, the interaction between the various professionals involved in the design and construction process, the timing and economic forecasts related to the feasibility of the project

[*] Antonio Basti is an Associate Professor at the Department of Architecture of the University of Chieti-Pescara, Italy, antonio.basti@unich.it.

[*] Michele Di Sivo is a Full Professor at the Department of Architecture of the University of Chieti-Pescara, Italy, michele.disivo@unich.it.

[*] Adriano Remigio is a freelance architect, graduated from the University of Chieti-Pescara, Italy, adrianoremigiouni@gmail.com.

and, finally, the census of the physical and technical documentation of existing buildings (Eastman et al., 2011; López et al., 2018).

It is also interesting how the use of these technologies forces us to redefine not only our approach to the project, but also our technical vocabulary and conceptual and operative tools used to share information among the various operators involved in the construction process.

The traditional linear approach to project production, based on the progressive, deeper exploration of technical-building characteristics, and divided into the three levels defined by the Public Procurement Code (Italian Government, 2016) as preliminary project, definitive project and executive project, tends to suffer from a temporal concentration during which the definition of functional and spatial qualities are fused with the direct identification of geometric and performance-related qualities of the elements and building systems.

Of particular interest it appears the innovation introduced by the spread of BIM object databases of building products, also for the potential impact of their use in the early definition of the construction choices. These objects are developed by manufacturers interested both in providing designers with technical supports that simplify three-dimensional modelling activities, and to capturing a share of the market by accompanying 3D models of their products with technical data sheets. Some even go as far as providing quality certifications and technical or/and performance specifications (e.g. the NBS - National BIM Library of building products in the United Kingdom or BIM Object).

Equally, also to produce design documents, the availability of a single “informed” three-dimensional model raises various considerations about the possible methods of communication, sharing and control of building solutions. More specifically, it is possible to imagine accompanying traditional two-dimensional drawings, required in any case for administrative purposes, with something akin to “multimedia” documents. These can be used by individual operators to navigate through the project to extract information as it becomes necessary. This makes it possible to ensure the correspondence, qualification, documentation and certification of what has been built. Last but not least, it is possible to imagine these same tools being used to support contractors and skilled workers during the logistic and temporal organisation of what we can refer to as the “digital building site” (Zhiliang et al., 2018).

Objectives, materials and methods

In the wake of these considerations, the decision was taken to make an early, though certainly not exhaustive, test of the BIM methodology as part of the design of a prefabricated and self-sufficient solar house designed by the team from the University G. D’Annunzio of Chieti-Pescara for the international Solar Decathlon ME 2018 (SDME 2018) competition.

The rigorous requirements of feasibility and transportability imposed by the rules, coupled with the limited time allowed for assembly/disassembly (respectively 15 and 7 days), made the SDME 2018 an important opportunity to test the advantages offered by BIM, in particular the potentialities for optimisation and digital management of the production and construction phases.

The principal objective of the study was to create a complete 3D model, articulated by building and technical subsystems according to the Italian UNI 8290 classification (Italian Authority for Standardisation, 1981). The model provides all information and details required to permit the successive articulation and querying of each technical element or technological unit.

The specific objective was to use the BIM model to develop procedures and tools for a 4D construction site programme, that considers the granted timeframe and the expressed necessity, as by the rules, that the decathletes (non-expert students) were to be directly involved in the construction of the building. A particular aim of this phase was to the test the interactions between the different digital tools utilised to verify the realistic possibility to develop digital supports that can be easily queried and consulted by users, either in training or non-specialised (in IT or constructions fields).

From the point of view of the case study, the solar house is a one-storey construction with a gross area of roughly 100 square metres. To confront adverse climate conditions, its volume is protected by an external skin designed to adapt to different meteorological situations. The primary technologies and materials are steel, rockwool, OSB panels, aluminium and gypsum board (see Figure 1).

From the perspective of the BIM modelling, the 3D model was developed in Revit and the 4D model in Navisworks both by Autodesk©. Both were licensed free of charge to students and professors, and familiar to and utilised by the co-author of this text A. Remigio. In methodological terms, the work was structured according to the indications provided by the Italian UNI 11337 rules (Italian Authority for Standardisation, 2017 op. cit.) codifying LOD (Levels Of Definition). Beginning with simple geometric masses framing the forms of the building (LOD A), the following phases defined the single parametric objects (technical elements), organised in “families” based on technological unit classes (structures, enclosures, systems, partitions, equipment). Each “family” contains the technical and geometrical attributes, common to each single object of the family itself. These attributes can be accessed and modified both at the level of the family and the level of each single object directly from the relational database associated with the 3D model (LOD C and D). The successive step was the construction of a WBS (Work Breakdown Structure) for the project, used to develop the 4D construction site programme. The process for converting the 3D model within the Navisworks platform requires a preliminary and univocal identification and codification of objects within a relational structure of reference (Utica et al., 2017).

This guarantees their traceability and position during the construction phases (LOD E). Once the “object” codes have been assigned to the time schedule, it becomes possible, using virtual simulations, to control interferences and ensure the fluidity of the phases of construction and the correct organisation of human and material resources.

Finally, simplified multimedia files can be extrapolated and queried. Based on the WBS, they make it possible also for non-expert users of Revit to access the information, graphics, process and technical information required to improve the organisation of the construction site and certify its results.

Results

As mentioned, the objective of the process of BIM implementation was to create an information database for a project whose single materials/products and technical elements are fully documented and classified in order to optimise the manufacturing and construction phases. In particular, the study concentrated on evaluating the implications of shifting different phases of work from the construction site to the workshop, typical of the organisation of prefabrication processes on a modern building site.

Two distinct simulations were made of the object of study: one referred to traditional in situ construction and a second based on the preassembly of technical/functional elements. This latter was designed considering the time restrictions of the competition, the need to transport material to the site and the know-how of the companies involved. The traditional construction site is based on a linear process (structures, enclosure, systems, finishes, furnishings) with an expectable increase in time (and costs) for building on site. It also often involves interferences between building contractors and systems installers, forced to overlap on multiple occasions.

Vice versa, a prefabricated building site helps reduce this problem by breaking the house down into four subunits preassembled in parallel, produced autonomously, transported to the site and assembled in situ using only dry jointing technologies. As an example, referred solely to the structure (steel space frame), the implementation of an industrialised and serial manufacturing process revealed a potential savings in construction time of approximately 64% with respect to a traditional in situ solution.

Equally, the adoption of a BIM approach to the modelling of objects (technical elements) made it possible to affect the quantitative and qualitative control of products and materials chosen. Each object has a graphic and informative transcalarity that allows, for example, for the production of more precise two-dimensional output (for example the construction drawings), or to extract quantitative data referred to specific subunits of prefabrication (such as the total weight or percentage of the opaque vertical enclosures or envelope panels).

This information is useful also for the optimum breakdown of construction subsystems (e.g. the external envelope) linked to transportation, to the pre-calculation of the weight of each shipping container, the definition of site equipment, programming the assembly sequence of the four subunits.

A particular consideration must be made of the LOI (Level Of Information) associated with BIM objects, which tends to influence the LOD that can be achieved in a model and, as a consequence, the level of quality of the project. There is a passage from simple lines of text inserted by manufacturers or designers, useful for identifying individual materials or technical elements (e.g. the product code of an aluminium mullion that is part of the opaque vertical envelope) to the implementation of technical product charts, quality certifications and construction site documents.

What emerges is the need to standardise as much as possible the LOD of all modelled components, in harmony with the level of advancement of the project.

To this end, it is useful to operate already during the modelling phase, providing the single families with several geometric parameters and information fields, that can be gradually implemented and updated by designers, manufacturers and builders. The result is the construction of a 3D model as faithful as possible to the real configuration of the building or its individual parts.

With this aim in mind, during the modelling phase, single families with geometric parameters and information fields were gradually implementable and updatable by designers, manufacturers and builders. The final result is the construction of a 3D model as faithful as possible to the real configuration of the building and its individual parts.

Similarly, the adoption of a codified WBS made it possible to easily query the model to calculate the quantities, availabilities and geographic position of each of the house's technical elements, during all phases of manufacturing. From this point of view, the experience suggested an approach that split the 3D model into architectural, structural and MEP (Mechanical Electrical & Plumbing) modules. This subdivision is already found in the software and hierarchically organised such that the first hosts the other two. While this procedure is initially laborious, it later offers an improvement in information management and multidisciplinary coordination and a reduction in drawing production time.

The construction of the WBS also made it possible to simulate different building scenarios for optimising production times in the factory and on site. The univocal identification of each single component made it possible to associate them with a particular construction phase, with forecast start and end dates, the number of workers involved and the type of work to be carried out. All of this is developed in an interactive manner, thanks to the synchronisation between the two platforms (the BIM model in Revit and the 4D Navisworks time schedule).

In this manner, changes made to the BIM model during intermediate designs revisions are immediately absorbed by the time schedule of manufacturing and building activities and eventual incongruencies and interferences are highlighted. The experience also made it possible to confirm the initial methodological assumptions about the optimum LOD for an exhaustive 4D construction site programme (LOD E). In other words, the 4D modelling requires a "solid backbone", the WBS, but also a consistent reinforcement in the network of data and information. This also serves to lay the bases for the future development of 5D cost analyses. In any case, it does not affect the possibility to carry out building site simulations also with less accurate LOD, focused on identifying organisational changes correlated with the development of a project.

A final consideration should be made about the modification of the communication methods and instruments, linked to the adoption of a BIM approach. the complete digitalisation of project, also supported by portable devices (tablets and smartphones), tends to make the use of hard copies increasingly less suitable to represent the full complexity of "informed" projects.

This is more evident during the construction phase, when the availability of additional 3D information in the form of dynamic axonometric sections both general and detailed, in lieu of canonical 2D representations, could assist operators during assembly.

The sole obstacle to the concrete implementation of this methodology appears the familiarity on BIM possessed by the various figures involved in the construction industry. Its application on a real experience showed the necessity to produce simplified outputs, preferably multimedia, to ensure the visualisation, querying and eventual implementation of information for non-expert users. In the case study, the optimum output took the form of an assembly manual, provided in an easy to consult format for decathletes and on site operators (suppliers, skilled worker, technicians).

Conclusions

The experience described, far from an exhaustive exploration of the topic, highlighted a vast number of aspects related to the use of BIM in design and construction process. in particular about the implementation, updating and querying of the structured collection of data, represented by the "informed" 3D model, that requires the adoption of specific methodologies and procedures for the organisation of graphical and technical information, able to facilitating the data access to a wide range of operators, with different levels of technical and IT (Information Technology) skills.

The potentiality of data integration hints the possibility for interventions both during and after the building construction, to direct its realisation (acceptance and certification of materials and products, documentation of constructive solutions adopted), document its final characteristics (as built status, traceability and final performance of materials and products used) and manage the subsequent maintenance and transformation works.

Finally, the possibility to create a shared web-based platform of BIM products whose minimum information content is both controlled and guaranteed (mechanical, thermal and environmental characteristics, maintenance and construction), coherent with diverse regulations and laws.

References

Ente Italiano di Normazione (1981), *UNI 8290-1. Edilizia residenziale. Sistema tecnologico. Classificazione e terminologia*, Italia.

Ente Italiano di Normazione (2017), *UNI 11337, Edilizia e opere di ingegneria civile - Gestione digitale dei processi informativi delle costruzioni*, Italia.

Eastman, C., Teicholz, P., Sacks, R., Liston, K. (2011), *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*, 2nd Edition, John Wiley & Sons Inc, USA.

Governo Italiano (2016), Decreto Legislativo 50/2016, *Codice dei contratti pubblici*, Italia.

López, F.J., Lerones, P.M., Llamas, J., Gómez-García-Bermejo, J., Zalama, E. (2018), "A Review of Heritage Building Information Modeling (H-BIM)", *Multimodal Technologies Interact*, vol. *2*, issue 2, pp. 1-29.

SDME (2017), "Solar Decathlon Middle East. Guide to the competition", available at: https://www.solardecathlonme.com/assets/pdf/rules.pdf (accessed 21 September 2018).

Utica, G., Pinti, L., Guzzoni, L., Bonelli, S., Brizzolari, A. (2017), "*Integrating laser scanner and bim for conservation and reuse:the lyric theatre of milan*", available at: https://www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/IV-5-W1/77/2017/ (accessed 21 September 2018).

Zhiliang, M., Shiyao, C., Na, M., Qiliang, Y., Junguo, F., Pengyi, W. (2018), "Construction quality management based on a collaborative system using BIM and indoor positioning", *Automation in Construction*, vol. 92, pp. 35-45.

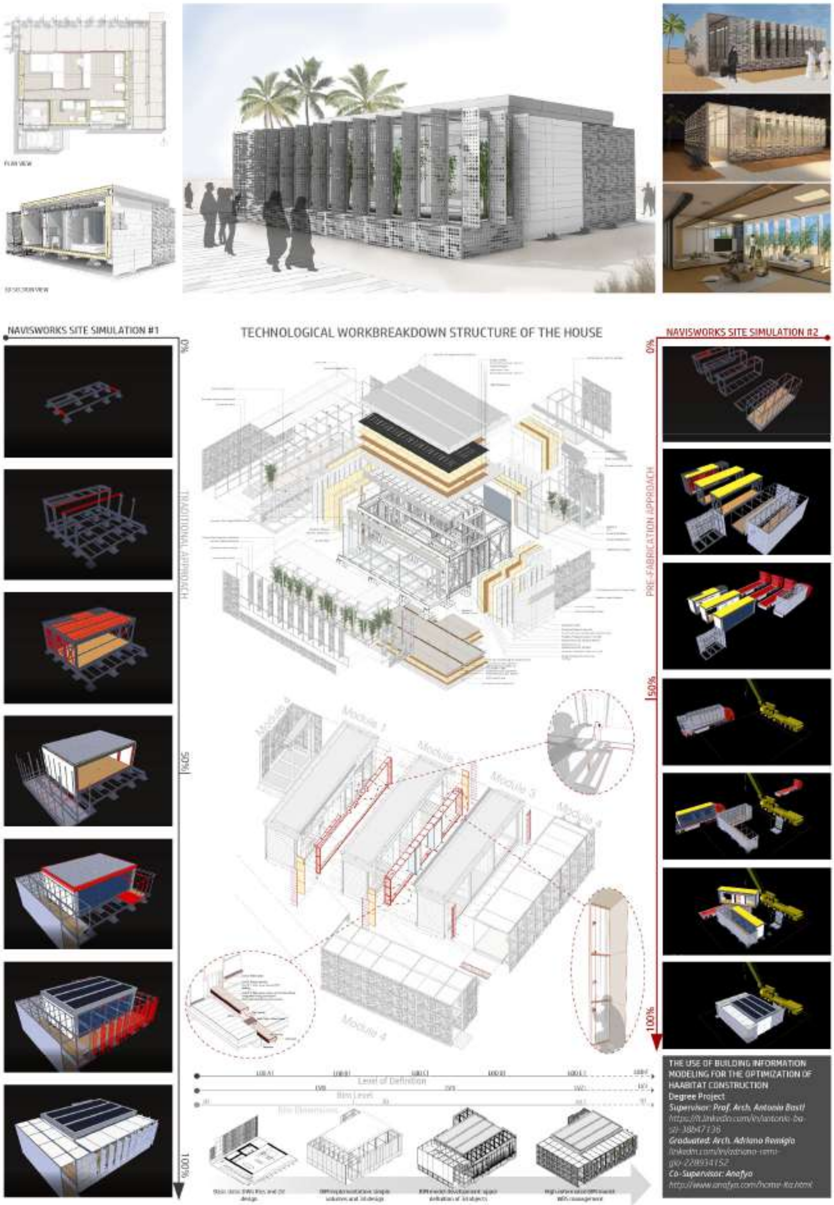


Fig. 1 - BIM design and optimisation of the construction process.

1.11 TOWARDS A MAINTENANCE 4.0. CHANCE VERSUS NEED

Maria Azzalin[*]

Abstract

Sustainability, resilience, recovering, adjustment, reuse, are expressions of urgency-emergencies. Interoperability, IoT, Big Data, Cloud, Augmented Reality, some terms of a new lexicon. They all introduce assumed discoveries and innovated approaches. They support and reaffirm the necessity of a proactive acting in a new dimension.
Maintenance 4.0. A mix of automation, connection, information and planning, whose operational routine goes transforming itself thanks to the Lean Thinking and the Digital Transformation. However, computer technology is only the motor not the pilot of the new way of working. The revolution involves the tools but it can take place only through coherent processes: the constant maintenance, the taking care of. Opportunity versus necessity.

Keywords: Maintenance 4.0, BIM, Augmented Reality, IoT, Lean Construction

Urban transformations, whatever be their nature, genesis or the mechanisms that rule them, happen according to a sequence that is expressed, on one side, through actions, which connects the subjects that make them to the objects that receive them and vice versa. On the other side, through connections that, inevitably became active in space and in time, and that concern the technical, economic-financial and social sphere, but also ethical and that of behaviour. Actions and connections that have a sphere of activities and reaction time, sometimes synchronous, evident, sometimes asynchronous, hidden inside the «pulsation of a butterfly's wings» (Lorenz, 1972). An image that in its poetic beauty, expresses an important physical-mathematical concept, partly already anticipated from Turing (Turing, 1950) and developed by Lorenz with his studies on Chaos Theory, according to which also light alterations of beginning conditions, are able to cause great variations in the behaviour of a physical system for a long time term. As a result, then, referring to the environmental transformations caused by man, the intervention of what Jonas defines «principle of responsibility» is inevitable (Jonas, 1979) that has to be applied for guarantee-

[*] Maria Azzalin is a PhD at the Department of Architecture and Territory, Mediterranea University of Reggio Calabria, Italy, maria.azzalin@unirc.it.

ing the survival of the future generations. It is the same axiom that we find again declined in the Protocol of Kyoto (1992), as «principle of precaution».

Also in the Theory of Decrease, of the circle of the eight “R”, by Latouche whose exhortation to the saving of the resources, if moved to architectural and urbanistic area of interest, sets up the “R” of the reuse and of the recovery of the existing building and, therefore, of the maintenance. (Latouche, 2007)

If on the one hand then, while pandering the principle of responsibility, sustainability and resiliency become the possible keys to reading of the environmental actions/transformations caused by man, in terms of respect, safeguard and maintenance in time; on the other hand the same terms are set as indicators of no longer negligible urgencies/emergencies of retraining, reuse, safety. Not only that, they feed, if brought back into the disciplinary and operational framework of the Maintenance, an urgent demand for innovation of the intervention processes on the existing heritage, but also of the design processes.

Chance versus necessity. Not with meaning of opposition, instead as expression of an active dualism, propositional. Transformations that demand the Maintenance a rereading of its own traditional strategies and operational practices, conjugating the three aspects of sustainability - social, economic, technical - in a perspective of resiliency, able to involve the different levels of action. Territory, city, building. But they also impose redefining and updating its own role inside the whole building process compared to new competences and professionalisms that the digital revolution has already introduced and to new approaches based on the transfer of the Lean Thinking (Womack et al., 1991) also to the sector of the constructions.

Today, we are truly living a real new revolution: The Fourth one. Every precedent step: Mechanization (XVIII century), Production in series (XIX century), Automation (XX century), has meant a deep transformation of the productive process and a general increase of productivity.

The current step that of Digitization also imposes a radical change of paradigm. A cultural revolution, in which, together with the principles of new disciplines such as the Ecology of the Mind by Bateson (Bateson, 1972) or the Behavioural Economics by Thaler (Thaler, 2016), Nobel prize in Economics in 2017, a new condition is becoming apparent. A condition in which “material and virtual” take on the same value in terms of resources to be put in value.

A vision of “digital oriented” development strongly stimulated by different national governments including Italy that, through the National Plan Industry 4.0 2017-2020, has introduced a series of measures finalized to favour the investments related to integration of “physical goods and digital technologies.”

Orientations in comparison to which the construction sector expresses proper and peculiar critical issues: If, from the one hand, in fact, the necessity of a strong acceleration in terms of innovation is shared, from the other one it is clear the limit to be the sector that has always been slow and unwilling to accept changes. Critical issues that have been underlined also by the World Economic Forum of Davos in 2016 on the Fourth Industrial Revolution, during which a specific focus has been dedicated precisely to the construction sector.

A missed opportunity, whose consequences, to date, are a general backwardness of the sector and a low productivity. Characteristics analysed and confirmed by a study, in 2017, of the CYFE (Centre for Integrated Facility Engineering) of the Stanford University (Fischer, 2017).

A background, this till now introduced, particularly articulated, useful in understanding dynamics and opportunities of digital transformation/innovation offered by Industry 4.0, characterized, according to the analyses conducted by some groups of experts from different Centres, among which the Boston Consulting, essentially from three levels of development: Smart Production, Smart Services, Smart Energy.

Three interacting levels that outline development guidelines towards which, the various sectors including the Constructions one and the Maintenance itself, must necessarily aim at.

Therefore, close to the terms sustainability and resiliency are placed Internet of Things, Big Data Analytics, Cloud, Interoperability, Virtual Reality and Augmented Reality, terms, that as the first ones, are no longer negligible, voices of a new lexicon which introduces to innovated approaches and to as many innovative operating practices of the design project and of Maintenance one in particular. According to a study conducted by the Italian Maintenance Association (AIMAN, 2017), Maintenance represents one of the most important areas involved in the strategies related to Industry 4.0. Both for the type of services provided, which affect all production sectors indifferently; and for the final objectives of such services, functional to keep in efficiency and to guarantee the correct functioning of the object maintained in the life cycle.

The National reference standard (UNI EN 13306:2018 Maintenance - Maintenance Terminology) defines it as «the combination of all the technical, administrative and managerial actions, during the cycle of life of an entity, directed to maintain it or to bring it in a state in which can perform the required function». Thus, if the objective of Maintenance has always been «to adapt and where possible constantly improve the systems to the changing needs expressed by users, redesigning or replacing them when necessary» (Cattaneo, 2012), clear expression of the requests for resilience, what is now becoming an element of innovation is a proactive maintenance approach.

An approach that, abandoning the principles of passive prevention, the FMECA, Failure Mode and Effects Criticality Analysis (Blanchard, 1978) and assuming as its own those of TPM, Total Productive Maintenance (Nakajima, 1998), bases its assumptions on active prevention, on the Lean Thinking (Womack et al., 1991) Lean Construction (VV.AA., 2014). Strategies, these latter that, already established in other industrial sectors, are spreading also in the construction sector in association with the IPD Integrated Project Delivery (AIA, 2007) and at BIM, Building Information Modeling (Borrmann et al., 2015), developing new production, organizational and management opportunities and, therefore, also a “Maintenance 4.0”.

It is always the AIMAN, to this regard, to state the necessary elements so that Maintenance actually enters the era 4.0: the key enabling Technologies, Information Communication Technologies (ICT) and technical-organizational processes to be implemented and a progressive digitization plan. Among the key enabling Technologies: Big Data Analytics, Augmented Reality, and Robotics. But also, Horizontal and vertical integration and Cloud.

Nevertheless, computer technologies, the opportunity through BIM models, to manage, check and implement over time all the available technical or/and administrative and management information, which are part of the maintenance strategies are «only the engine not the pilot of a new way of working» (VV.AA., 2016). The new tools and opportunities offered are, in fact, brought back within a holistic vision of the entire building process and, in particular, the life cycle of a building, considering together: quality, durability, environmental, social and economic costs. This scenario includes some of the experiences carried out in the last years by the writer and still in progress. Experiences that have allowed to deal with the aspects mentioned above, both in terms of awareness of the opportunities given by the digital revolution, and with respect to some critical issues that undoubtedly affect the design and management processes and, therefore, the maintenance issues.

Among the most significant experiences are: the establishment of BimCo, an innovative start up that deals with digitization in BIM; the development of a project for an academic Spin-off that has passed the first phase of the selection of the Public Notice POR Calabria FESR 2014/2020; the participation in the drafting of the ITACA Calabria Protocol. Three the main issues addressed: digitization; smart management of information and their transfer from a maintenance standpoint to operational tools.

With reference to the digitization, the experience carried out with BimCo, confirms the potentialities underlined for some time by the world of R&D (Sjostrom et al., 2004) and Standardization (EU Project STAND-IN), (Liebich, 2007). Potentialities which are related to the extended and shared use of interoperability systems, IFC Industry Foundation Classes (ISO 16739:2013 Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries), for the exchange of information among the different operators in the construction sector. Such use was encouraged at national legislative level with the Legislative Decree 50/2016 that incorporates the relative European Directives.

The experience gained with BimCo, also allows to underline some of the factors of slowdown in the adoption of BIM, among all, the still low level of interoperability of architectural, structural, plant engineering, calculation, etc, software, each of which uses a proprietary data representation system.

The goal is the dissemination and use of open data. In addition, the definition of a set of technical standards able to regulate and codify BIM processes. Joint commitment of ISO, CEN and the various national regulatory bodies, including UNI (Italian National Unification Body), which is working on the Italian UNI 11337 series (UNI 11337:2016 Building and infrastructure Digital management of information processes of construction).

Commitment to which is added with reference to the maintenance field, the contribution made by the USACE (US Army Corps of Engineers) who developed the COBie (Construction Operations Building Information Exchange) a non-standardized norm. Digitization and smart data management are therefore two of the central characteristics of Maintenance 4.0, aspects conveyed to the guidelines that have directed the second experience, the participation in the project of the proposal for an academic Spin off. An experience that has done properly both the characteristics of innovation and the critical issues inherent in the general thematic of the tools and procedures for systematization, management, transfer, processing and feedback of information. It could be said, paraphrasing a reflection by Molinari (Molinari, 1989) "Information for Maintenance. Information from Maintenance".

It is the experimentation of a circular vision of information that ensures the dialogue between the different operators in all phases of the life cycle of the product and allows the passage from the actual maintenance based on breakdown to a proactive approach: Prognostic and Predictive Maintenance. The experience till now conducted in the first phase of elaborating the Spin-off proposal, has shown how the association of BIM and IoT, the one as intelligent and interrogable digital repository, the other as a set of methods and data transmission protocols, despite the critical issues underlined above, introduces countless technical, managerial, economic opportunities. Aspects, also underlined by the planning document of the British government, Construction 2025, according to which in the coming years, the BIM technology combined with the IoT will allow an overall reduction of 33% of the costs related to the whole life cycle of buildings. At the same time, they will reduce of 50% the time between the planning phase and that of commissioning.

The future in this case as well as the vision of the Spin off, consists in defining cloud-based IoT solutions, on intelligent system services, that allow effective forecasting and prevention of the failure through the monitoring of performances.

Objectives confirmed by experiences such as Autodesk Project Dasher, a BIM-based application integrated with sensor systems for reading performance (electrical and occupancy) of buildings over time. Opportunities that, for operational practices of maintenance bring to the progressive affirmation of the association BIM – Lean that directs towards more efficient scenarios of predictive maintenance and Facility Management thanks to the tools of Lean Construction Management (Sacks, et al., 2010).

At the same time, as already highlighted several years ago by Molinari, it emerges the need to reconfirm research addresses on the role of «retroactive informative support of maintenance» (Molinari, 2002), of «privileged observatory» of the phenomena that characterize the transformations over the time of the building systems, their operation and their ways of use.

The possibility of collecting and managing a large amount of data, in fact, reissues the still open question of structuring and re-reading the feedback data, because they can be usefully transferred in life cycle assessments, in estimating the useful life of materials and components (ISO 15686:2000 Buildings and Constructed Assets - Service Life Planning) and then towards production, on the one hand, and design, on the other.

However, digital innovation, as we said, is only the engine not the pilot. The revolution involves the tools but it can take place only through coherent processes: the constant maintenance, the taking care of. It concerns assumed discoveries, reread in a new dimension that combines two modern terms BIM and Lean. A maintenance-oriented design approach that applies the principles of Lean Thinking and recognizes that maintainability is an indispensable design requirement; allowing to guarantee over time the status of the building and its parts, the functioning, the full use of technological systems and the permanence of safety and reliability requirements Issues that the experience of participating in the drafting of the ITACA Calabria Region Protocol (2017) has tried to transfer, in current practices. This by introducing them among the contents of the assessment Area E – Service Quality, which represents one of the five Areas with respect to which the Protocol is articulated in its national version (UNI/PdR 13/1:2016 Environmental sustainability in buildings - Operational tools for assessing sustainability). Aspects that, with reference to the aforementioned Area E, characterize the version of the ITACA Calabria Region Protocol as peculiar and distinguishing factor compared with National and other regional versions. Expression of the will to reaffirm, through the adoption of a series of categories and criterions already present in the SBTool, from which the ITACA Protocol has originated, the centrality of the maintenance aspects for building life cycle.

In this context, the support tools are “rediscovered” too. The Maintenance Plan, as well as the Booklet of the Building, or the Use and Maintenance Book become dynamic tools, capable of receiving and implementing from time to time the feedback coming from the Building Automation and monitoring systems and from the same maintenance activities. So that in order to guarantee in time the best possible operational solution, but also the environmentally correct one and, finally yet importantly ensure a social value, in terms of customer care, to the end users of the asset.

Disregarded opportunities, Cattaneo affirmed «In the last forty years, since when Donella Meadows and her MIT group wrote the Report on The Limits to

Growth for the Club of Rome, nothing new has happened related to maintenance» (Cattaneo, 2012).

Today, perhaps, a renewed opportunity seems arising for Maintenance: Maintenance 4.0. Necessity versus chance.

References

AIA (2007), *Integrated Project Delivery – A Working Definition*, American Institute of Architects, California Council, 15 May 2007.

AIMAN (2017), *1° Convegno Osservatorio Italiano Manutenzione 4.0*, Malpensa, Milano.

Bateson, G. (1972), *Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology*, University of Chicago Press.

Blanchard, S.B. (1978), *Design and Manage to Life Cycle Cost*, Weber System, Forest Grove.

Borrmann, A., König, M., Koch, C., Beetz, J. (2015), *Building Information Modeling*.

Cattaneo, M. (2012), *Manutenzione, una speranza per il futuro del mondo*, Franco Angeli, Milano.

Fischer, M. (2017), "Produttività e digitalizzazione nell'industria delle costruzioni", conference, CYFE, Søborg, Denmark, 23 March 2017.

Jonas, H. (1979), *Das Prinzip Verantwortung: Versuch einer Ethik für die technologische Zivilisation*, Frankfurt/M.

Latouche, S. (2007), *Petit traité de la décroissance sereine*, Mille et Une Nuits, Paris.

Liebich, T. (2007), *IFC Development Process – Quick Guide. Report of the EU- STAND-IN Project.*

Lorenz, E.N. (1972), "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?", in *139th Meeting of the American Association for the Advancement of Science*.

Molinari, C. (1989) *Manutenzione in edilizia. Nozioni, problemi, prospettive*, Franco Angeli, Milano.

Molinari, C. (2002), *Procedimenti e metodi della manutenzione edilizia. La manutenzione come requisito di progetto*, vol. 1, Esselibri-Simone, Napoli.

Nakajima, S. (1984), *TPM: Total Productive Maintenance. Maximising Overall Equipment Effectiveness, Japan Institute of Plan Maintenance.*

Sacks, R., Koskela, L., Dave, B., Owen, R. (2010), "Interaction of Lean and Building Information Modeling", *Construction, Journal of Construction Engineering and Management*, vol. 136.

Sjöström, C., Jernberg, P., Lacasse, M.A., Haagenrud S.E. (2004), *Guide and bibliography to Service*, Life and Durability research for Buildings and Components, CIB Publication 295.

Thaler, R.H. (2016), *Misbehaving: The Making of Behavioural Economics*, Penguin Books Ltd, United Kingdom.

Turing, A.M. (1950), "Computing machinery and intelligence, *Mind*, New Series, vol. 59, n. 236 (October 1950), pp. 433-460.

VV.AA. (2014), *Lean Construction – Leveraging Collaboration and Advanced Practices to Increase Project Efficiency*, Smart Market Report, McGraw Hill Construction.

VV.AA. (2016), *Breve introduzione all'era digitale del mondo delle costruzioni*, Consiglio Nazionale degli Architetti Pianificatori Paesaggisti e Conservatori.

Womack, J.P., Jones, D.T., Roos, D. (1991), *The Machine that Changed the World: The Story of Lean Production*, HarperBusiness.

1.12 THE ENVIRONMENTAL-ORIENTED COMPLEXITY OF DESIGN PROCESS

Anna Dalla Valle[*]

Abstract

In the building sector, the invisible technology - skills, organization, collaboration, information flow - represents even more the added value for highly competitive work environments, especially if with a view to sustainable development. In this context, the complexity of the invisible is unveiled via the deepening of a concrete case study, stressing the dynamics introduced by the paradigm of environmental sustainability. Starting from the current organizational set-ups, five hotspots are identified to guide and manage invisible technologies within design processes. Furthermore, in order to combine the ongoing transformations and the future challenges, a new professional figure assimilable to a middleware is expected to emerge.

Keywords: Environmental sustainability, Invisible technology, Design process, Hotspots, Competences

Present

Nowadays a very hot topic – even if largely unexplored – is the understanding of the transformations underway in the organizational setups of design process, especially in relation to the dynamics introduced by the paradigm of environmental sustainability.

Today, in fact, the building sector and all the related responsible parties – AEC firms (architectural and engineering structures but also construction companies) – are characterized by a high complexity that is intensified over the years (Renz, Solas, 2016) due to continuous transformation processes dictated by two main factors. On one hand, from the growing globalization of the market, encouraged by the progress in the transport sector and telecommunications infrastructures, and on the other, by the increasingly wide range of requirements that contribute to make the design process even more iterative and articulated. In this context, sustainability issues and in particular environmental sustainability certainly play a key role (Ortiz et al., 2009), since more and more established at international, national and local level.

[*] Anna Dalla Valle is a PhD Candidate at Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, anna.dalla@polimi.it.

Here, the pivotal factor is that they presume and promote within the organizational setups a holistic and transdisciplinary view, redesigning the boundaries of knowledge, the roles of the project and the entire supply chain of the built environment (Srivastava et al., 2013; Trebilcock, 2009).

This transformation process involves all the actors of the building process, affecting notably the main operators: AEC firms, and all the resources embedded: tangible resources, such as materials, plants, equipment, tools and money, and intangible resources, such as knowledge, organization and intelligence (Dalla Valle et al., 2016). In this regard, the two most evident socio-economic phenomena are: on one hand the digitization of tangible resources, with the so-called digital revolution of BIM, and on the other the specialization of intangible resources, determined by the growing division of labour with significant repercussions on the decision-making process. The problem is that while tangible resources or visible technology is in everyone's eyes and everyone talks about it, almost nobody speaks about the so-called invisible technology (Sinopoli, 1997), which actually represents the real added value for highly competitive work environments. In this way, the focus shifts from the tools used during design to the people and competences engaged, to their organization within the process, to the ability of collaboration, cooperation and coordination between the different subjects (Rezgui et al., 2010), as well as to the communication and information flow needed in general and, especially, with respect to environmental issues. The ongoing transformations and dynamics have been analysed and are discussed below starting from a case study, deepened in the USA during an internship at HDR, an integrated design firm affirmed at international level. The case study in question represents a particularly complex project with federal mandate and allows to specify five hotspots useful to orient the transformation of the invisible technologies of the future, essential to meet environmental issues (Fig. 1). It is worth mentioning that that these hotspots are not conceived in a static way as focal points of attention, but in a dynamic perspective as goals to be achieved during the design process.

Synergy between multidisciplinarity and specialization

First *hotspot* is the synergy between multidisciplinarity and specialization. Indeed, more complex and detailed the projects are, wider is the range of competences and specializations required that must be able to collaborate and work in synergy (often managed and coordinated by subjects in charge) with the aim of identifying the most appropriate solution to the problem to be solved.

The project under study demanded the engagement of over thirty different disciplines, brought back into the analysis to the *OmniClass* classification, recognized worldwide and structured in disciplines and sub disciplines according to different levels.

In this way, most of the actors involved belong to the Design Disciplines, which encompass from Architecture and Engineering to the Specialty Design. In the latter, it is interesting to note the need to add the category *Other* to include all those specializations not yet formalized and recognized by the classification but required by the project, emphasizing the increasing specialization of the competences. In addition, the project embeds, to a lesser extent, exponents of the Investigation Disciplines, the Project Management Disciplines (crucial for the coordination and management of all the disciplines and specializations involved) and the Support Disciplines. The only macro categories not included are the Facility Use Disciplines and the Planning Disciplines, emblematic since representative, on one hand, of a long-term vision (Facility) and, on the other, of a systemic vision and extended context (Planning). Moreover, deepening the different disciplines in terms of number of people involved, it comes to light the significant incidence of architectural competences, witnessing how, despite the support of all the other practitioners, they continue to represent the cornerstone of the project (Deamer, Bernstein, 2010).

Management of the competences in progress

Second *hotspot* is the management of the competences in progress. More complex the projects are, more it is possible that the competences and/or actors themselves vary within the design process, demanding a constant check and management of the continuous changes. Some disciplines are scheduled only for specific phases of the process (Transportation, Public Relations), while others (the majority) are required for all phases, affecting thus the whole decision-making process. Furthermore, it is possible to distinguish the disciplines defined as “static”, constant within the process (Geotechnical, Fire Protection, Security Engineering, etc.), from those defined as “dynamic”, characterized by a variable number of people within the process. In all cases, even when for a discipline the number of actors is apparently constant, it is possible that the same people at issue change during the process, leading in some situations the change of the whole design team from one phase to another (A/E Management, Architecture, Health Service Design, etc.). All these factors, carrying out continuous transformations in the organizational setups, further increase the complexity of the design process, calling for an even more robust monitoring and management in order to not weigh on the effectiveness of the process.

Integration of the environment as competence in the competences

Third *hotspot* is the integration of environmental issues as competence in the competences.

Indeed, more the environmental sustainability requirements and goals become shared and demanding, more the environmental competences must be spread and integrated into the design team via specialized actors as well as common objectives and wisdom and a responsible commitment of all the subjects involved. To this end, new professional figures are emerging in order to meet the environmental and life cycle issues. Nowadays, these skills are provided by a small number of actors that nevertheless have a great impact within the decision-making process, especially with regard to the artifacts' life cycle. In view of the actors involved in the project, it is worth mentioning the need for a redefinition of the subjects currently included in the *OmniClass* classification, which proves the continuous development of the disciplines and competences demanded. In fact, the *Energy Analyst* is included within *Building Envelope Design*, turned into *Building Energy Design* to include beyond the envelope the overall relationship between architecture and systems. While the so-called *Sustainable Champion* is attached to the *Environmental Design* with the addition of the term *Sustainability* because, although it generally refers to environmental issues, it increasingly tends to embrace the economic and social aspects of the project. The wide field of action, focused for the *Environmental Design/Sustainability* on LEED certification, water and daylight analysis and for *Building Energy Design* on energy and renewable analysis and Life Cycle Cost analysis, has been examined in depth and explained in terms of environmental information evaluated. With reference to *EN15978 standard - Sustainability of construction works*, the information that today mostly affect the decision-making process are: plant systems, construction systems, energy in use and, to a lesser extent, water in use declined in relation to the different systems powered. Only LEED certification, which currently represents one of the main drivers, seems to offer a broad spectrum of environmental information, looking into by means of specific credits: the installation phase (CxA), the waste derived from the construction process, the emissions determined by the surfaces, the maintenance process (CxA).

Inclusion of the environment as paradigm of the whole design process

Fourth *hotspot* is the inclusion of the environment as paradigm of the whole design process. Indeed, more the project is inclined to environmental sustainability, more the environmental issues must become the cornerstone of the process, requiring specific studies (depth) but also dissemination (extension) during the design. Also, in this case, as seen for the competences involved, some environmental analysis concern only specific phases of the process, while others are developed continuously. Constant at design level since requested by clients and/or imposed by various regulations are: the energy and renewable analysis and the LEED certification, with the verification of the several prerequisites and the checklist of the credits intended to reach. Instead, the water and daylight analysed, promoted directly by LEED, are developed only in more mature phases, such happens for LCC analysis which only affects the central phases of the process, verifying the cost/effectiveness of the adopted solutions as demanded by federal mandates. Moreover, looking into the number of analysis performed during the process, they are generally concentrated in the early design phases, showing how they represent a crucial point in the design development. The related decision-making process is however characterized, on one hand, by a continuous comparison between environmental-oriented alternative solutions and, on the other, by a constant verification of the savings obtained by adopting the established design strategies.

Consolidation and development of relations between the process actors

Fifth and last *hotspot* is the consolidation and development of the relations between the actors of the process. Indeed, more complex the project is and more it tends to environmental sustainability, more the existing design relationships must be consolidated and new relationships must be developed. For this purpose, available and innovative tools and methodologies must be adopted and arranged to ensure effectiveness of the involvement. As said before, in fact, the relationships between the parties involved and the consequent workflow and information flow represent a crucial aspect for the so-called invisible technology, especially if towards environmental sustainability. The case study in question shows, on one hand, that from an environmental perspective only few actors are in charge and, on the other, that a widespread network is demanded.

In this way, the Environmental Design/Sustainability and the Building Energy Design must immediately start collaborating and working in synergy with the main supporting disciplines (Architecture, Interior Design, Civil, Mechanical/Plumbing, Electrical Engineering, Health Service Design, Vertical Design, Other Specialty Design, Cost Estimation, Quality Assurance, Construction Disciplines and Facility Use Disciplines), with the joint goal to achieve optimal design solution. The identification of the network suggests among which disciplines nowadays there is a stronger communication, collaboration, cooperation and coordination from an environmental and life cycle perspective. However, it is important to not neglect that more complex the projects are, more the network is extended, involving as in this case, competences of an integrated design studio (HDR) as well as several external consultants.

The complexity of the organizational setups increases thus exponentially, also because even when different disciplines are part of the same firm, often the actors are not in the same place but in offices located worldwide. Hence, the increasingly demand for tools and methodologies aimed at promoting and fostering the collaboration and cooperation among the parties of the process.

Future

The suggested five *hotspots* disclose, even if in a synthetic way, the complexity of the invisible technology induced within the design processes by the paradigm of environmental sustainability. However, this scenario must be projected in the future and must deal with the forthcoming challenges, aiming to design sustainable buildings with high environmental performance (Boecker et al., 2009). To this end, the commitment is twofold.

On one side, buildings must be conceived and designed as systems, in which each subsystem and component affects and is in relation with the others, considering the whole life cycle.

On other, the same design team must work like a system, in which all members understand how their choices affect the decisions made by all the others.

In order to combine, on one hand, the goals induced by the ongoing transformations of the invisible technology and, on the other, the future challenges induced by environmental sustainability, a new professional figure is expected to emerge. It is a subject assimilable to *middleware* that, as happens in the IT sphere, deals with the interrelation between the user who requested a service and the basic resources by means of a highly heterogeneous distributed system. This figure acts as an intermediary between the client (user) who entrusted the project (service) and the actors of the process (basic resources), with the task of activating networks and information flows (distributed systems) among the different parties involved (heterogeneous).

Nevertheless, a crucial aspect is the approach and the way in which it provides the service required: on one hand, it adopts and supports a systemic vision of the project and, on the other, it fosters the process optimization from an environmental and life cycle perspective, heading, monitoring and managing the invisible technology.

To this end, this new figure, called above all for particularly complex projects (as the one at hand), turns out to be starting from the early stages the actor in charge for identifying the main relationships to be strengthened to comply with project environmental goals.

In this way, it encourages communication, collaboration and coordination between the design disciplines involved. Moreover, it allows to support the project development and at the same time the process organization, transforming resources first into *capabilities*, i.e. minimum capacities, and then into *maturity*, i.e. quality achieved by the integration of good practices.

The integration of the new professional figure assimilable to a *middleware* proves not only the need for new competence in the construction field (Krenz et al., 2014), but also how the question of interdisciplinarity becomes, in some cases, neo-disciplinarity.

References

Boecker, J., Horst, S., Keiter, T., Lau, A., Sheffer, M., Toevs, B. (2009), *The integrative design guide to green building*, Wiley, New Jersey.

Dalla Valle, A., Lavagna, M., Campioli, A. (2016), "Change management and new expertise in AEC firms: improvement in environmental competence", in *Sustainability and Innovation for the Future*, proceeding of the 41^{th} IAHS World Congress.

Deamer, P., Bernstein, P. (2010), *Building (in) the future: Recasting labour in architecture,* Priceton Architectural Press, New York.

Krenz, P., Basmer, S., Buxbaum-Conradi, S., Redlich, T., Wulfsberg, J.P. (2014), "Knowledge management in value creation networks: Establishing a new business model through the role of a knowledge-intermediary", *Procedia CIRP*, vol. 16, pp. 38-43.

Ortiz, O., Castells, F., Sonnemann, G. (2009), "Sustainability in the construction industry: A review of recent developments based on LCA", *Construction and Building Materials*, vol. 23, pp. 28-39.

Renz, A., Solas, M.Z. (2016), "Shaping the future of construction. A breakthrough in mindset and technology", available at: http://www.weforum.org/docs/WEF.pdf.

Sinopoli, N. (1997), *La tecnologia invisibile*, Franco Angeli, Milano.

Srivastava, M., Franklin, A., Martinette, L. (2013), "Building a sustainable competitive advantage", *Journal of Technology Management & Innovation*, vol. 8 (2), pp. 47-60.

Rezgui, Y., Hopfe, C.J., Vorakulpipat, C. (2010), "Generations of knowledge management in the AEC industry: An evolutionary perspective", *Advanced Engineering Informatics*, vol. 24, pp. 219-228.

Trebilcock, M. (2009), "Integrated design process: New paradigms in sustainable architecture", *Arquitetura Revista*, vol. 5(2), pp. 65-75.

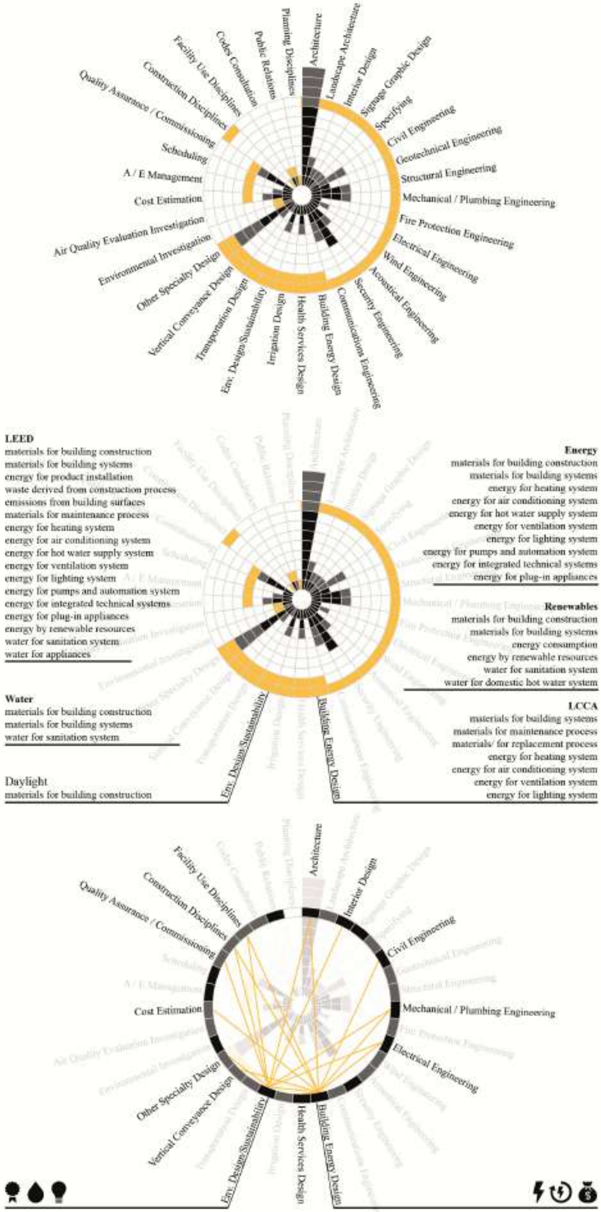


Fig. 1 - Five hotspots to orient the transformation of the invisible technologies of the future.

1.13 THE INNOVATION WITHIN BUILDING DESIGN AND MANAGEMENT PROCESSES

Valentina Frighi[*]

Abstract

The everyday modifications caused by the advancements introduced by the 4th Industrial Revolution determined a lot of changes even within the built environment, making a large part of the existing stock inadequate towards current standards.
In order to reduce its vulnerabilities, a sustainable strategy could be aimed at implementing the performance of existing buildings through interventions aimed at giving them the ability to "adapt" to the unique context in which we operate. Therefore, this contribution aims at defining, in its general features, a design and management strategy for the existing stock, to be applied during its entire life cycle, underlining the potential role that new technologies play in this process.

Keywords: Smart Buildings, ICT, Internet of Things, Innovation, Technological design

Architects are nowadays facing a radical change whose causes are multiple and only partially determined by the current social and economic conjuncture.

Triggered by the blast of the real estate "bubble" in the already far 2008 and still evolving according to often unpredictable dynamics, the resulting crisis seems never-ending. In this scenario, the evolution of the relationship among professionals and inhabitants cannot be neglected, influenced by the presence of other figures – more or less expert – who are variously allowed to intervene on building environment in operations that should be prerogative of competent technicians. To this, it has to be added the regulative framework, which should be considered as a reference for practicing profession but that actually seems at least murky. In the context outlined above, the challenges that design activity deals with, can no longer leave the operating conditions introduced by the "Industry 4.0" out of consideration: the digitalization effects indeed, today more than tangible, significantly influenced the organizational setups of construction processes, modifying their design actions in terms of roles, expertise and contents. In this new building cycle, in which, contrarily to previous ones – generally marked out by quantitative additions – we'll have to face the need to reduce soil consumption in view of the urgency to act sustainable process of re-

[*] Valentina Frighi is a PhD candidate at the Department of Architecture of the University of Ferrara, Italy, frgvnt@unife.it.

generation of existing buildings, the new technologies introduced by the advancements of technological progress play a key role in the integrated and sutainable management of the existing stock.

Right in 2016, R. Del Nord stated that the ongoing digitalization process would be destined «to radically influence the design processes, both in contents and in processing methods as well» (Perriccioli, 2016). It cannot be denied indeed, that these technologies came over all areas of everyday life, including architecture (Neuckermans, 2017), forcing it to face this change. In the same way it is undeniable the fact that these technological scenarios are endowed with significant consequences on the economy of the country: the global IoT market, and more in general, of ICTs for buildings, is one of the main drivers for the economic growth of construction sector. Among others, Navigant Research[1] estimates, over a ten-year period, a growth for this market equal to over 15 billion dollars. In 2020, a shorter-term goal, the well-known agencies Gartner and ABI Research predict that the number of network-connected objects will be among 26 and 30 billion dollars (Baldi, 2016); the so-called Smart Buildings, born through the applications of Building Automation technologies to edifices with the aim of reducing construction, monitoring and management costs[2], are fully part of this ever-expanding market. Thus, even in architecture, the signs of the digital disruption[3], are more than evident, determined by the introduction within such sector of systems and components with high technological innovation to face modern needs of change. The energetic and environmental question as well as the radical transformation of project's demand (Mussinelli, 2016), made the number of buildings inadequate towards contemporary needs constantly increasing. So that this innovation can become vehicle to achieving higher levels of architectural quality (Campioli, 2011), then providing an operational response able to find a balance between performance to be guaranteed and regulations to be respected, a double change of perspective, by all the actors of this process, is needed.

First of all, designers must accept the loss of their privileged status as repositories of specialized know-how, limited to a very specific area, while they have to acquire awareness about the strategic role they play in this new context,

---

1 From 6,3 billion dollars in 2017 to over 22 billion in 2020. Navigant Research, "The Global Market for IoT for Intelligent Buildings is Expected to Exceed $22 Billion in 2026", available at: https://www.navigantresearch.com/newsroom/the-global-market-for-iot-for-intelligent-buildings-is-expected-to-exceed-22-billion-in-2026 (accessed: 3 July 2018).

2 Talon and Strother (2017) expected that the adoption of BATs/BACSs would allow to obtain, within 2028, the savings of more than 150 billion TEP/years, correspondent to about the 22% of consumption of the entire building sector and to about the 9% of the total energy consumption of the European Union.

3 Term with positive meaning introduced in 1997 by Clayton Christensen in his "The innovator's dilemma: when new technologies cause great firms to fail" to define a disruptive change, intended as the moment in which the advent of a new technology brings a change in manners, thus determining the complete modification of the previous model.

thanks to their dialogue-oriented aptitude, on many levels, intrinsic in the architect's education, capable of being translated into an unequalled ability to become promoters of such innovation (Sinopoli, Tatano, 2002).

Similarly, end users, free from the passive role they performed in the past as common buyers, have now acquired an active role in this transformation process. Encouraged by the dissemination of information through new channels accessible to all, they have become *prosumers*[4], aware and evolved users equipped with decision-making independence and interested in consumption management, control and monitoring, energy saving and home automation; to resume their attitude in a word: they have been involved in the smart management of the built, becoming self-media[5] (Cloutier, 1975) able to actively participate in the creation and management of buildings during their entire life cycle.

Therefore, to face the needs of this new liquid society (Bauman, Bordoni, 2015), new reference tools are needed: Cloud Computing, new business models, development of wireless networks and intelligence, Key Enabling Technologies and Information Technologies which applied to project and construction provide new perspectives of update for forms, contents and operative architecture's manners, in response to the appearance of changed reference frameworks on which design activity is based on.

From this reasoning, arises the will to wonder about how the new possibilities offered by the impact of the Web and ICTs on social and productive systems stand in relationship to these issues, and, in particular, how they can concretely contribute in generating buildings able to respond to current needs, not only in performance terms but also adapting and transforming themselves according to external stresses or factors (exogenous or endogenous) that can modify their characteristics of use, reducing vulnerabilities of construction systems of which they are part of, thus restoring the balance condition that allows their proper function in time and space within which they are inserted, though their progressive adaptation. Getting back on what D'Ambrosio[6] (2017) on the twofold characterization of the adaptation concept, it's interesting the distinction made between what was defined "incremental adaptation", that means a requalification process precisely carried out though strategies definable adaptive, and what was instead defined "transformative adaptation", intended as a rethinking of the design approach towards a systemic planning of building process through mitigation strategies.

---

4 Term obtained from the merging of "producer" and "consumer" words, introduced for the first time from Marshall M. and Barrington N. (1972) in *Take Today: The Executive as Drop-out, Harcourt Brace Jovanovich*, University of Michigan (USA).

5 No more recipient of messages, previously established from producers and suppliers, but now able to deliver messages and to influence the creation of tailor-made buildings.

6 V. D'Ambrosio (2017), "La progettazione ambientale per i sistemi urbani resilienti", in M.T. Lucarelli, V. D'Ambrosio, M. Milardi, *Resilienza e adattamento dell'ambiente costruito* (op. cit.).

Therefore, in order to propose a sustainable strategy for the achievement of the aforementioned objective, a possibility could be aimed at developing a multi-scale strategy (that takes into account the specific features of each application scales), defining requirements and performance to be achieved.

First of all, in order to implement effective strategies, it is necessary to understand the behaviour of different building systems over time; the step further will instead be aimed at defining homogeneous terms of comparison among materials, components and systems that could be completely different.

Then, a following phase will be aimed at identifying the requirements, function of the showed up current needs that buildings must have, trying to predict their possible evolution over time thus determining any variables that could compromise their operation.

Given the complexity of the typological and technological characteristics of the existing building stock (above all, their being unique for geographical, temporal and operational features) (Norsa, 2005), a first step towards the definition of the aforementioned requirements could be reached through the classification of buildings by virtue of their geographical application context, as well as for their macro typological and technological characteristics; hence, the following interventions to be implemented will descend from such classification, according to distinctive and peculiar features of each cluster identified, in a direct relationship. The different classes of intervention can be established by making a parallel with the current regulation on energy efficiency[7], establishing for each level identified certain actions to be undertaken.

The types of intervention can then be distinguished according to whether they are carried out on new buildings or on the existing stock, including, in the first case, all demolition and reconstruction actions for which the supposed design choices must necessarily take into account the whole buildings' life cycle as well as the durability over time of the materials and components used.

On the other hand, in the second case, the predicted actions, whether they involve a deep renovation (first or second level) or energy efficiency interventions, should aim at extending buildings' useful life, with the goal of improving its performance response. Clearly, the increasing levels of complexity that are function of buildings' features, will be less manageable in all those cases in which interventions to be done are simultaneous to actions needed to maintain the components' efficiency over the whole useful life.

Therefore, in this context, it is necessary to resort to tools able to predict and manage this complexity, according to an integrated approach that can be implemented from the very early stages of designing and planning the overall work. Hence, technologies introduced by the 4th Industrial Revolution certainly represent a useful tool for the management of the abovementioned reference framework, thanks to the presence of integrated and interoperable systems.

---

7 Decree "Requisiti Minimi", 26 June 2015.

The techniques brought in, capable of digitizing the operations that contribute to the creation of an architectural work (such as BIM systems), help in solving criticalities intrinsic in this process through, for example, the detection of geometric interferences between heterogeneous components (clash detection) or the check for consistency with rule and constraints (rule checking), or, again, they allow, thanks to home automation devices, the collection, elaboration and analysis of different types of data, providing an operational support for actions of logistic fine-tuning, energy management and control and monitoring.

Currently on-the-market-available systems present various levels of automation, from the basic level to systems equipped with integration and interoperability capacity, even among different devices.

In literature, automation systems for smart buildings are distinguished in first, second and third operation devices; buildings in which multiple autonomous and self-regulating devices are installed, able to independently operate each other – such as security systems and automated systems for mechanized compartment ventilation (HVAC) – are considered first generation.

The second category instead includes systems connected to each other through networks that allow remote control, even operating from a single central unit, such as lighting control systems depending on occupants' behaviour.

Finally, third-generation systems are those able to adapt their functioning – in terms of monitoring and control – to boundary conditions, varying it according to the context. This last systems' generation, although still in an early stage of development, is clearly the most promising.

The existing components that operate within a smart system, able to adapt to the surroundings, not only through intelligent actions but as part of a real "network", collecting data, communicating and transmitting them – even after further elaborations – would allow to open new and very interesting possibilities for controlling and implementing building materials and components performance. In this process, even new building materials, the so-called smart materials, equipped with original performance, often variable, controllable and selectable, play a very important role. In the same way, even innovative construction methods, recently developed, such as, for instance, 3D printing technologies, thanks to the possibility they offer to reduce costs and construction time increasing at the same time quality and safety on site.

Last but not least, the development of off-site building production approaches, able to fine-tune times and resources, favouring the specialization of all the manufacturing along the supply chain.

Although indeed, about the 80% of all construction works is still an on site production, the interest towards new off site attitudes, aimed at increasing the predictability, uniformity and repeatability of works is exponentially growing, both because to a lesser extent of working spaces in construction areas, as well as due to the progressive loss of skilled labour and to the increasing rigidity of safety and environmental standards.

The possibilities offered by the integration of ICTs in constructions' design and management processes would make buildings real UCG (User-Generated Content), guaranteeing their functionality over time and, above all, their compliance with the ever-changing needs of their occupants, making them (inter)active and interoperable structures thanks to the introduction of the aforementioned technological innovations, as element of mediation among multiple instances, sometimes juxtaposed but essentially interconnected.

So, design in digital ages, must necessarily confront itself with less recent but still current challenges related to the reduction of environmental impact, enhancing the existing building stock while respecting safety and wellness conditions of users, becoming at the same time investor of new demands, recognizing the new material culture linked to new digital technologies and enriching itself from the contributions that technological innovations provide to meet new quality standards and ever-changing needs (Losasso, 2017).

In conclusion, in order to achieve such ambitious goal, a reconsideration of the current way of designing is needed, moving towards the production of architectures not only capable of rediscovering and adopting technical and design solutions able to deal with the context, exploiting available passive resources, but above all, designed to be equipped with adaptive and recovery capacities, effective at all the scales that mark out building process.

Certainly the abovementioned technological resources, capable of allowing an on-demand control by end users, as well as to obtain return data on such functioning, significantly contribute to progress in this direction, allowing to gather useful information on the operation of devices and components to further calibrate, during the whole building life cycle, the interventions needed to avoid a decay, even localized, of its performance response.

References

Baldi, D. (2016), "Internet-of-Things: Impatto sul mondo civile ed industriale", available at: https://www.ingenio-web.it/6012-internet-of-things-impatto-sul-mondo-civile-ed-industriale (accessed: 3 July 2018)

Bauman, Z., Bordoni, C. (2015), *Stato di crisi*, Einaudi, Torino.

Campioli, A. (2011), "Qualità dell'architettura: innovazione, ricerca tecnologica e progetto", *Techne*, n. 1, Firenze University Press, Firenze, pp. 62-69.

Cloutier, J. (1975), *L'ere d'Emerec ou la communication audio-scripto-visuelle à l'heure del self media*, Les Presses de L'Universite de Montreal.

Losasso, M. (2017), "Tra teorie e prassi: cultura, tecnologia, progetto", *Techne*, n. 13, Firenze University Press, Firenze, pp. 9-13.

Lucarelli, M.T., D'Ambrosio, V., Milardi, M. (2017), "Resilenza e adattamento dell'ambiente costruito", in Antonini, E., Tucci, F. (eds), *Architettura, Città e Territorio verso la Green Economy*, Edizioni Ambiente, Milano, pp. 186-201.

Mussinelli, E. (2016), "Prospettive del progetto tecnologico tra ricerca e formazione" in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano, pp. 96-101.

Neuckermans, H. (2017), “La progettazione architettonica nell’era della tecnologia”, *Techne*, n. 13, Firenze University Press, Firenze, pp. 33-37.
Norsa, A. (ed) (2005), *La gestione del costruire. Tra progetto, processo e contratto*. Franco Angeli, Milano.
Perriccioli, M. (ed) (2016), *Pensiero tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano, pp. 96-101.
Sinopoli, N., Tatano, V. (eds) (2002), *Sulle tracce dell’innovazione. Tra tecniche e architettura*, Franco Angeli, Milano.
Talon, C., Strother, N. (2017), *White Paper – 10 Trends for Intelligent Buildings in 2017 and Beyond. Digital Transformation and Market Evolution*, Boulder (CO), Usa, Navigant Research, 1Q.

1.14 RATING SYSTEM AS DESIGN TOOL TO MANAGE COMPLEXITY

Lia Marchi[*]

Abstract

During the last decades the way we have managed the built environment has deeply changed. New factors of indeterminacy and unpredictability have been introduced due to the economic and environmental crisis, and the harshening of particular social issues. Thus, new designing approaches have become necessary. In this framework, sustainability building Rating Systems (RS) have gradually spread as design tools. In some cases, they specifically incorporate principles of resilience to cope with criticalities of the built environment, both acute and chronic. On this basis, the paper proposes the formulation of a RS to increase the resilience of industrial sites, a key asset in the management of territory. Hence, the project becomes an open protocol, flexible and adaptable on a case-by-case basis.

Keywords: Uncertainty, Unpredictability, Resilience, Rating System, Industrial facilities

Introduction

Changes in the socio-cultural, economic and environmental dynamics of athropized systems that have occurred during the last decades called for a deep reflection about operating methods and roles of actors involved in the management and transformation of the built environment.

The lasting of economic crisis, the increasingly frequent natural catastrophes, the augmented vulnerability of large social groups (Saporiti et al., 2012), the intensification of migration and the changed paradigms in living and manufacturing are just some of the factors that increase indeterminacy and unpredictability both in people habits and in functioning of settlements. Thus, in recent years the built environment has been more and more in need of providing resilient solutions to change (Burroughs, 2017)[1].

In this framework, the traditional "cause-response" design approach often resulted to be inadequate in effectively tackling acute events (e.g. earthquakes, floods) or long-term changes (e.g. new types of families).

---

[*] Lia Marchi is a PhD student at the Department of Architecture, University of Bologna, Italy, lia.marchi3@unibo.it.

[1] According to Burroughs resiliency in design is a necessary approach to manage the uncertainty state of current heritage.

Hence, many studies on resilience at the building scale have been undertaken, in particular addressed to extreme and rapid changes (Heidrich, 2017).

Beyond, also new patterns of requirements, economic constraints and a renewed social interest for common goods have promoted fruitful reflections on the role of actors and on the practices to be adopted in the building sector. As a result, new design approaches have been proposed. In many cases they are based on theories formulated since the Seventies, among which: the project that becomes a process, more and more open to the biography or narration of the context (De Carlo, 1973), and the project as a composition of patterns already in nuce in the site (Alexander, 1977). Therefore, there has been a shift to these open methodologies – both in terms of content and operations: here, the role of architects is increasingly measured as the ability to "design the process".

I Rating System come strumenti progettuali

In this framework, a new group of tools for the management of the built environment emerged: the multi-criteria systems for the assessment of building sustainability or Rating Systems (RSs). Although originally designed for different purposes, RSs are also useful tools to guiding the project, as they provide a structured procedure to map needs and their mutual relations.

These tools are based on a robust analysis of the intervention context, which aims at identifying its factors of strength and weakness. On this basis, matrixes of corrective actions are formulated, deeply rooted in the place observation. Their multi-criteria structure makes RS suitable tools to balance the multi-faceted issues of a project: these systems can act on a case-by-case basis seeking for the "best compromise", that is a key concept of resilience.

As a result, overcoming the concept of mere assessing means, some RSs have recently been developed by implementing resilience objectives and serving as guide to designers. REDi[2] (Almufti, Willford, 2013) and RELi[3] (Wholey, 2015) are two important references for this new family of methods. The importance of the issue is also highlighted by the attempt to integrate principles of resilience into the most common international RSs, such as LEED (Wilson, 2015). In parallel, similar specific experiments are spreading in literature (Re Cecconi, 2018; Burroughs, 2017). While the LEED extension integrates the existing scheme with three new pilot credits, REDi and RELi are entirely built to endorse requirements of resilience. These latter adopt a holistic approach for all the evaluation categories, with the aim of achieving buildings which can optimally and effectively adapt to whatever change (acute or chronic).

---

2 The Resilience-based Design Initiative has been developed by ARUP.

3 The protocol has been developed by Perkins+Will in partnership with The University of Minnesota.

Among the novelties introduced by these tools, one is particularly related to resilience and it is specifically clarified in RELi[4]. The design process is iterative: after choosing the project strategies, the design team is invited to quickly prototype the project and to test it several times through the RS. Each subsequent application of the protocol reveals missed opportunities and critical issues not yet addressed, which are corrected step by step. This produces a progressive refinement of the design, up to reach the highest level of resilience achievable for the case.

Industrial sites, a complex asset

In this context, the paper proposes an experimental application [5] of the principles of these new RSs to manufacturing places, a heritage often neglected by territorial management policies, but fundamental to increase the resilience of the built environment. As a matter of fact, industrial sites are among the main responsible of anthropological impact on the environment. Interference with the landscape[6] involves the physical dimension, through a series of heavy effects on the main ecosystem matrices (soil, water, air, material resources, etc.). In addition, also the aesthetic-perceptual sphere is involved, as industries generate intense contrasts with the scenery, often without mitigation (Busquets, Fabregas, 2007). Production buildings are frequently perceived as detractors of the landscape (Cassatella, Gambino, 2013) and provoke diffuse social disturbances. Since the Eighties, the attention of researchers and policy makers for the environmental compatibility of industry has been growing. Gradually, the morphological and aesthetic-perceptual quality of buildings have also been addressed.

However, it still lacks a unitary reflection where the multiple connotations of the topic are combined together: that is, mitigating the impacts that occur at different scales with needs of manufacturing processes.

Therefore, the research general objective is to formulate strategies to mitigate the impact of industry on the landscape, both addressing existing and new buildings. Hence, an operative tool to support the design is proposed, by adopting the resilience-based RSs as reference to manage such a complex and peculiar asset.

---

4 Data retrieved from the dedicated website http://c3livingdesign.org/?page_id=13783 (accessed 02 May 2018).

5 The reference is the PhD research project “Landscape compatibility of industrial plants” by Lia Marchi, XXXII Cycle of Doctorate in Architecture, University of Bologna (2016-2019). The study is supported by Orogel (FC).

6 The assumed landscape definition is the one by European Landscape Convention (2000). Accordingly, the landscape’s components are: environmental or natural; social/cultural; aesthetic-perceptual.

A Rating System for industrial facilities

To do this, a system for assessing impacts of factories on the landscape has been developed; the procedure addresses together the environmental, aesthetic-perceptual and social/economic aspects. The system is associated to a repertoire of mitigation tactics, from which the actors of the process – companies and designers – can select best practices based on the functional, expressive, economic and socio-cultural requirements which fits their project at best.

The research method is broken down into three blocks, aimed at:

- identifying a set of indicators to measure the impact of factories on the landscape and priorities interventions; then, developing a system of credits for the assessment of the impacts (Activity 1);
- collecting remarkable case-studies into a repertoire of best practices, from which extract a catalogue of mitigation tactics on the landscape (Activity 2);
- testing the protocol (the system of credits combined with the best practice repertoire) on Orogel, an agrifood company that supports the research; then developing some mitigation scenarios (Activity 3).

According to the premises, the article presents the development of the first group of activities, aimed at formulating the assessment system (RS).

The first step for developing the new RS identifies the principal impacts of industrial settlements on the landscape. A literature and sector-based analysis led to depict the overall problem, identify common practices and draw up a list of the most relevant impacts on the environmental, socio-cultural and aesthetic-perceptive components of the landscape. Then, each impact was associated with at least one indicator suitable to measure the specific effect of the industrial site on the landscape.

Afterwards, a review of the most common rating systems was made in order to select the most consistent with the research and assume it as reference. Therefore, among the more internationally widespread RSs, the ones which are specifically dedicated or applicable to industrial buildings have been selected (Tab. 1). Hence, LEED v4 BD + C: Warehouses and Distribution Centres was selected both for the highest percentage of credits corresponding to the author's list of impacts and for the greater percentage of credits potentially related to aspects of the perceptual-aesthetic (PA) sphere.

Then, the study integrates the LEED system – which originally addresses only environmental impacts – with a new thematic area referring to aesthetic-perceptual disruptions and the related socio-cultural interferences (Tab. 2).

This is possible as the LEED credits' weighing process allows integrations to the system without compromising its fundamental mechanisms: each credit gets one or more points based on its relative effectiveness to contribute to the general objective of the system; hence, it is always possible to introduce new thematic areas and/or new credits, as long as the scores are recalculated.

Rating system	Version	Specific	Adaptable
BREEAM	BREEAM International New Construction 2016		x
CASBEE	CASBEE for Buildings (New Construction) 2014**		x
DGNB	- DGNB New Industrial Buildings* - Core 14	x	 x
GREEN STAR	Green star - Industrial v1 2010 (up.2014)	x	
LEED India	IGBC Green Factory Building v1.0	x	
LEED US	LEED v4 for BD+C: Warehouses and Distribution Centers (update 2016)		x
Protocollo ITACA	Protocollo ITACA Nazionale 2011 – Edifici industriali (update 2012)	x	

* the specific scheme is only in German.

** information assumed due to the numerous warehouses certified at Prologis (https://www.prologis.com/sustainable-industrial-real-estate/environmental-stewardship/CASBEE-certification**,** accessed 05.12.17)

Tab. 1 - Comparison between Rating System.

	Thematic Area	N. of credits
LEED	LT – Location and transportation	7
	SS – Sustainable site	6
	WE – Water efficiency	5
	EA – Energy and atmosphere	7
	MR – Materials and resources	5
	EQ – Indoor environmental quality	10
	IN – Innovation	2
Author's addition	PA – Perceptual-aesthetic aspects	8

Tab. 2 - The assessment system.

However, it is necessary to underline that the new thematic area (PA) refers to credits that are generally measured by qualitative indicators, which are intimately different from the quantitative ones typical of environmental analyses. Therefore, great attention was paid in the choice of the new indicators, and an effort to select from the literature those with the most objective and quantifiable features was made. Then, each new credit has been described through a specific card, which has been added to the LEED original cards included in the user manual.

Overall, the developed assessment system refers to the iterative approach implemented by RELi. This means that the project is validated in subsequent phases, during which it is progressively refined, up to the evaluation of residual effects that cannot be mitigated. The same circular procedure was applied to the research itself, which was tested twice, gradually improving the tool itself.

As a result, the current version of the protocol (V1) has been obtained by combining the described system with the catalogue of mitigation tactics (Activity 2), and then it has been applied to Orogel (Activity 3).

Results and conclusions

Although in progress, the research attempts to formulate a new support design tool to increase the resilience of the built environment, starting from the regeneration of existing industrial sites and the good design of the new ones.

This objective led to an experimental application of the basic principles of the new RSs family to the industrial asset, by adopting a sound and structured reference such as the LEED protocol. In this context, the designer assumes the role of director of the transformation, who sets the criteria of analysis and defines the general tactics of intervention without declining them into specific solutions, which are instead left to the subsequent application of the protocol on particular case studies. Up to date, the assessing system of Protocol V1 consists of 51 credits, gathered into 8 thematic areas. The application of V1 to Orogel highlighted the potentiality of the system, which makes it possible to identify issues and intervention priorities, and producing open design responses based on the different needs of the involved stakeholders. Hence, the company – or the designer on its behalf – can improve its landscape impact by selecting the most suitable mitigation tactics, based on the emerged criticalities. The system outlined above constitutes an analytical and proactive basic structure useful for managing the transformation of a complex heritage as the industrial one.

References

Alexander, C. (1977), *A Pattern Language: towns, buildings, construction*, Oxford University Press, New York.

Almufti, I., Willford, M. (2013), *REDi Rating System*, available at: www.arup.com.

Burroughs, S. (2017), "Development of a tool for assessing commercial building resilience", in Ding, L., Fiorito, F., Osmond, P. (eds), *International High-Performance Built Environment Conference (iHBE 2016)*, Elsevier, pp. 1034-1043.

Busquets i Fabregas, J. (ed) (2007), *Per una corretta visione del paesaggio: linee guida*, Generalitat de Catalunya, Barcelona.

Cassatella, C., Gambino, R. (2013), "Linee guida per i paesaggi industriali, un'esperienza di ricerca", in *XXXIV Conferenza italiana di scienze regionali*, pp. 1-14.

De Carlo, G. (1973), "L'architettura della partecipazione", in Richards, J.M., Blake, P., De Carlo, G., *L'Architettura degli anni Settanta*, Il Saggiatore, Milano.

Heidrich, O., Kamara, J., Maltese, S., Re Cecconi, F., Dejaco, M.C. (2017), "A critical review of the developments in building adaptability", *International Journal of Building Pathology and Adaptation*, vol. 35(4), pp. 284-303.

Re Cecconi, F., Moretti, N., Maltese, S., Dejaco, M.C., Kamara, J.M., Heidrich, O. (2018), "Un rating system per la resilienza degli edifici", *Techne*, n. 15, Firenze University Press, Firenze, pp. 358-365.

Saporiti, G., Scudo, G., Echave, C. (2012), "Strumenti di valutazione della resilienza urbana", *Te-MA*, vol. 2, pp. 117-130.

Wholey, F. (2015), "Building resilience: A Framework for Assessing and Communicating the Costs and Benefits of Resilient Design Strategies", *Perkins+Will research journal*, vol. 7, pp. 7-18.

Wilson, A. (2015), *LEED Pilot Credits on Resilient Design Adopted!*, available at: www.resilientdesign.org (accessed on 11 July 2017).

1.15 GREEN PROCUREMENT AND ARCHITECTURE. NEW HORIZONS AND SKILLS FOR PROFESSIONALS

Riccardo Pollo, Corrado Carbonaro**

Abstract

The European Union, in its latest document on green purchasing, underlines the need to adopt solid Green Public Procurement policies by the public administrations. Italy with the Ministerial Decree of 11 January 2017 has established that all public procurements must comply with the minimum environmental criteria (CAM), which must be guaranteed in all phases of the building life cycle, since the design phase. Therefore, all the professional sectors involved by these norms, must acquire specialized and multidisciplinary skills, not yet fulfilled by the professional offer. The paper intends to identify strategies for the launch of new professionals, consistent with evolving standards and with the rapidly evolving professional labour market demand.

Keywords: Green Public Procurement, Minimum Environmental Criteria, Ecodesign tools, New professionalism, Building Life Cycle Design

Introduction and regulatory framework

The global warming dramatic increase makes clear the need for a radical paradigm shift not only in the energy generation from fossil fuels, but in the production and consumption model itself. The green economy, circular economy and green procurement issues have been emphasized by the awareness of the unsustainability of the current model of globalised economy, by the way of life of wealthy countries and communities; as well as the economic gap between the rich and the poor. The Green Economy is defined by the European Commission as “an economy that generates growth, creates jobs and eradicates poverty by investing and safeguarding the resources of the natural capital on which the survival of our planet depends” (see COM (2011) 363 of 20 June 2011). The European and national laws on Green Public Procurement (GPP) introduced complex procedures for the purchase and implementation of eco-compatible goods and services by public bodies and agencies.

---

* Riccardo Pollo is an Associate Professor at the Department of Architecture and Design, Polytechnic University of Turin, Italy, riccardo.pollo@polito.it.

* Corrado Carbonaro is Technical Manager of LaSTIn Laboratory at the Department of Architecture and Design, Polytechnic University of Turin, Italy, corrado.carbonaro@polito.it.

The public sector is identified as the leader in the environmentally good practices. The GPP procedures are widespread and range from stationery products, to cars and buildings. The building sector is certainly one of the more problematic fields for a GPP policy due to the well-known complexity of the building itself and of its management processes. The wide range of architectural and technological options, of functions, the long physical life and the heterogeneity of the building elements are the factors of such complexity.

On the other hand, the building stock is a key element of sustainability due to its high impact on the environment.

In past decades the implementation of an effective green purchasing policy has required a specific regulatory framework. Starting from the community document on the "Integrated product policy, developing the concept of environmental life cycle" (COM (2003) 302) and the Public Procurement Directive (2014/24 / EU), the Environmental decree was introduced at national level (L. 221/2015), within the National Action Plan on Green Purchases (PAN GPP, 2008 - 2013) and followed by the Ministerial Decree 11/01/2017 "Adoption of minimum environmental criteria for interior furnishings, construction and textile products". This rich regulatory production has defined the procedures to be adopted in the various stages of the purchasing process and, within the scope of market availability, the requirements aimed at developing design solutions, identifying better products and services from an environmental point of view in their life cycle. In the legislator's intention, the systematic application of such rules allows the diffusion of environmental technologies and environmentally sustainable products with a significant leverage effect on the market and pushing all economic operators to adapt themselves to the highest public administration standards, including the private sector as well.

In the GPP, the topics of sustainability and eco-compatibility go hand in hand with the management of public works tenders, a topic, that of competition and transparency, of particular importance and delicacy. In the relationship between efficiency/flexibility and transparency/control, the rules have gradually identified different expressions of the roles of public procurement bodies and private subjects, asking for a high design, management and legal capacity. In particular, the recent revision of art. 95 of the Public Procurement Code introduces a fundamental tool to raise the quality standards, including environmental performances, through the allocation criterion paired with the most economically advantageous bid criterion. This criterion requires that, in general, contracting authorities award contracts «on the basis of the supply criterion […] identified on the basis of the best quality/price ratio or on the basis of the price or cost element, following a cost/effectiveness comparison criterion such as the life cycle cost» (paragraph 2 article 95 Legislative Decree 50/2016).

Also the introduction of the concept of life cycle cost seems to be very important and is further specified in art. 96 that requires the contracting authorities to specify in the tender documents «the data that the tenderers must provide and the methods that the contracting authority will use in order to determine the life cycle costs on the basis of such data» (Article 96 of LD 50/2016). As clearly stated by the Decree on the Minimum Environmental Criteria (CAM) in the building sector «the award at the lowest price remains applicable but [...] only residual». Through the aforementioned normative indications, the previous measures are confirmed, starting from the regulation implementing Law 109/94 (Merloni Law) which in 1999, referring to the general objectives of the design of public works, referred programmatically to

> «The best relationship between the benefits and the overall costs of construction, maintenance and management. [I] [...] principles of minimizing the commitment of non-renewable material resources and maximum reuse of natural resources involved in the intervention and maximum maintainability, durability of materials and components» (translated by the authors).

These aspects of quality, albeit underlined, remained devoid of references to feasible application methodologies, still restricted to research and experimentation. The proper reference to the life cycle and to the economic and environmental effects of building products, their project, maintenance and management and discharge did not correspond to a practice due to the lack of operational tools. The quest for environmental quality, for reduction of energy consumption was now present in the legislation. Instruments and methodologies partly validated and in progress of refinement has been adopted particularly in the field of energy balance of the building plant system and in the development of renewable sources. The application of the rules about GPP and CAM involves all phases of the building process paying attention to specific techniques ensuring the performances of the product at different scales, neighbourhood, single building and components. Furthermore, the construction phases and the qualification of the subjects involved, designers, construction companies and suppliers, are ruled by law. We can certainly say that the implementation of CAM requires a consistent use of a wide range of design skills and knowledge usually lacking in the construction industry skills. In the CAM implementation process, the principles, processes and methods of environmental design are applied at different levels, involving energy experts, management specialists, environmental product certification experts, Life Cycle Costing technicians, and skilled people in Rating Systems for architectural design (LEED, Breeam, ITACA).

Evaluation of the application for the design according to the CAM (Minimum Environmental Criteria)

In recent years the regulatory evolution on both energy and environmental issues shifted the technological project, which must be multi-criteria, multidisciplinary and systemic.

In such a way, the research carried out within the Department of Architecture and Design of the Polytechnic of Turin aims to identify the environmental indicators to be taken into account in order to ensure environmental efficiency in the whole building life cycle, to develop tools and methods for the design and analysis of the technological project, to improve the regulatory framework and to understand how the actors of the urban and building design can be part of the mindset change. The direct experiences carried out within the research group have highlighted many challenges in the current professional practice to be faced. All the actors are involved: public bodies, design firms and construction companies. The picture highlights lack of skills and conflict between the regulations in different fields (urban planning, energy, environmental). The essay, therefore, proposes a double line of investigation: the evaluation of the consequences of the new CAM rules relating on the procurement system, trying to understand how in the design phase the critical issues can be overcome, and the development of tools providing designers and construction firms through a database of existing products meeting the requirements of the CAM legislation.

The first line of research was developed through a survey called "Minimum Environmental Requirements and Green Public Procurement" (Pollo, Carbonaro, 2018), sent to designers, experts and public officials, with 6 questions:

- Has the application of CAM led to significant changes in the way of designing? If so, what are the main ones?
- Are the rules in the calls for tender consistent with the other regulations? Can conflicts arise?
- In your opinion, have these tenders been consistent with the objectives of the standard? If not, why?
- The CAMs included in the tender or in which you participated was only the "minimum" or even "reward"? Are all the minimum requirements considered during the evaluation phase?
- Is there, in your opinion, a construction market (companies and producers of materials and components) that responds efficiently to CAM requests?
- In your opinion, can CAM rules trigger new professional opportunities? If so, how and with which subjects (companies, contracting authorities, design teams, professional associations, universities)?

So far, the results of the survey have given almost homogeneous indications highlighting the need to promote the following actions:

- Disseminate in-depth knowledge of environmental certification systems;
- Develop standard methodologies;
- Eliminate the uncertainty regarding the remuneration of such specific professional competences;
- Share information on technical standards, performances, prices of products;
- Develop specific local price lists;
- Specifically train the technicians of the P.A., following the detected lack of preparation on the still new issues of environmental sustainability;
- Impose greater clarity and homogeneity of environmental certifications;
- Identify actions to reduce the burdens for construction firms;

- Develop a system of verification, monitoring and control of the implementation of CAM, evaluating the impacts ex post;
- Identify a method for assessing the impact on the whole public procurement system, which assesses the burdens and benefits of all stakeholders involved.

Following the results of the consultancy experiences and of the survey, a database of materials and components was developed called "CAM_PER, minimum environmental criteria materials and building components database", created following a collaboration of the LaSTIn laboratory of the DAD Department (C. Carbonaro) with professor R. Giordano.

The database currently collects data sheets containing technical data (e.g. thermal conductivity, mechanical strength, density), and eco-compatibility data (e.g. environmental certification, percentage of recycled material, recyclability) related to a hundred construction products. In addition, the database is equipped with a check list for both compliance with the minimum environmental requirements of the project and for checking the completeness of the documentation produced. Furthermore, research on the probabilistic evaluation of the durability of buildings (Pollo, 2014) and of the C&D material flow at urban scale have been carried out and are still under development. (Pollo et al., 2015).

The scenarios opened by the new rules on the design of public buildings, affect the approach of the whole building sector professionals. A reflection is underway on the effectiveness of the new CAM rules and on the benefits of GPP schemes for public and private stakeholders. Among the actors who first have to adapt to the change, we find Architects. Such professionals strongly suffering from the crisis of the construction sector can now change the approach to their practice looking at a new and promising professional field.

In this perspective, the Green Economy could be a favourable professional outlet, constantly growing. In the construction sector, despite the crisis, a noticeable investment increase in the Environmental sector has been recorded (23.9% from 2011 to 2017) (Symbola, Unioncamere, 2017).

The environmental certification market is also growing: Italy is the second country in the world for ISO 14001 certificates (increase of 280% from 2005 to 2015) and the third country by number of Emas certificates. The number of environmental product certifications was very rewardable already in 2015: 1,887 FSC certifications, 191 Environmental certifications of EPD product (first country in the world in 2015) and 344 Ecolabel certifications (Symbola, 2016).

It is, therefore, a matter of fact that the eco-product market and environmental certification can offer many business opportunities for the professionals in the building sector. If the market of the Green Economy is growing strongly, on the contrary, the current situation of the architect agencies is discouraging.

In Italy the number of members of the professional associations is very high (2.5 architects per 1,000 inhabitants, the double than in Germany).

The corresponding potential market for professional services is only € 105,000 per capita per year (2014 data), well below the European average

(ACE, 2017). Because of the strong competition and lack of opportunities in the traditional field of design, professional firms begin to focus on the diversification of skills, as evidenced by the increase in innovative and alternative activities to those traditionally carried out. Between 2010 and 2015, Italian architects increased their "specialist and innovative" activities by 5.1% compared to a 9.6% reduction in activities closely related to architectural design (CNAPPC, CRESME, 2016). The traditional professional market is therefore facing a crisis that can also be tackled through a greater differentiation of activities linked to growing labour markets: green economy, eco-design, environmental planning and eco-friendly product innovation.

A conclusion: the strategies for a new professionalism

Strategies to meet the demand for specialized skills to support the design and services of high qualification in the field of environmental sustainability, need to pursue two related paths. On the one hand, research on harmonized methods, procedures and standards should be developed, and on the other hand, dissemination of skills has to be done. The two roads, to be successful, require a multidisciplinary approach, shared by all the stakeholders involved in the transformation processes of the city and the territory (Fig. 1). The research, entrusted to Universities and Research Centres, aims to support the whole sector in the development of design methods and procedures to manage effectively and efficiently the building process, analysing their impacts and results in order to guarantee the principles of eco-circularity of materials and buildings. In other words, it is necessary to develop tools that are easy to use (software, price lists, product and component databases) for a design approach that takes into account the whole life cycle of buildings. The process of training skills must, however, take place following two tracks aimed at different users: professional subjects and academic students. The former must be able to take advantage of continuous training, which gives the opportunity to skilled people to update through highly professionally and aimed training courses (architects, technicians of public institutions, contractors). The second one is aimed at training of master's degree students in architecture and civil engineering and third level academic education for the diffusion of specific skills related to the issues of the Circular Economy and the life cycle design concepts.

The perspectives identified on the issues of the tools for CAM implementation and the widespread of competences will act on two different temporal horizons: the contingent one, giving to the professional sector the skills and employment opportunities, and the future, helping to provide advanced training to the professionals of the next generations.

References

Architects' Council of Europe (2017), *The Architectural profession in Europe 2016, a sector study*, Mirza & Nacey Research.
Ciribini, A., De Angelis, E., Pollo, R., (1994), "Ciclo di vita utile di organismi edilizi recuperati", *Recuperare*, n. 2, pp. 118-125.
CNAPPC, CRESME (2016), *Osservatorio Professione Architetto Quinta indagine congiunturale sullo stato della professione in Italia*.
European Union (2016), *Buying Green. A handbook on green public procurement*, Publications Office of the European Union, Luxembourg.
Fondazione Symbola (2016), *Certificare per competere. Dalle certificazioni ambientali nuova forza al Made in Italy*, I quaderni di Symbola, Nola.
Fondazione Symbola e Unioncamere (2017), *GreenItaly*, I quaderni di Symbola, Nola.
Pollo R. (2014), "Progetto, durabilità, manutenzione: un metodo per la previsione della durabilità", *Techne*, n. 7, Firenze University Press, Firenze, pp. 178-185.
Pollo, R., Levra Levron, A., Marino, D. (2015), "Riqualificazione dell'edilizia residenziale pubblica: indagini sul patrimonio di ATC Torino", *Techne*, n. 12, Firenze University Press, Firenze, pp. 199-206.

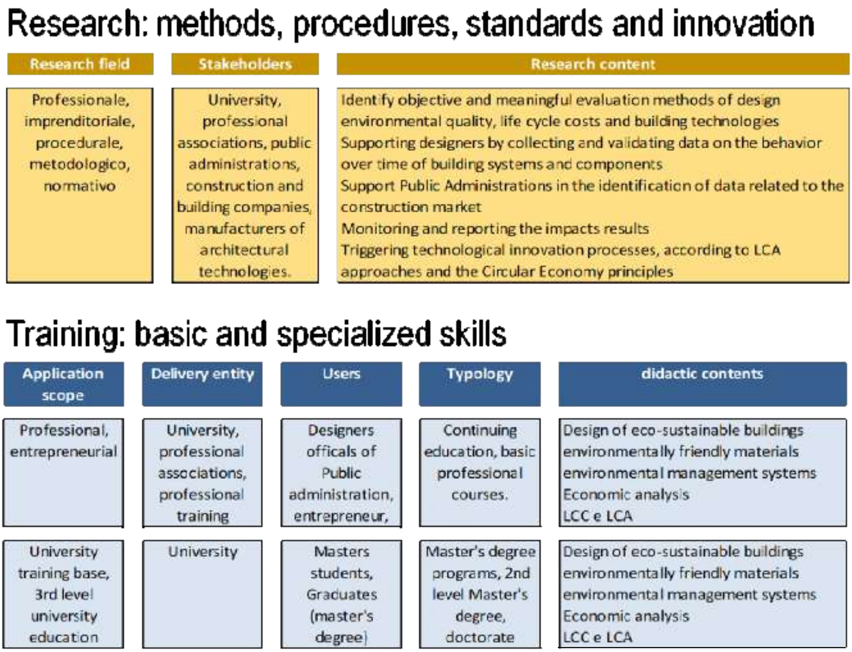


Fig. 1 - Outline of the strategic lines for the dissemination of the multidisciplinary skills necessary for an eco-sustainable design and for compliance with the minimum environmental criteria.

1.16 TENDENCIES AND NEW PLAYERS FOR PARTICIPATORY DESIGN

*Giovanni Castaldo**, *Martino Mocchi**

Abstract

Over the last century, the theme of participation has proved a main issue in the architectural debate, leading to a change in its very concept, which from being a mere consultation tool has become an active element in the definition of urban plans and strategies, producing significant effects on the project production process. The last twenty years have been characterized by the attempt to frame the change in a new regulatory apparatus, to solve the criticalities and doubts that emerged. Considering this evolution, the affirmation of spontaneous collective subjects between population and local authorities represents a new phenomenon, with a lot of potentialities for the future. The paper aims at reflecting on this point, referring to a case in Milanese context.

Keywords: Citizen Participation, Débat public, Urban Design, Participatory design, Local Association

The issue of participation in urban transformation processes

The involvement of local population in the built environment and territorial design processes had represented a crucial topic all throughout the last century, involving disciplines such as sociology, economy, city and housing planning.

In the Italian context, the first experiences came in the Fifties, during the process of reorganization and reconstruction of the cities after the Second World War. The identification of local needs and the realization that community services assumed in that case a fundamental role, involving themes such as the renewal of building policies, the management of social housing districts, the alignment of architectural debate with the central European one. This scenario strongly affected design procedures, due to the development of a "fruition and needs"-based approach, which produced an improvement in the traditional ty-

* Giovanni Castaldo is a PhD and an Adjunct Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, giovanni.castaldo@polimi.it.

* Martino Mocchi is a PhD and an Adjunct Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, martino.mocchi@polimi.it.

pologies used for community centres, local services and the "neighbourhood housing" design.

Between 1956 and 1963, during the so-called *"secondo settennio INA-Casa"*, the debate on reconstruction and realization of social housing districts grew, demonstrating the necessity of dealing with new topics as town planning policies, the emergence of peripheries, the identification of new strategies for territorial design. In the course of the Sixties, the discussion assumed a specific political connotation, in relation with the social struggles in support of the affirmation of the *"Comitati di Quartiere"* – decentralized administrative organizations whose representatives were directly elected by the population (Majocchi, 1985). The following decade, the enactment of the Gui law acknowledged the right to those organizations to express their binding advice after the consultation of local citizens (Dente et al., 1978).

The process of institutionalization of the participation led in the following decades to the definition of a complex and articulated set of regulations for standardizing urban plans and projects, with the designation of technical commissions operating at a local scale. A further step followed the new powers given to the regional authorities, the reinforcement of the local jurisdictions and the affirmation of the European Union. This culminated in the establishment of the VIA – Environmental Impact Assessment – and VAS – Strategic Environmental Assessment – procedures, which represent essential tools for fostering a wide inclusion of the population in the territorial transformation, guided by the principles of openness and transparency. The administrative and constitutional reforms occurred during the Nineties and the Noughties, also regulate the procedures of consultation, giving specific responsibilities to the local authorities (Schiaffonati, 2008). In more recent years, after a wide debate on the concept of "active participation", a new level of social involvement is emerging, reflecting the population's proactive role in the definition of projects and plans. This produced the necessity to update the administrative scenario, activating specific municipal and decentralized tools for managing popular consultations and participation, such as "participatory financial statements" (*Bilanci Partecipativi*) and "public working tables" (*Tavoli di Partecipazione*).

In 2016, the promulgation of "*Codice degli Appalti*" (Legislative Decree 50/2016) introduced the "public debate" – from the French *débat publique* (Karrer, Scognamiglio, 2016) – as a new method for fostering the public consultation in case of big territorial transformations. The procedure is based on an active confrontation among citizenship, public administrators and local promoters, aiming at generating design alternatives, variants and cooperative solutions (Pillon, 2016). The regulation of this scenario has been completed during the last year through the development of the notions of "horizontal subsidiarity", "social partnership" and "administrative barter" (Tartaglia, 2018).

The role of "active participation" in recognizing new responsibilities to citizens, local authorities and stakeholders, frames a new panel of players involved in the "production of the project", putting an end to the traditional exclusivity between developer and designer.

The consequences produced by these transformations are still to be evaluated, revealing potentialities but also criticalities. On the one hand, the growth of the number of players involved in the project may represent a response to the crisis of the traditional procedures, caused by the downturn in the construction market and the consequent reduction of the investment power of public administrations. During the last years, this scenario has encouraged private initiatives, supported by international financial capitals, in taking projects and actions, without ensuring an adequate level of public and local benefits. Active participation could play a leading role in this sense, reconnecting the project with the needs of the population and the collective interests. On the other hand, the possibility for local groups and inhabitants – without a specific knowledge – to take active part in the project activity, might lead to narrow and self-interested visions, not able to support and understand the long-term aspects of the transformations. Furthermore, the success of participatory processes necessitates contextual conditions, requiring the local population to have a good degree of sensibility to foster a flexible and multi-level network among citizens, public authorities and stakeholders (Mussinelli, 2008).

New players and new practices in participatory processes

The outlined scenario around participatory processes brings out a very dynamic situation, determined on the one hand by the necessity to reinforce the regulatory apparatus through the introduction of new laws and requirements; on the other hand, by the emergence of new doubts and uncertainties about their effective operation. In these critical circumstances, the affirmation of new players who act as "collective individuals", aiming at coordinating and encouraging a bottom up participation on the basis of a common need, plays a significant role. We are dealing with spontaneous associationism, which operates out of a logic of private gain, taking the form of free associations, participated studios, communitarian organizations. These organisms represent intermediate bodies between political authorities and private citizens, solving some of the problems highlighted, as the lack of specific knowledge by the population, the possibility of promoting long-term territorial visions, the ability to establish an effective dialogue with the institutions (Fanzini, 2017).

Among the many cases, a first interesting experience is represented by the collective "Urban Curators", created in 2007 in the United States by a group of students of the Rohde Island School of Design. By acting in peripheral districts of the city of Providence, Urban Curators generated urban processes able to meet the local expectations and to encourage a spontaneous bottom up participation of the citizens. The modus operandi comes from the belief that urban regeneration could arise not only from the physical transformation of the space, but also from the construction of a new "gaze" on it.

Starting from this awareness, students put physical "frames" around elements in abandoned or degraded urban places, aiming at stressing their potential cultural meaning and aesthetic value. The definition of new perspectives inside the city and the emphasis placed on specific objects, activated generative relationships with the local public, encouraging the affirmation of spontaneous creativity able to redefine the comprehension of the space. The "Urban Curator" collective, therefore, doesn't express a mere complaint for the situation, but tries to leave a tangible mark on the territory, giving concrete expression to that concept of "care" which Martin Heidegger considered the essential trait of the relation between men and environment. Although this initiative belongs to a clearly artistic horizon, the scope of the experiment can be considered in a wider perspective. Even in the architectural and urban field, in fact, the organization of the "collective care" of the territory proves as a character defining element in order to activate successful actions of transformation and valorisation of the environment. This consideration was the basis, for example, of the "*Luchtsingel*" initiative in Rotterdam, where the potentials related to the new methods of project production became evident (Drift, 2014). In 2012, in a phase of real estate crisis and stagnation in the urban regeneration process, a group of citizens, led by the ZUS – *Zones Urbaines Sensible* architecture firm, was able to address the expectations of the local community within a project of transformation of the urban space, in synergy with the municipal settings. The project concerned in particular the redevelopment of a leftover building, the construction of an infrastructure funded through a civic crowdfunding campaign supported by the municipality and the implementation of other redevelopment of some public spaces. In addition to the physical and spatial consistency of the carried out interventions, which actually enabled the regeneration of a significant portion of Rotterdam central area with positive socio-economic impacts, the procedural aspects of the project are certainly relevant elements. The presence of active citizenship led by a team of qualified experts, combined with the development of a flexible and adaptive governance model with reference to both public and private goals, were necessary conditions to experiment an innovative way of designing, which has been able to convey widespread interests, to define frameworks of needs and requirements, to find resources for the management of the design as well as of the processes. Another case of particular interest can be identified in the BLDG – Build, Live, Develop, Grow Memphis experience, which originates as a local network that includes operators, associations and individuals, brought together in order to start urban regeneration projects. In this case too, the objective is to encourage the social participation in the decision-making and caring processes of the territory, through concrete actions. Among the numerous projects realized since 2013, the most interesting is probably "The Hampline", which represents an innovative cycle path within the city of Memphis, able to offer at the same time structures and spaces, to host services to citizens, spaces for recreational, artistic and leisure activities.

The presence of an “intermediate body” between the institution and the private citizens was fundamental in the mediation of individual needs in view of the collective interests, in the management of relations with other bodies, such as foundations and institutions, as well as in launching a civic crowdfunding campaign, which has been crucial for the success of the project.

The case study of the Association Urban Curator TAT in Milan

The selected case histories reflect a recognizable international trend regarding the organization and the management of new practices of active participation: the spontaneous citizens’ association, the active professional firm, the territorial network. In all the above mentioned cases, one can find an organization in an intermediate position between citizens and public institutions, demonstrating the possibility of autonomously activating initiatives developing real projects. The involvement of the citizenship in the processes is strictly intertwined with the identification of new possible ways of producing projects, combining a wide participation with high technical and professional expertise.

The attempt to transfer this scenario in the Italian context led to the foundation of the Association Urban Curator TAT-Technology Architecture Territory in 2016, which brings together a group of university professors, architects, professionals, urbanists and scholars of economic and social issues. According to its mission, the Association has the objective of playing an active role in the processes of transformation of the metropolitan area of the city of Milan, stimulating the debate and proposing initiatives and projects on the themes of the quality of the public space, the regeneration and redevelopment of urban fabric (Schiaffonati et al., 2017). The conducted initiatives, focused on the South-East area of the city of Milan, have found the support of some Municipalities – in particular Municipio 4 and 5 – and the interest of many stakeholders and institutional representatives. This general appreciation for the followed approach as well as for the proposals produced a confrontation between citizens and local politicians, with the aim of continuing the research and the proposed actions, actively contributing to the debate and sharing of ideas on crucial and controversial urban themes. The operational tool of the discussion is represented by the project, conceived as proper place for comparing different points of view matured in the research, not only through general expressions of opinion, but also through concrete proposals supported by analysis and feasibility studies. This way of working has led to experimenting new forms of designing, with a first step of consultation among the professionals within the Association and then a second step of confrontation with the public’s interest.

The result of the work carried out in the first two years has given rise to a series of publications on topics of urban interest, which have animated the citizen debate (Urban Curator TAT, 2017).

The dialogue with local institutions and stakeholders, carried out through moments of public participation and discussion, is continuing on issues of central importance, such as the regeneration of the former railway yards, the relationship between the city and the agricultural context, the *Navigli* project, the planning of sport facilities.

Conclusions

Within a general framework of development of participatory processes, characterized by the arise of the notion of "active participation" and the consequent strengthening of the instruments of regulation and control of this phenomenon, the article aimed at proposing an analysis of its potentialities and criticalities. On the one hand, it is evident that the presence of citizenship in the processes of urban transformation represents a resource, in the perspective of the protection and enhancement of a collective interest increasingly challenged by the prevalence of the private initiative, incentivized by the continuous weakening of the role of the public sector. On the other hand, these procedures may encourage and develop processes of "voluntarism" of the project, which could result in a general lowering of the quality of the product. The spontaneous initiatives would not always be supported by adequate technical and management skills, without a direct dialogue with the political institutions and banded to local interests not supported by wide-ranging visions of urban development.

These criticalities became evident, for example, on the occasion of the recent conclusion of the "Participatory Budgeting" promoted by the Municipality of Milan, whose results were also compromised by procedural and bureaucratic problems. On the basis of these considerations, the paper highlighted the strategic role that associations could play in the perspective of facilitating, informing and guiding the participation, providing more mature competences and critical sensitivity. The association could assume the role of an "intermediate body", rooted in a very specific territorial area, but able to operate in a *super partes* logic, aware of strategic visions of urban development, including citizens but also professionals, designers and experts, able to support proposals with appropriate expertise (Schiaffonati, 2017). This scenario, with reference to the field of the practices of architectural and urban design, introduces a new dimension in the "project production" process, renewing the traditional relationship between client and designer. The project emerges as the outcome of an interdisciplinary path, which involves a large number of actors, a consequent updating of the modes of representation and communication, a reference to new forms of clients and identification of urban problems (Mussinelli, 2014).

This is a rapidly evolving scenario, difficult to judge in a definitive way. At the same time, it will increasingly affect the project production as well as the possibilities of urban regeneration.

References

Dente, B., Pagano, A., Regonini, G. (1978), *Il decentramento urbano: un caso di innovazione amministrativa*, Edizioni di Comunità, Milano.

Drift (2014), "Learning from the Luchtsingel", available at: https://drift.eur.nl/wp-content/uploads/2017/03/Learning-from-the-Luchtsingel.pdf (accessed September 2018).

Fanzini, D. (2017), *Tecnologie e processi per il progetto del paesaggio. Reti e modelli distrettuali*, Maggioli, Santarcangelo di Romagna.

Karrer, F., Scognamiglio, A. (2016), "Débat public all'italiana, ovvero come mutuare nozioni senza innovare comportamenti", in *Aperta Contrada*, available at: https://www.apertacontrada.it/2016/04/07/debat-public-allitaliana-ovvero-come-mutuare-nozioni-senza-innovare-comportamenti/ (accessed September 2018).

Majocchi, A. (1975), "Decentramento urbanistico e lotta per la casa", in Dragone, U. (ed), *Decentramento urbano e democrazia*, Feltrinelli, Milano.

Mussinelli, E. (2008), "Partecipazione e governance istituzionale", in Vitrano, R.M. (ed), *Architettura strategica. Tecnologie e strategie del progetto partecipato*, Luciano Editore, Napoli, pp. 65-79.

Mussinelli, E. (2014), "Identità della ricerca nella progettazione tecnologica ambientale", in VV.AA., *La cultura tecnologica nella scuola milanese*, Maggioli, Santarcangelo di Romagna, pp. 171-177.

Pillon, A. (2016), "Dibattito pubblico, un'opportunità anche per l'Italia", *Techne*, n. 11, Firenze University Press, Firenze, pp. 45-49.

Schiaffonati, F. (2008), "Le origini del progetto partecipato", in Vitrano, R.M. (ed), *Architettura strategica. Tecnologie e strategie del progetto partecipato*, Luciano Editore, Napoli, pp. 43-58.

Schiaffonati, F. (2017), "Per una centralità della figura dell'architetto", *EWT Eco Web Town*, n. 16, vol. II.

Schiaffonati, F., Castaldo, G., Mocchi, M. (2017), *Il progetto di rigenerazione urbana. Proposte per lo scalo di Porta Romana a Milano*, Maggioli, Santarcangelo di Romagna.

Tartaglia, A. (2018), *Progetto e nuovo Codice dei contratti. Innovazioni nel processo edilizio*, Maggioli, Santarcangelo di Romagna.

Urban Curator TAT (2017), *Proposte e progetti per il Sud Milano. Il ruolo dei Municipi*, Notizie dal Comune, Cavenago.

1.17 TRAINING TO RESEARCH. STRATEGIES TO BRING CLOSER UNIVERSITIES AND FIRMS TOWARDS JOINT RESEARCH

Massimo Rossetti[*]

Abstract

The paper wants to highlight how, within the educational offer of the schools of architecture, the presence of lessons focused on the development of research projects linked to the construction sector could contribute to a rapprochement between universities and firms in joint research activities. Comparing, in fact, all the goals of the European Commission with the Italian targets concerning indicators related to training and research (rate of school dropout, percentage of graduates, investments in research and development), shows a distance where is essential to intervene: to strengthen research, and to bring together two often distant realities - universities and firms - but, actually, in close contact inside the same supply chain.

Keywords: Research&Development, Construction Sector, Training, University, Firms

An overview of the construction sector

> «The construction industry is very important to the EU economy. The sector provides 18 million direct jobs and contributes to about 9% of the EU's GDP. It also creates new jobs, drives economic growth, and provides solutions for social, climate and energy challenges. The goal of the European Commission is to help the sector become more competitive, resource efficient and sustainable»[1].

In a few, essential words, the European Commission describes, showing significant data, one of the most important industrial sectors of the "Old Continent"; where, however, the situation is much more complicated and difficult to manage than the same data say. This is the case of Italy, where the construction sector is struggling to bounce back after more than a decade of deep economic crisis. Ten years that have been a real watershed, before of which the sector lived years of prosperous and uninterrupted growth. The construction world of today, on the contrary, not only tries to find back if not a clear horizon, at least a stability, but above all is almost daily wondering on what its own nature may

[*] Massimo Rossetti is an Associate Professor at the Department of Architecture and Arts, Iuav University of Venice, Italy, massimo.rossetti@iuav.it.

[1] https://ec.europa.eu/growth/sectors/construction_en.

be, and on the best ways to undertake to assume a mature and solid conformation during future years.

The main indications come from the European Commission, which indicates four challenges that the sector must face following the crisis:

> «The construction sector has been hit particularly hard by the financial and economic crisis. The main challenges facing construction are:
> - Stimulating demand: Efficiency improvements in existing buildings and renovations have the highest potential to stimulate demand.
> - Training: Improving specialised training and making the sector more attractive, in particular for blue-collar workers, technical colleges and universities.
> - Innovation: More active uptake of new technologies.
> - Energy efficiency and climate change: Buildings account for the largest share of total EU final energy consumption (40%) and produce about 35% of all greenhouse emissions»[2].

According to EU Commission, the trajectories that the construction sector must undertake seem to be very clear: the efficiency improvements and renovations in existing buildings, usually quite old - especially in Italy - as a way of stimulating demand; training, in order to make the whole sector more attractive, especially for a graduate; innovation, for a sector that certainly does not excel concerning the introduction of new techniques, methodologies and tools; energy efficiency, an obligatory path, considering the fact that the construction sector is the greater responsible for energy consumption in Europe. It is especially the second point, training, where we believe it is necessary a profound rethinking of the current dynamics in the relationship between education – particularly at university level – and research activities, especially in the professional field (Rossetti, 2011 - 2018). But, analysing the scenario, it could be quite difficult.

The Italian delay between the Europe 2020 Strategy and National Reform Program

As is well known, the Europe 2020 Strategy, which represents the continuation of the Lisbon Strategy of 2000, considers the "knowledge economy" one of the main factors for the future continental growth: «It emphasises smart, sustainable and inclusive growth as a way to overcome the structural weaknesses in Europe's economy, improve its competitiveness and productivity and underpin a sustainable social market economy», through the three "smart", "inclusive" and "sustainable" growth models, and five targets: employment, research and development (R&D), climate change and energy, education, poverty and social exclusion. Specifically, the goal is to make Europe the driving force of knowledge, thanks to targets such as a school dropout rate of less than 10%, a

[2] Cf. https://ec.europa.eu/growth/sectors/construction_en.

percentage at least of 40% of graduates between 30 and 34 years old, and investments in research and development equal to 3% of GDP expenditure.

Observing the Italian scenario, it seems instead that "bel paese" is heading strongly towards a contrary direction. If, in fact, we analyse the data presented in the most recent National Reform Program (NRP), a programmatic document that «outlines actions to contain macroeconomic imbalances, to promote competitiveness and to pursue the objectives set by the Strategy» (ISTAT, 2010), we see that Italy's targets in terms of training and research do not correspond to what is required by Europe 2020 Strategy.

According to the NRP 2018, in fact, the target of Italy to 2020 for research and development is 1.53% of GDP, substantially half of the Strategy; university degrees are expected between 26 and 27%, between fourteen and thirteen points less than European targets, while the school dropout is expected to be 16%, six points higher than in Europe. Numbers that, by themselves, indicate how the "training-research" path is not at the top of priorities in the development of the country.

The Italian planning would therefore require a strong reinforcement both of investments in research and of professionals to it dedicated, during both the training period and the working activity. Nevertheless, the analysis of the current scenario does not provide a particularly favourable framework for the implementation of a structured training-work supply chain in the field of research.

In fact, in 2016 Italy invested in R&D only 1.3% of GPD, compared to an average for the OECD countries of 2.3% (OECD, 2017). Data that underlines the need for more investments in research activities on a national level.

Similarly, observing firms, the situation is not positive. According to ISTAT, «Italian companies still invest little in R&D (0.7% of GDP compared to 1.3% of the EU average, and employ fewer workers, 4.1 per thousand inhabitants against 5.4) » (ISTAT, 2016).

The scenario does not change if we consider only the construction sector, which represents 7-8% of the national GDP. To which, however, the term "activities with a low rate of innovation" perfectly fits. The companies in the construction sector, that present innovative activities, are 20.3%, against 29.5% of services and 45.4% of industry (ISTAT, 2014). Beyond the figures, what is striking is not so much the lack of research activity - which can still happen, even if in an episodic or isolated manner - but the absence of a comprehensive and dynamic system, of a solid, shared and widespread research methodology, both locally and nationally. Unfortunately, something that is deeply rooted in the history of the Italian industry (Guerraggio, Nastasi, 2010).

To this must be added that, despite the quality of Italian research is internationally recognized, the country's system faces a shortage in terms of "critical mass": the 4.73 researchers every thousands of Italian workforce people are, in fact, opposed to much more high numbers of Finland (about 14), France and Germany (about 9) (OECD, 2017). A lack that also results from the number of graduates between 30 and 34 years: 21.7% in Italy, against 35.8% of European average (MIUR, 2016).

Leaving behind, for once, the comparison with other European countries, an operation that is perhaps an end in itself and that most of the times sees Italy loosing, the figures describe a country that is not able to remain close to the rest of the continent but that, much worse, probably does not believe in the need to expand the training activity, of any age and any level, nor in the strengthening of research. The problem is heightened if we consider basic research, the main activity in Italian universities.

According to the 2018 ISTAT Italian Statistical Yearbook, in fact, in 2015 the Italian University allocated 56.1% of total R&D expenditure to basic research, reserving 33.8% for applied research and only 8.6% to experimental development. Basic research, moreover, is supported mostly by universities, with 58.7%, with much lower percentages by companies (23.3%), by public institutions (14.3%), and by non-profit institutions (3.7%). The situation is the opposite looking at applied research, mainly carried on by companies (44.5%, which instead allocate only 9.8% to basic research), by universities (23.4%), by public institutions (19.2%), and by non-profit institutions (the remaining 4.8%). Finally, if we look at experimental research, the gap is even greater: the share of companies is 87.9%, the one of universities 8.6%, 3.1% is carried on by public institutions and 0.4% by non-profit institutions (ISTAT, 2018).

The scenario is clear and well known: a prominent basic research activity carried out by universities and public institutions corresponds to a prominent activity of applied and experimental research carried on by companies. A foreseeable scenario: universities and public institutions may not have the necessary resources for applied research, finalized to produce results that can be used in a short time, while the company may not have time (and will) to invest in basic research, with unpredictable times and sometimes uncertain results.

A form of public funding support for basic research, however, is crucial at this point, just because firms, as seen, cannot engage themselves in activities with very long, or even absent, return times. A fundamental activity, compared by Francesco Sylos Labini to the infrastructures of a territory:

> «Funding of basic research can be compared to the State intervention in the construction of major works (motorways, railways, bridges, etc.). The time scales related to these situations are also very long, and this is precisely why private individuals are not directly interested in investing substantial capital in basic research. But the effects can be important as a whole» (Sylos Labini, 2010).

At this point, an assessment of the situation is possible: in Italy, investments in R&D are lower than the EU average, and are above all in the short-term future projection; investments in research by the construction sector are low; the number of researchers is below the European average; finally, the forecast of graduates, in the short-term, is lower than the one required by the EU. To all this must be added that, in schools aimed to train professionals in the construction sector (in other words, also schools of architecture), the absence of lessons specifically focused on research methodologies.

In light of all this, it is clear that between firms working in construction and architecture schools, even if they are both part of the same supply chain, a link is missing: a link that testifies a strategic coordination and common vision on research activities. A possible proposal is therefore to introduce, in the education of an architecture student, training opportunities (courses, workshops, seminars, etc.) aimed at preparing a research programme in the construction sector.

Training to research: a new approach for architecture schools

As it is known, the construction sector moves a huge amount of money in investments, despite the dramatic period of crisis from which it comes out. The same sector, however, seems to no longer need the architect's figure, at least in Italy. The numbers are merciless: Italy is the country, in Europe, with the highest number of architects (2.5 per thousand inhabitants, compared to 1.6 that were recorded in 2000) (CRESME, 2018).

Given the previous analysis, the picture is therefore the following: on the one hand, a saturated market, which no longer requires, or at least not so much, qualified architects; on the other, an endemic leak of research-oriented professionals, including research in the construction sector.

A possible "antidote" to this anomaly could be introducing - in a systematic and structural way, making it fully integrated into the courses - lectures that present the discipline of research in architecture and, by extension, to the construction sector. This could be a form of basic training, which, however, allows students to move towards the formation of a professionals oriented to research.

The absence of a basic training in research is something that is well confirmed by who starts to attend a PhD. The difference between the various types of research (basic, applied, experimental, etc.), the setting of the working methodology, the identification of results and objectives, the critical issues and the possible repercussions in terms of dissemination, the opening of new research areas that others may face in the future; these are all topics absent from the schools of architecture in Italy.

Training to research therefore appears to be something essential. An operation that cannot be performed in an episodic, sporadic or unstructured manner, leaving it only to the initiative of the single teacher who, generously, decides to introduce into his course some research notions; that, instead, passes through a deep-rooted revaluation of human resources and training. In fact, back in 2010, ISTAT reported that:

> «closely connected to the target of growth in R&D spending is the one of enhancing human capital. A scarce endowment of human capital, in fact, negatively affects the model of productive specialization of companies, while a low innovation production system involves low returns on invest-

> ment in human capital, a vicious circle that in this phase characterizes, and does not less, Italian system» (ISTAT, 2010).

It is therefore fundamental to break this "vicious circle". If real life says that the demand for research professionals is almost null, we believe that if there is a possibility of not being stuck in a situation that has been the same for too many years, this is to consider research and training as a product, just like all other goods necessary for the country.

Again, Sylos Labini best describes this situation:

> «Italy of our time does not have a productive network that requires a large amount of qualified personnel (with university education), and since when there are no more large companies in which the State has a controlling interest, the situation has worsened. In fact, there are only a few large high tech companies investing in research and development, for which the demand for research and specialized researchers is low, as is the private financing of applied research. [...] If there was more pressure on research by the economic system, universities and public research would probably have more incentives to be less self-referential and closed in on themselves, and could be considered in a more positive perspective» (Sylos Labini, 2010).

The choice to intensify the research request by the economic system would undoubtedly be a sort of "quantum leap" in the way the current training is structured; but it would probably be a necessary step to seriously start a policy of rapprochement between firms and universities for joint research activities.

References

CRESME (2018), *L'architetto nella città del future Scenari di trasformazione del mercato e della professione*.

Guerraggio, A., Nastasi, P. (2010), *L'Italia degli scienziati. 150 anni di storia nazionale*, Bruno Mondadori, Milano.

ISTAT (2010), *Rapporto Annuale*.

ISTAT (2014), *L'innovazione nelle imprese*.

ISTAT (2016), *Rapporto Annuale*.

ISTAT (2018), *Annuario Statistico Italiano*.

OCSE (2017), *Main Science and Technology Indicators*.

Rossetti, M. (2011), "Università, ricerca, costruzioni: lo scenario di un paese in direzione contraria (e ostinata)", *Archivio di Studi Urbani e Regionali*.

Rossetti, M. (2018), "L'anello mancante. Prove di avvicinamento tra Impresa e Università", in Bellini, O.A., Ciaramella, A., Daglio, L., Gambaro, M. (eds), *La Progettazione tecnologica e gli scenari della ricerca*, Maggioli, Santarcangelo di Romagna.

Sylos Labini, F. (2010), *I ricercatori non crescono sugli alberi*, Laterza, Bari.

1.18 PROJECT PRODUCTION AND UNIVERSITY. VALUES, CONTRADICTIONS AND OPPORTUNITIES

Oscar Eugenio Bellini, Andrea Tartaglia**

Abstract

In addition to education and research, University should pursue the "third mission" to disseminate the acquired knowledge for the development of the Country. Facing a demand for design quality, innovation of models and processes, in the past the academic world has contributed to implementing the effective disciplinary and professional tools, transferring innovations in the professions and sharing what was taught to respond to the needs of the society. Today this does not happen anymore and in the Schools of Architecture the enhancement of knowledge, which mainly passes through the architectural project, assumed as a research tool, remains substantially prohibited by inappropriate and contradictory legislative devices.

Keywords: Third mission, Profession, University as service, Project

Towards innovation in the National and European system

The most recent National and European policies aimed at socio-economic development highlight the need for a continuous and systemic relationship among production, industry, services and research, avoiding barriers between public and private actors, to create synergies and interactions that contribute to innovation and scientific and technological advancements.

University should not only participate in the construction of connections between transformations of the productive system and the world of knowledge and research, but it must take a completely global perspective "contaminating" itself with the economic system of the Country (Roggero, 2018).

As with the "highly specialized competence Centres"[1], whose institution was financed for the two-year period 2017/18 with 40 million euros or with the intro-

---

* Oscar Eugenio Bellini is an Associate Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, oscar.bellini@polimi.it.

* Andrea Tartaglia is an Associate Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, andrea.tartaglia@polimi.it.

1 Introduced by the "National Plan Industry 4.0" of the Ministry of Economic Development, the "Highly specialized competence Centres" are designed as public-private partnership structures which, in addition to guidance and training activities for companies, must participate and promote innovation projects, industrial research and experimental development.

duction in the Code of public contracts of the “partnership for innovation” which, in coherence with the EU indications, pushes innovation through initiatives supported by public finance. In the early Nineties, Henry Etzkowitz had identified in academic research the necessary element to stimulate the development of territorial systems, theorizing the model of the “triple helix” in which the triad University, Industry, Public Administration had to originate a new knowledge society in place of the industrial one (Etzkowitz, 1993).

In Italy, University seems to find insurmountable obstacles in the field of urban planning and architecture which is characterized by a pulverized professional structure that makes significant investments in research and development impractical. Some regulations limit the research institutions and the University to deal with the socio-economic context, preventing the transfer of the theoretical and experimental results. The opportunity to overcome the dichotomy between University and Profession is also considered as a problem of the single professor who aims at subtracting work opportunities from those working in the profession. On the opposite, the question is if this does not limit the possibility of innovating processes and products in the project and construction sector, slowing down the development of the Country, as has already happened not long ago. But also, if, today the University still has the skills and tools to be “engine” of innovation for the socioeconomic system, as it has already happened in moments not far away. Recent seasons have seen some of the most brilliant exponents of the Italian technological design academic world stimulating innovation in the “real world”. In the Eighties, in the field of industrialized building production, the design of modules and the construction with panels in Architecture - according to the principles of maximum integration between the time of design and production - we can refer to the prototype of the Post Office.

In the Nineties, the research “Meta-project for hospital buildings” coordinated by Roberto Palumbo had marked a gap in the definition of techno-typological solutions in health care buildings with evident repercussions on projects financed by the national construction program for health buildings (Article 20 of Law 67/88). In the 2000s, the collaboration of Romano Del Nord with the Ministry of Education, University and Research was virtuous for the definition of normative standards and models to answer to the needs of student housing. These studies have merged into the technical annexes of the 338/2000 Law on University residences. In more recent times, the reference can go to the rich repertoire of “Studies, Researches and Projects” of Technology of Architecture and Territory promoted by the TEMA Laboratory (Technology Environment and Management), coordinated by Fabrizio Schiaffonati at the BEST Department of Politecnico di Milano, which exemplify perfectly what it means to work between research and profession (Schiaffonati et al., 2015).

A season of innovation and experimentation from which the area of the Architectural Technology must restart in order to open up and re-establish its action, not only in the Schools of Architecture but in society.

Moments that had the undisputed merit of having operated a «continuous verification of the validity of the theoretical-practical armament of the discipline with respect to the evolution of the "project demand" expressed by the operators» (Karrer, 2015: 28) promoting results and recognizing social, economic and scientific value to the discipline.

Project and University research

The Architectural project represents a plural, dialogic and multiple instrument. The only one able to anticipate environmental transformations and able to manage the challenges of the quality of cities and urban life, of multi-ethnic societies, of economic and social responsibility, of climate change, of the overcoming of the dependence on fossil energy and of the needs of knowledge and progress. Its production is a process of scientific research, which progresses with theoretical reflection and finds concreteness in the experiential and pragmatic comparison. The only one that allows the interpretation of the complexity of reality, also in terms of problem solving (Losasso, 2011).

Although in our Country there is a regime of incompatibility between profession and University teaching, by virtue of this principle, there is a growing determination by the Schools of Architecture and the related Departments in proposing the Public Administration with contracting[2] to carry out activities of study, analysis, evaluation, but not design, construction and urban planning, based on procedures that often take on "creative" connotations and deal with instrumental partitioning of the services to be entrusted. An attitude that is legitimate due to the didactics and research fields of many Scientific Sectors, in which the production of the project coincides with the content itself of the discipline and becomes the occasion to celebrate the social value of the project and to seek the "common good". On the etymological level, the terms profession and professing own the same derivation, which emphasizes the public aspect: profateor, to say publicly, or assume a public responsibility. The University professor, as well as the professional architect, - even more if the two roles overlap - should ask not to provide an abstract knowledge but to act with a "spirit of service": public subject in law and duty of employment of responsibility. The University, a public institution that does not allow conditioning and makes autonomy of thought its essential prerogative, should not be allowed but it should be obliged to work in this direction, carrying out the role of "University as service".

2 In Italy, 50% of the total amount of activities carried out on behalf of third parties comes from 10 Universities. The share of financing on behalf of third parties on total research funding varies widely between disciplines, partly due to different external financing opportunities, partly due to differences in competitive public funding. This share of total funding varies between 57% for the scientific area linked to the Project (Civil Engineering and Architecture) to 22% in the Area of Physical Sciences (ANVUR-VQR-2004-2010).

Idea theorized in the Eighties by the Jantsch Report (Karrer, 2015), which gives credible and scientifically valuable answers to civil society, interacting with public operators. The University is not a company founded on the principles of productivity and profit. Its efficiency is measured by the indicators of the "Third Mission", as a set of "activities with which the Universities enter into direct interaction with society" (ANVUR, 2014). For the accumulation of generic quantities, or the creation of a product that of those quantities is the automatic result. But a concept of broad meaning, perhaps even of difficult interpretation, which although including activities of academic productivity, in terms of technology transfer to industry, provides for the creation of common, public goods, with social content and civil progress and public engagement that can be part of an expanded definition of the project. A place in society that is not simply an answer to needs but it is able to anticipate and direct them (ANVUR, 2017).

An incompatibility of principle, penalizing and instrumental, which juxtaposes professional orders and University, preventing the latter from carrying out any project action. The University's commitment to a real demand for programming, design and project has already led - as we have already seen in the recent past - to the implementation of disciplinary and professional tools, with the transfer of innovations to the advantage of the world of professions and the possibility of matching what is taught with the needs of society. This is because, also by the project, the University has the duty to transfer, in addition to theories, operational skills, to propose direct experiences and to develop models and methods that can be transferred and replicated (Tartaglia, 2018).

Researching the quality and effectiveness of a professional education on the architectural project, long recognized abroad[3], has recently been reaffirmed by the CNAPPC and the CUIA. They have underlined the need to establish an indissoluble relationship between teaching and project «practical and application activities in the laboratory and on the territory integrated with applied research and knowledge transfer», in «osmotic relationship with the profession, as expressly indicated by the EU Directive». This in the context of «strengthening the applicative professional dimension through [...] the valorisation of the project experimentation, of the role of the research laboratories in the education, in particular the master and of the third level», in order to activate «occasions of comparison and division with the themes of the development of the cities and regions that see a new and more intense integration between education, research and profession» (CNAPPC, CUIA, 2017: 13, 20).

---

3 «In order for teachers of architecture to guide students in achieving their capabilities as architects, it is necessary for teachers of architecture to have close contact with professional practice. It is therefore desirable for the majority of teachers to be either practicing architecture or to have substantial practice experience. It is advisable that a teacher who practices architecture should be encouraged to do so, provided that this activity does not impede the academic performance of that person» (UIA, 2002: 19).

Perspectives

Within the articulated national legislative framework, on a formal level the methods for resolving the quarrel University/Profession relationship appear clear. The issue on the political and academic level is more delicate, despite the pressures that the Scientific Societies and the disciplinary groups, have been promoting for some time. If considered from a temporal perspective, the incompatibility between teaching and free profession leads to questioning certain issues. The first concerns the risk of the lack of credibility that the Italian Schools of Architecture may have on the national and, even more, international education market. The ability to call professors, who discuss the project for practicing it, can only produce a greater appeal on students.

Secondly, the inability to exercise the professional design within the University is likely to divert the research interests of many Scientific Sectors on purely theoretical-methodological aspects or pure analysis, diverting the interest from the practical and operational ones, exacerbating the academic approach and exasperating specialism, which still today marks the gap between University and real society. The result is a drift towards design education that is completely detached from concrete issues, whereas, in contrast, University should build a constant relationship with reality to change and improve it through innovative proposals and experimental trajectories.

Another consideration concerns the loss of cultural and scientific centrality that the Schools of Architecture are undergoing in the debate on the themes on the complexity of the architectural project. A drift that is taking place in favour of the professional associations, which are taking roles that do not compete to them and for which they do not always have the necessary skills.

More dramatic could be the consequence in relation to the progressive growth and affirmation of a generation of professors trained outside the gym of the architectural project. Professors and researchers not experts and prepared on the technical application aspects that the discipline imposes[4] and, therefore, unable to dialogue with contract professors who, borrowed from the profession, speak the language of “doing”.

---

[4] The possibility or not of exercising the project risks producing discriminations in the evaluation of professors who are allowed to experiment with the project in comparison to those to which it is formally prevented. Think of the art. 2 of the Ministerial Decree 89/2009 which, as part of the assessment of academic qualifications, provides that «the selection boards of the procedures [...] analytically performs the comparative assessment of the qualifications of the candidates on the basis of the following elements duly documented [...] realization of project activities in relation to those scientific-disciplinary sectors in which it is foreseen». And to the DM 8/2010 “Guidelines VQR 2004-2008” establishes: «they are taken into consideration for the evaluation of the panels [...] compositions, drawings, designs, performances, organized exhibitions and exhibitions, artefacts, prototypes and works of art and their projects». From this, it is clear that the legislator, although in a non-explicit form, has considered the practice of planning for those Scientific Sectors in which it is planned.

Within a few years, in the Schools of Architecture we will face the paradox that the professors will educate on pure theory, not being able to count on practical experiences and not having never exercised and verified the construction of the building.

A bleak and partly incomprehensible picture, where the only way out seems to be the commitment to build new synergies and interactions with those who deal with the transformations of the environment outside the University, at different levels and degrees, to avoid a further dangerous and in some ways irreversible "peripheralization of the project" in the Country (Scoccimarro, 1987).

The real challenge

The challenge to innovate the architectural project, as a highly complex technological act, characterized by articulated sectors and many different production sites, can represent an opportunity for redeeming the quality of the profession and for creating adaptive and resilient urban realities (Schiaffonati, 2017). This requires the modification of the current relationships between academic and professional dimension, to project them towards a strategy for the architectural system and towards new collaborative forms (CNAPPC, CUIA, 2017) The need is to recover, in didactic terms, an approach based on clear competences, through a culture of polytechnic matrix - as a superposition between humanistic and scientific technical cultures - to lead to an education able to assure the student/architect autonomy and intellectual flexibility, with which to free oneself from that "generalist" dimension that connotes degree courses called specialized instead. In fact, «we are witnessing a progressive activation of degree courses, especially master degree courses, which take highly characterized titrations with respect to emerging themes or intervention scales, diverting the attention from the project as an instrument/process that the professional must be able to coordinate in all its phases» (Tartaglia, 2018: 92).

A state of affairs weighed down by having translated the theme of the technological level of the architectural project to the purely technical one, progressively diverting attention to the importance of the quality of the design product as a set of contents and actions, and to focus exclusively on the interest in the quality of the design process. This has made the role of the architect as "director" of the project, in the face of a segmentation of knowledge, so that the seismic, energetic, environmental, landscape problems, etc., have become independent variables, out of a systemic logic, to be addressed in cascade during the executive development of the project.

It does not mean opening up to a clash between the different skills that involve the project, but giving just the right value, in inter and transdisciplinary terms, to the specialisms that characterize the training paths that lead to the exercise of the profession.

Disciplines often integrally present in the Departmental structures and which must be calibrated on the basis of specific education paths for the professions, and which can lead to an effective development of skills and abilities, so as to understand the need to overcome the ideational moment as a single training action, accentuating the aspects of feasibility and constructability.

A never-ending story that can only be closed if politically and culturally sustained by all the involved subjects, avoiding protectionist and corporatist logics, which leads to not taking the project as a formidable tool for the construction of the common good.

It is necessary to go back to the field research, to the interlocution with the needs of society and to the interaction with the economic world and with the production sector, getting involved and getting hands dirty because «a relationship between teaching and research in the modern University is one of international concern» (Prosser, 2005: 3).

Failure to overcome corporate upheavals and the absence of a closer dialogue between who teach and who practice, as well as penalizing society, impoverishes the formative quality of future project managers, called to face a labour market increasingly international and competitive. A gradual process that can only be carried out when the Schools of Architecture have been able to reprove their real abilities, demonstrating in fact, and not only in their intentions, their potential, without claiming generic rights to the practice of profession, but demonstrating, with expertise and scientific knowledge, innovative skills and not a substitute for free profession. Claiming with the results a role of a competence centre able to simultaneously put human and scientific resources in action on the many aspects of the architectural project. It is conceivable to make the Architecture departments responsible for taking care of the project quality questions fielding a disciplinary armament of theoretical and practical nature, based on a high capacity for scientific research and innovation, which is not always available in the professional world. This requires the University to change attitudes by identifying systems of rules and formats of response tools that allow it to "free up" the energies it has, arriving by example to provocatively "give" (abroad) quality projects on which to open the comparison with civil society. The hope is to overcome that academicism that still permeates many universities returning to offer a recognized and recognizable contribution to the community transferable in construction. A return to an integration between the University world and the real world, which is measured and applied with and in the territory, taken as an expression of the demand and supply of research, development and education. An area where the project cannot be taken as an action, but as a context (cultural, economic, etc.) to stimulate "mentality" and "attitudes" useful to transform ideas into reality and make them become engines of development (Bellini, 2018).

A «scientific design research», which can provide systemic solutions, and not only formal answers (Del Nord, 2016).

But also an opportunity to overcome the non correspondence between demand and format to the response to the need for a project, and on the one hand it shows an established inadequacy «of the consolidated theoretical and practical armament and, on the other, laziness, at the limit of inertia, of demand operators, especially public/collective, to the innovation of processes and products» (Karrer, 2015: 31). A context in which the project "made by technologists" is characterized as an activity of knowledge, prefiguration and anticipation of the possible. A place of prediction of reality, of formulation of scenarios and feasible visions, based on actions that contemplate, at different levels, the integration between knowledge and education, also on the strength of a plurality of methods that refer to the "project based" didactic studies. Complex actions, which arise *hic et nunc* from the world, and which condense and outline the achievement of new and better horizons of life.

References

ANVUR (2014), *Rapporto sullo stato del Sistema Universitario e della ricerca 2013. Le professioni nell'Università. Un primo studio sulla presenza e sul ruolo delle libere professioni in ambito accademico*, STR Press, Roma.

ANVUR (2017), *Valutazione della Qualità della Ricerca 2011-2014 (VQR 2011-2014). Rapporto finale di area. Gruppo di Esperti della Valutazione dell'Area Architettura (GEV08a)*, 20 November.

Bellini, O.E. (2018), "Il nexus fra didattica e ricerca nella Progettazione tecnologica", in Bellini, O.E, Ciaramella, A., Daglio, L., Gambaro, M. (eds), *La Progettazione tecnologica e gli scenari della ricerca*, Maggioli, Santarcangelo di Romagna, pp. 195-208.

CNAPPC, CUIA (2017), *Conferenza nazionale sull'architettura. Verso una strategia di sistema per l'architettura italiana: formazione, ricerca, professione*, Roma.

Del Nord, R. (2016), "Potenzialità dell'Area tecnologica in tema di 'ricerca progettuale'", in Perricioli, M. (ed), *Pensiero tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano.

Etzkowitz, H. (1993), "Enterprises from Science: The Origins of Science-based Regional Economic Development", *Minerva*, vol. 31, issue 3, pp. 326-360.

Karrer, F. (2015), "Gli insegnamenti di una esperienza", in Schiaffonati, F. Mussinelli, E., Majocchi, A., Tartaglia, A., Riva, R., Gambaro M., (2015), *Tecnologia Architettura Territorio. Studi ricerche progetti*, Maggioli, Santarcangelo di Romagna.

Losasso, M. (2011), "Il progetto come prodotto di ricerca scientifica / The project as product of scientific research", *Techne,* n. 2, Firenze University Press, Firenze, pp. 78-85.

Prosser, M. (2005), "Foreword", in Jenkins, A., Mick Healey, M. (eds), *Institutional strategies to link teaching and research*, The Higher Education Academy, New York.

Roggero, G. (2018), *La produzione del sapere vivo. Crisi dell'università e trasformazione del lavoro tra le due sponde dell'Atlantico*, Franco Angeli, Milano.

Schiaffonati, F., Mussinelli, E., Majocchi, A., Tartaglia, A., Riva, R., Gambaro M., (2015), *Tecnologia Architettura Territorio. Studi ricerche progetti*, Maggioli, Santarcangelo di Romagna.

Schiaffonati, F. (2017), "Per una centralità della figura dell'architetto", *Eco Web Town*, n. 16, vol. II, Edizioni SUT, pp. 17-23.

Scoccimarro, A. (1987), "La periferizzazione del progetto", in Crespi, L. (ed), *La Progettazione tecnologica*, Franco Angeli, Milano.

Tartaglia, A. (2018), *Progetto e nuovo Codice dei contratti. Innovazioni nel processo edilizio*, Maggioli, Santarcangelo di Romagna.

UIA - International Union of Architects and Architectural Education (2002), *Reflections and Recommendations*, document adopted by the 22th UIA General Assembly, Berlin.

1.19 A NEW PROFESSION FOR THE ARCHITECT. THE PROJECT MANAGER

Mariateresa Mandaglio, Caterina Claudia Musarella**

Abstract

In recent years, the profession of the architect is facing a complex change at both the procedural level and role, generating contradictions and conflicts of interest for an architecture increasingly conditioned by new technologies and the consequent frenetic timing. Today a professional must be aware of the innovations in progress and able to meet the needs of users and standards that require professionals with greater technical-managerial skills. This contribution intends to investigate the complexity of "making architecture" today, where the project imposes a diversification of roles, an interweaving of relationships and responsibilities that make the architect just one of the many protagonists of the building process.

Keywords: Architecture, Complexity, Innovation, Management, Project Manager

General information

The construction sector and the public administration interested in the project are increasingly becoming aware that to innovate, increase efficiency, solve problems, a systematic approach is necessary that allows governing the processes, regardless of their technical content.

Today, in fact, a professional needs to work in the design, the implementation, and the management of public and private works and, at the same time, to solve the problems inherent in relationships with the Client, too. The goal of the work is to investigate the complexity of "making architecture" today, in a constantly changing landscape, where traditional lines generate strong contradictions and conflicts of interest, reflecting on the limits and the liberties of architecture nowadays always more conditioned by the technology and the current frenetic timing required. The complexity of the projects imposes a diversification of roles, an intertwining of relationships and responsibilities that make the architect just one of the many protagonists of the building process.

* Mariateresa Mandaglio is a PhD at the Mediterranea University of Reggio Calabria, Italy, mariateresa.mandaglio@unirc.it.

* Caterina Claudia Musarella is a PhD at the Mediterranea University of Reggio Calabria, Italy, caterina.musarella@unirc.it.

It is in this context that the role of the designer is destined to change based on different professional fields: director of the planning process of the future able to dialogue with the different disciplines.

An appropriate management and the consequent figures that govern it seem, therefore, to be the solution to the coordination of such a complexity of roles.

Design in 2020

A building has always been deeply marked by the building process that led to its construction. The architectural styles are the assimilation of material and immaterial needs of those who commission the work, conditioned by the available resources of materials and skilled workers.

The rules and laws in force determine the dimensional and distribution characteristics of the buildings by regulating their mutual interaction and imposing a specific language.

The project is a snapshot of the building process, taken at a certain moment, destined to change in its later versions, assimilating the changes in the process itself. The architecture achieved is the sedimentation of these snap-shots and presents traces of every influence of the process.

In the words of Alvaro Siza: «The project is to the architect how the character of a novel is to the author: he constantly goes beyond it, it is necessary not to lose it, the drawing follows him, but the project is a character with many authors» (Siza, 1997).

The production process and its organization have a strategic role in defining or redefining the form and language of architecture; management techniques therefore seem to be the solution to the coordination of multiple roles: clients, designers, builders, suppliers, financiers, control authorities, certifiers, testers, etc. It, therefore, emerges how necessary it is to change the leadership of the construction process, from the traditional "client-designer" combination to recent forms of management, respecting costs, times but above all the quality of architecture. Although the theme of management has been adopted since the Eighties in the disciplinary field of Architecture Technology, highlighting the management aspects of the profession to be implemented through highly structured organizational models and project control techniques inspired by the philosophy of project management (Schiaffonati et al., 1985).

It is only with Law 109/1994 that the conditions for management in public works are laid by introducing the person in charge of the Procedure (RP) as a reference of the client with respect to the management of the process and procedures contract. The management theme taken up by 163/2006 is deepened and consolidated with the new Procurement Code, attributing to the figure of the RUP (Unique Responsible of Process) an assumption of responsibility similar to that of a Project Manager.

In fact, with the entry into force of Legislative Decree 50/2016 and the Legislative Decree 57/2017, among the many new features, the figure of the RUP is decidedly strengthened by highlighting itself in Article n.38 of the new Code which, regardless of the amount of the contract,

> «the RUP have to have the qualification of Project Manager, with a view to highlighting the planning and management skills of the development of specific projects, the coordination of all available resources, the interventions aimed at ensuring the unity of the intervention and the achievement of objectives in the times and costs provided with quality of performance and risk control» (translated by the authors).

Furthermore, in September 2016, the Italian Standardization Agency published the UNI 11648 standard, that gives, in a formal level to the figure of Project Manager defining the knowledge and skills needed to cover professionally this role. Recently, also internationally, the figure of the Project Manager has been defined by the ISO 21500 standard, later transposed and published in Italy as UNI ISO 21500 "Project Management Guide".

While being clear the will of

> «enhancing the role of Project Manager, emphasizing the skills of planning and managing the development of specific projects, also through the coordination of all available resources, and the interventions aimed at ensuring the unity of the intervention, the achievement of the objectives within the expected times and costs, the quality of the performance and the control of the risks» (translated by the authors).

There is still no organic framework for the dissemination, management and development of the aforementioned principles, which can help the activities of the RUP and other actors of the contracting station.

It is also important to highlight the substantial difference between the figure of the Project Manager applied in the public sector and that in the private sector. In fact, if in the private sector the Project Manager assumes complete tasks and responsibilities, in the public, the aforementioned figure, identifiable in the RUP, has a limited application both in the procedures and in the actions to be undertaken.

The discipline of Project Management in the building sector

Before going to analyse the discipline of the Project Management and the concept of Project Manager it is necessary to place the theme in the building sector. Architecture management in the past is often been neglected because it is considered superfluous, if not even an obstacle to design creativity. However, good management is a fundamental complement to good architecture.

More and more some of the challenges that the architect faces in his activity are not only technical but also of coordination and depend on the characteristics of the profession and the interaction with a complex environment and a very competitive market.

These are skills in line with the declaration of Norman Foster in an interview published by Harvard Business Review in 2011 to answer at the question: «What makes an architect a good architect?» Foster highlights the orientation towards results and excellence, the inclination towards experimentation, but also the ability to return constant, positive and negative feedback, the ability to listen and dialogue with the customer, as well as negotiation and problem-solving skills. In fact, «it highlights the need to pursue a project path/process characterized by the interaction of controlled and controllable skills to support the creative idea underlying the project itself» (Lucarelli, 2018).

In the management of complex projects, for some time now the application of Project Management has been affirmed, as a tool aimed at guaranteeing a management path that is as systematic as possible, for any type of process that has a beginning and an end. The Project Management starts from the very definition of the project, understood as a process characterized by a "life cycle", which from the beginning (the concept), through the development phases, arrives at the end (the realization).

The same Archibald, father of the philosophy of Project Management, defines a project like «a complex effort that has a beginning and an end» (Archibald, 1994), thus giving the project a connotation of process and not of an object or result. The management of the projects follows the development, or better, the life cycle of these, defining a path made of phases, which, if studied and organized in a detailed and analytical way, allow the simplification and, better still, the positive conclusion.

As already mentioned, among the principal managers of the project organization, the pivotal figure, the one that plays the role of coordinator of resources within a process made not only of things but above all of people, is the Project Manager. The managerial organization has become a need and no longer a simple choice, so also the role of the Project Manager, from simple activity, has assumed all the characteristics of a profession, complete with a code of ethics and certification.

In the building process, the technical drafting phase is crucial: scope, quality, time and costs here have to defined and developed at the executive level. Paradoxically, the weak link in the chain, those who until now have been more distant from the use of specific tools and techniques of Project Management, are precisely the Architects.Therefore, in carrying out their technical service they are not limited to the development of a discipline: the architect is very often responsible for the integration between the specialized disciplines and is overall responsible for the design of the project in respect of the purpose, in time and in the established budget.

Indeed, the figure of the architect, as film director, thanks to his cultural education, possesses, in fact, those transversal skills indispensable for that role of integration and coordination: of Project Manager.

While on one hand the technical preparation, the company organization and the compliance with the regulations appear sufficient to govern the designing phase, it is clear that the application of the management's own tools are decisive for planning and controlling both the design phase that of execution. That to release the project deliverables with the required qualities, successfully managing the expectations of the stakeholders.

Only a few years ago, the architecture departments of Italian universities, finally recognizing their importance, have included management discipline in their teachings and, today, a strong cultural and professional drive in this sense is also given by the increasing use of BIM (Building Information Modelling). The BIM is not only identified as a simple software, but also as «a process that includes the generation and management of digital representations of the physical characteristics and functioning of a work» (Miramonti, 2014) and simulates the entire life cycle of a building, including the construction phase and maintenance operations.

The hope is that this digital revolution is an opportunity for the designer not so much of a technological update, but a cultural growth based on the new approach, transversal and complete, comparable to that of the Project Manager.

As Gropius said almost a hundred years ago:

> «The power and role of the architect will depend in the future on his spiritual ability to transform himself, on his strength in resolving his high tasks in an appropriate way to our time characterized by technique and economy, the ability to conceive the building as form of vital processes. If assumes this attitude, despite the pressure of industrial methods, he will not lose ground, but he will gain. Will be able to explain to the public, through his activity, that the engineer will be able to supplant him, because the essence of his profession is not that of the technician, but that of an organizer who embraces the whole, which must bring together in a single thinking about all the scientific, social, technical, economic and formal problems of building, systematically merging them into a unified work thanks to the collective work of numerous specialists and workers» (Gropius, 1928).

To understand the importance of the approach it is appropriate to report the different definitions that give discipline:

> «The application of the systemic approach to the management of technologically complex activities or projects whose objectives are explicitly set in terms of time and cost parameters». (Cleland and Kind, 1988)
>
> «Plan, organize, manage and control the company's resources for a relatively short-term objective, which has been set to accomplish specific goals and objectives using the systemic approach to management by assigning function personnel to a specific project» (Kerzner, 1989).

Or, directly from PMI[1] (Project Management Institute):

> «Project Management is the application of knowledge, skills, tools and techniques to carry out activities in order to achieve and exceed the needs and expectations of Stakeholders on a given project».

From these definitions, it follows that the expression Project Management refers to any structured approach to the realization of a project, understood as a set of activities of finite duration over time. Therefore, it provides a set of methodologies and directives to achieve the final goal of a project, respecting the constraints imposed in terms of time, costs, quality and resources.

It is necessary to consider that a project is provided by innovation and by the aspects of innovation, a process, on the other hand, is provided by repeatability. In fact, all the activities of an organization can be configurable as distinguishable processes in management, support, development processes, etc...

A process is therefore an interrelated series of actions, events and mechanisms aimed at adding value. A project, on the other hand, is characterized by a life cycle, which is subdivided into successive phases until the results and preset goals are achieved. Project Management develops through the planning, execution and monitoring of the progress of the activities that make up the project. Management processes characterize each phase, through which it is possible to plan, execute, coordinate and monitor the state of the project throughout its development. Furthermore, the discipline of Project Management is constantly evolving because the traditional principles and methods of management of the industrial era are not sufficient for planning, control and government of projects or programs. Projects are composed of many activities that require more skills than traditional organizations. It is, therefore, necessary a solid and adequate preparation able to manage the multidisciplinary, necessary for an effective performance of the technical aspects related to the executive phase of the building process aimed at increasing the ability to use methodologies of analysis and organizational planning to facilitate the implementation phase and management of specific technical-procedural solutions.

Conclusions

It is possible to trace an analogy between the fundamental points of the Vitruvio treaty *De Architectura,* and actual legislation in five words: knowledge, ethics, common good, quality of architecture and responsibility.

The architect, aware of the commitment he made, makes a real ethical pact with society and the environment - as well as with the client - swearing to take into account all the factors that constitute the historical, natural and environmental context in which works.

---

1 Project Management Institute (PMI) ® brings together over 600,000 industry professionals in more than 185 countries and is internationally recognized as the most authoritative body.

The result of this study leads, therefore, to look at the architect as a film director, is not a figure considered only occasional, but assumes a defined role and responsibility both towards the client and the community. The figure of the Architect-Manager, in fact, to make relevant decisions in all phases of the contract, from the planning to the design, to the testing of the intervention, through new visions and approaches of the operational practices of the project.

In light of what has been said, on the one hand there is a tendency to identify a new professional figure with an ever-increasing qualification, on the other hand the awareness that the architect's role is destined to change on the basis of different professional fields. They become a director of the process planning of the future, able to dialogue with the different disciplines and a know-how holder, able to follow the innovation process.

To do this we need a leap in scale in the knowledge of professionalism and growth in new markets that innovation draws through a road that accompanies the architect to multidisciplinary and integration through specific skills.

References

Archibald, R.D. (1994), *Project Management: la gestione di progetti e programmi complessi*, Franco Angeli, Milano.

Cleland, D.I, Kind, W.R. (1988), *The Project Management handbook*, Engineering Management and Manufacturing Management, John Wiley & Sons, Inc., New York.

Gropius, W. (1928), "Der Architekt als Organisator der modernen Bauwirtschaft und seine Forderungen an die Industrie", in von Block, F. (ed), *Probleme des Bauens*, Muller & Kiepenheuer, Potsdam.

Kerzner, H. (1989), *Project Management: A Systems Approach to Planning, Scheduling, and Controlling*. Van Nostrand Reinhold, New York.

Lucarelli, M.T. (2018), "Prefazione", in Russo Ermolli, S. (ed), *The Changing Architect*, Maggioli, Santarcangelo di Romagna.

Miramonti, C. (2014), "BIM: il nuovo approccio per progettare e costruire", in *Dossier U&C*, n. 9, available at: https://www.promosricerche.org/images/Documenti_pdf/Dossier/D_2014/ Dossier__UC_9_ottobre_2014.pdf.

Schiaffonati, F., Crespi, L., Uttini, B. (1985), *Produzione e controllo del progetto. Modelli organizzativi, tecniche decisionali e tecnologie per la progettazione architettonica*, Franco Angeli, Milano.

Siza, A. (1997), *Scritti di Architettura*, Skira, Milano.

1.20 DIGITAL TECHNOLOGIES, CONSTRUCTION 4.0 AND HUMAN FACTORS

Erminia Attaianese[*]

Abstract

The article describes current applications of new digital technologies in the construction sector, considering different stages of the building process, and proposes human factors as crucial elements for developing new physical and relational infrastructures whose collaborative, autonomous, auto-organizing and responsive nature, triggers new problems about interaction, control and optimization.

Keywords: Enabling technologies, Building process, Cyber-physical-systems, Ergonomics

Technological domains in the digital era

The diffusion of new low-cost technologies and the pervasive use of digital artifacts have started a process of radical transformation that concerns, by several points of views, not only the physical and organizational context in which we live and work, but ourselves, our cognitive, relational and behavioural models, cultural codes, the way we use and interact with systems and the environment. Digital access and connectivity, digital data and automation, are seen as the four key factors of this transformation, that by an operational perspective, takes advantage of the potentialities offered by the extreme extension of mobile access, resulting from the widespread availability of the Internet, and from the new and unthinkable possibilities of connection, communication and synchronization of distant and different entities, which support the creation of technological equipment characterized by autonomous, responsive and self-organizing systems (Altobello, 2016).

The increasing development of systems able of collecting, organizing and analysing big amounts of complex data, is bringing to identifying new types of information to advantage every link of value chain, which is progressively losing its linear feature, for assuming the multinodal, dynamic and collaborative dimensions of a value network (Allee, et al., 2015).

Modern information and communication technologies may be the nervous, connective and reticular tissue of this digital scenario, capable of realizing new

[*] Erminia Attaianese is an Associate Professor at the Department of Architecture, University of Naples Federico II, Italy, erminia.attaianese@unina.it.

relationships models and new a-spatial and a-dimensional reference environments, whose nodes are constituted by an increasingly wide and variety of processing systems, characterized by increasing computing power and storage capacity, in the face of decreasingly sizes and consumptions.

These elements, based on cognitive learning models, self-diagnosis and reconfiguration, make possible to develop networks of highly reactive physical and digital objects, able of perceiving and interacting not only each other, but also with people and with the environment, going over traditional categories of physics, for outlining entities in which the physical world and the virtual world converge.

Enabling technologies and Industry 4.0

Despite the expression Industry 4.0, today also widespread in our country (MISE, 2016), was proposed for the first time in 2011 in Germany to indicate the competitive approach aimed at strengthening competitiveness in German manufacturing industry, based on a High Tech strategy, (Hermann, et al., 2015), already in 2009 the European Union had identified a group of high knowledge enabling technologies, as tools that alone or in an integrated way, for their systemic relevance, could have represented growth and development factors for adequately addressing crucial challenges for the future of society, such as climate change and the improvement of energy efficiency (COM, 2009). The combination of IoT (Internet of Things), Cloud, Big Data and Big Data Analytics technologies, for example, can support conditions of ubiquitous intelligence. Each physical entity has the potential of generating or receiving huge data that provide information on its state and on the state of the physical, natural and anthropic environment which surrounds it, to store, process and organize such data, to extrapolate additional information with respect to those obtainable from each individual device, to convey the information obtained to the outside, and to take decisions independently, on the basis of the collected information. With simulation technologies we can model detected phenomena with the creation of their digital twin, to manage them not only visually, but also in a multi-sensorial way, thanks to Virtual Reality and Augmented Reality systems. Starting from digital modelling, we can also print complex shapes objects by adding material, overcoming limitations due to geometric constraints of traditional processes based on the removal of material, and favouring more economical and sustainable on-demand productions, thanks to the availability of Additive Manufacturing technologies, or 3D printing.

Finally, Robotics and Advanced Automation allow to go beyond the dichotomy between automatic systems and manual systems, for developing mechanical systems closely connected and cooperating with human operators, that are intrinsically collaborative complex devices able to interact easily, and autonomously, both with other technological and digital systems, and with human beings, adapting and reconfiguring to the needs deriving by processes and actors.

Principles and reference scenario

The convergence and integration of the different enabling technologies makes possible to conceive and create interconnected entities of cyber-physical and cyber-social nature in which mechanical and digital systems and integrated networks control technological and anthropic processes, that in turn, influence calculation algorithms adapted to them through feedback on human behavior and environmental data (Bondavalli, et. at., 2016).

The principles of interoperability, virtualization, decentralization, real-time capability and modularity on which the design of such systems must be founded (Hermann et al. 2015), give them the ability to connect environments, objects, processes, organizations and people, and develop their sensitivity to the context, to being autonomous and responsive, able to operate starting from the information deriving from the physical world and the virtual world, collected and processed in real time, but above all suitable to act collaboratively, developing an active and effective communication among the human and technological entities of which they are constituted. These systems are not only smart, and therefore not only capable of collecting and analysing large amounts of data. They may be cognitive, able to learn in a non-deterministic way, exploiting the experiences gained through direct and natural interaction with human beings and the environment (Kelly, et al., 2016).

Digital tools and the building process

Some enabling technologies are already used in the construction sector.

This is the case of digital representation and simulation systems that starting from Computer Aided Design programs have led to Building Information Modelling (BIM), which are based on the ability to incorporate, in a unique information system, and starting from its three-dimensional modelling, different typology of data, useful for the development of the product to be designed (Ghaffarianhoseini et al., 2017). From the simplest BIM, these systems are evolving towards more complex data-driven design programs, able to manage the increasing number of data related to the different phases of the building process (BIM 3D, 4D, 6D, BIM LCA).

Other experiments concern systems for centralized control of planning and construction processes.

By integrating IoT, Cloud and Big Data simulation technologies, new platforms that can implement not only the site's just-in-time management, but also real-time space and site management, interacting with innovative systems for monitoring and monitoring logistics, can be obtained (Figliola, 2017).

About construction methods, robotic manufacturing processes of particular building components are being developed (Figliola, 2017), often obtained through 3D printing (Willmann, et al., 2016), which may also involve masonry robots (Dakhli, Lafhaj, 2017). On the contrary, it seems more mature to produce, under the control of a central server, directly on site and in real time, customized building materials (mortars, plasters and other mixtures), which are thus highly controllable and traceable (Dogne, Choudhary, 2014).

The development of BIM systems for the management of buildings use finds a consolidated trend of application in monitoring the efficiency conditions for predictive maintenance, emergency and security management and the retrofitting planning of buildings (Ghaffarianhoseini et al., 2017). Among these, energy management is one of the main fields of experimentation of new conception BIM, which by integrating other enabling technologies, today developing systems that are trying to integrate in the building the ability to learn from users' behaviours, and to translate proactively data deriving from such behaviours, for producing autonomous actions of control and adaptation and support the hosted activities (Pasini et al., 2016).

Potentiality, criticality, opportunities

Looking at the experimentations that are being carried out, and what has been produced and disseminated so far, we can state that, in general terms, we are still far from a real digital transformation of the construction sector, especially considering that these are limited experiences, mostly related to research activities. The possibility of imagining and implementing new systems for relating the involved entities and new criteria for organizing anthropic processes, the true revolution that this digital scenario prefigures, appears only touched on, in the developing prototypes of the construction sector, not only in our Country.

The potentialities offered by the new socio-cognitive schemes that cybersocial systems allow to devise seem to be almost unexpressed, systems which, being able to overcome the barriers of space and time, and the traditional distance between natural and artificial, could conjugate, in a pervasive, responsive and collaborative way, people and technologies, real and virtual environments, also in the construction industry, with good significant repercussions both for the effectiveness and efficiency of the activities and for the sustainability of the processes (Zhuge, 2014).

Rather, there is a strong tendency to validate the traditional relational system of building production, adding to tested devices, according to established mechanisms, additional dimensions to be controlled or effects to be assessed, without going beyond the predominantly linear concept of the building process, which traditionally proceeds for mostly rigid and consequential phases, rarely capable of adjustments and feedbacks and, above all, almost never able to develop, along its predetermined trajectories, an adequate sensitivity to the dynamics, mainly random and unstable, that the environmental and anthropic variables, on which the life cycle of construction depends, necessarily call into question. On the contrary, it is essential to be able to intercept those dynamics, especially in their social, human and behavioural dimensions, for activating competitive and technically innovative processes which, at the same time, can accommodate the growing requests for inclusion, in a perspective of impacts reductions and ethical and social responsibility.

People in the development of innovative cognitive models in construction

The human dimension is a central factor in this discussion. First, because people do not just have the traditional role of users in the new cognitive models that we can conceive within the advanced digital scenario, but they are an integral part of those models, constituent elements, like the physical-mechanical, cybernetic and information components. It is essential to place the humans, their characteristics, needs and behaviour in the centre of the design and management of the new generation of systems that can be developed from these models, whose ability to perceive, process, learn and adapt to the contexts and the environment, represent the main challenges to which new technologies must respond, to obtain relational and collaborative infrastructures conceived as means, dynamic mediums, responsive interfaces, through which meaningful, active and complex interactions between people, information and environments may be developed (Sowe et al., 2016).

Secondly, because it is well now known that the built environment can contribute to sustainable development only if all the subjects who for different reasons interact with it, reduce with their unconscious or aware behaviour, throughout its life cycle, the use of natural resources and impacts on the environment, preserving the cultural values of the context to which it belongs, and protecting health, comfort, accessibility and safety. For this reason, it is unavoidable to assume compatible attitudes and lifestyles, which brings out the question of habits and behaviours' appropriateness, both individual and collective, in relation to which inhabitants play a crucial role, because they are increasingly called to adapt their needs to the conscious use of available resources, and to use systems fostering and implementing virtuous and conscious behaviour. Ergonomics, as global human science, provides methodological tools that can support the developing new cognitive and context aware models, also for the design, construction and management of the built environment, able to grasp, elaborate and adequately respond to the variability of the technical, environmental, social and behavioural factors that the sustainability necessarily involves. After all, sustainability and ergonomics are mutually coherent and complementary approaches, because they both require a multi-systemic perspective (Thatcher, 2017). The understanding of human behaviour and performance, in their interaction with socio-technical systems, typical of the ergonomic approach, can be the keystone of this transformation process thanks to the potential offered by enabling technologies, which must be centred, and at the same time powered, by the human factor.

References

Allee, V., Schwabe, O., Krause Babb, M. (2015), *Value Networks and the True Nature of Collaboration*, Meghan-Kiffer Press Tampa, FL, USA.

Altobello, V. (2016), *Domini tecnologici dell'Intelligenza Artificiale*, Report "Le innovazioni del prossimo futuro", AIRI.

Bondavalli, A., Bouchenak, S., Kopetz, H. (2016), *Cyber-Physical Systems of Systems*. Springer.

COM (2009), "Preparare il nostro futuro: elaborare una strategia comune per le tecnologie abilitanti fondamentali nell'UE", SEC 1257.

Dakhli, Z., Lafhaj, Z. (2017), "Robotic mechanical design for brick-laying automation", *Cogent Engineering*, August 2017, pp.1-22.

Dogne, N., Choudhary, A. (2014) "Smart construction materials & techniques", proceedings of the National Conference on Alternative & Innovative Construction Materials &Techniques (AICMT), Gwalior,India, August 2014, vol.1, pp. 12-16.

Figliola, A. (2017), "Post-industrial robotics: esplorazione di architetture informate nell'era post-digitale", *Techne*, n. 13, Firenze University Press, Firenze, pp. 256-266.

Ghaffarianhoseini, A., Tookey, J., Naismith, N., Azhar, S., Efimova, O., Raahemifar, K. (2017), "Building Information Modeling (BIM): Clear brnrfits, undertstanding its implementation, risks, challanges" *Renawable and Sustainable Energy Reviews*, vol. 75, pp. 1046-1053.

Hermann, M., Pentek, T., Otto, B. (2015), "*Design principles for Industrie 4.0 scenarios: a* literature review" Working Paper 01/2015. Technische Universitat Dortmund.

Kelly, E., Hamm, S. (2016), *Macchine intelligenti. Watson e l'era del cognitive computing*. Egea. Milano.

MISE Ministero dell'Industria e dello Sviluppo Economico (2016), *Piano Nazionale Industria 4.0*.

Pasini, D., Mastrolembo Ventura, S., Rinaldi, S., Bellagente, P., Flammini, A., Ciribini, A.L. (2016), "Exploiting Internet of Things and Building Information Molediling framework for Management of Cognitive Buildings", *IEEE 2th International Smart Cities Conference (ISC2 2016), Trento*.

Sowe, S.K., Zettsu,K., Simmon, E., de Vaulx, F., Bojanova, I. (2016), "Cyber-Physical Human Systems: Putting People in the Loop", *IT Prof*. vol. 18(1), pp. 10-13.

Thatcher, A. (2017), "The role of ergonomics in creating adaptive and resilient complex systems for sustainability", *Contemporary ergonomics and human factors 2017, Ergonomics and Human Factors Conference 2017 Daventry, UK.*

Willmann, J., Knauss, M., Bonwetsch, T., Apolinarska, A.A., Gramazio, F., Kohler, M. (2016), "Robotic timber construction. Expanding additive fabrication to new dimensions", *Automation in Construction*, vol. 61, pp. 16-23.

Zhuge, H. (2014), "Cyber-Physical Society - The science and engineering for future society", *Future Generation Computer System*, 32, pp.180-186.

1.21 AUTOMATION GEOGRAPHY. REDEFINE THE PREFABRICATION

Margherita Ferrari[*]

Abstract

Industrialization and prefabrication today refer to a production chain different from the context in which these concepts are delineated. This supply chain is being transformed and increasingly able to respond promptly to the needs of society. In the architectural process this change contributes to transforming new structural languages and, through the use of machines in the production of building components, redefines fundamental concepts in the architectural process, such as matter and flexibility.
Automation and robotics are instruments that bring innovation, but that can be defined as such, only if they are used with the mastery and awareness of material culture.

Keywords: Prefabrication, Automation, Structure, Assembly

Introduction

New constructions, new requalifications, new constructive systems: this adjectival does not necessarily and exclusively indicate a new building practice, different from the one previously employed or historically established, provided that there is a reasoning about the meaning of what is built, in terms of relationship with the cultural dimensions. The investigation on "the new" means to investigate by virtue of the history of its production. A reading of the machines for building production, through innovations and failures that allows identifying goals and objectives of innovators, can strengthen the awareness that, in the discipline of architectural technology, there are those essential foundations for the growth of a system that moves between the past, understood as a set of shared goods and knowledge, and the pursuit of future innovation. This innovation presupposes recognizing a change in the design paradigm, which is not limited to the transformation of the production tools but to its repercussions on the design and above all the redefinition of concepts such as industrialization and prefabrication. Automation in this process is not only the substitution of a machine for man's work: it is a real logical transformation, in which the entire manufacturing process is rebuilt on a completely new basis (Lilley, 1957).

[*] Margherita Ferrari is PhD at the Iuav University of Venice, Italy, margheritaf@iuav.it.

Today this basis is formed by flexible instruments capable of extending the operational abilities of man.

The architectural design objectives have been adapted to the needs of contemporary construction: production is increasingly customized and addressed to customer needs; the designer, more than in the past, is faced with a continuous need for updating. However, in this context of change, the development of increasingly sophisticated production systems and machinery helps redefine the limits of the materials historically used in construction and it is generating a state of indeterminacy in which the boundary between human competence and instrumental competence is confused.

Robot and construction

Robots, the emblem of automation, can reproduce processes performed to date by man and machine tools: thanks to automation, the production process is faster and more flexible through the deployment of machines suitable for using multiple tools, according on the activity to be carried out.

The industry begins to respond in a timely and diversified manner and it creates specific products according to customer requirements: this is what Stanley M. Davis in 1989 defined as mass customization. Today it is now feasible beyond the boundaries defined by literature and it determines a series of innovations between production and design, even in the architectural sector.

Industrial production, that is associated with the concept of "standardization" and therefore with the large quantities of serial products, is moving ever more towards the "customization" of the made-to-measure product.

The process recalls an artisanal production dimension. This dimension should not be understood strictly in reference to manual processing, but rather to the ability to dominate the dialogue between action and reflection (Micelli, 2011), enhancing the idea of the project through research and development of the same tools for work. The same scientific research for the use of automation in the production sector, is not aimed only at large industries, but all types of producers.

The connotation linked to the concept of automation has evolved as a function of the machines: the automation was first linked to a production of large quantities, whose sale represented a method to mitigate the expenses for the purchase of machinery; now it is free of the number of final products, since machines are flexible and their cost can be absorbed with a smaller number of products that are also different from each other.

This condition has also benefited from accessing financing plans, such as state and European ones, for the purchase of machines, software and tools aimed at implementing the company activity, streamlining processes and promoting training activities for the staff.

The improvement should not be understood in terms of quantity, but of quality, that deals with the ability to respond directly to customer requests and, therefore, to the needs of society: knowing how to accompany a customer is a determining factor in the development of a company, regardless of its size. Thus, the "eternal duels", crafts and industry, can find common roads enhancing the reciprocal peculiarities and, hence, overcoming an opposition that is more ideological than real (Micelli, 2011). It could be considered as a hybrid manufacturing, that is a production capable of using artisanal skills on a large scale and replicating them where necessary, creating a new form of manufacturing[1]. Using automation and, therefore, robotics in architecture allows to increase the modelling and assembly capabilities of the elements, permitting to rediscover and rewrite even the same structural conformations. Matter is enhanced by digital information: matter is «enriched by the laws of the immaterial world of digital logic», matter is digital (Gramazio, Kohler, 2008).

Robotic manufacture is the main tool through which to extend this digital potential. It allows going beyond the intrinsic potential of the material and, at the same time, it allows leading the designer to rediscover the latter, forgotten in recent decades with industrialization and mass production. This also means rediscovering material culture[2] that is the «heritage of ideas, techniques and customs that are transmitted as a collective expression» (Nardi, 1994). This culture belongs to a society and in the most specific case of a craft.

Material culture incorporates tacit knowledge[3], that is knowledge resulting by handed down experience, based on techniques and attentions that have been consolidated throughout history. It is a form of knowledge that characterizes craftsmanship: robotics and digitalization can, therefore, bring the production process back to an artisanal form, more precisely, to the vision and conception of a craftsman's own material, but with new tools to experiment the properties of materials and, above all, to use them with awareness. Taking such skills back in the dimension of architecture means recovering the ingenuity of structural design which

> «implied some form of elegant parsimony in the exploitation of natural and human resources: it is more than a matter of virtuosity or pride for designers and makers, it is also a matter of social responsibility for all users» (Carpo, 2011).

---

1 This hybrid manufacture is nowadays indicated with different terms such as Smart manufacturing or Post-industrial manufacturing, or with reference to national reference plans, such as Industry 4.0.

2 In cultural anthropology, it refers to the link between the action of the technique and the cultural context in which it develops, so the cognitive aspects: these studies refer to the sphere of the anthropology of the techniques.

3 The concept of tacit knowledge was first used in 1966 by the philosopher Michael Polanyinel in *The Tacit Dimension*; in 1995 it spread with the publication of Ikujiro Nonaka and Hirotaka Takeuchi, *The Knowledge Creating Company*. It has also recently been featured by Richard Sennet in *The Craftsman*, 2008.

Beyond industrialized flexibility

Today, a robot is the most suitable tool for reading and interpreting digital commands and the complexities of projects developed using computational design systems.

A robot is capable of responding to simultaneous variations during construction and of adapting to construction changes: if a single element is moved «an infinite number of relations in the complementary logic between geometry and tectonics, between the individual element and the whole structure, have changed» (Gramazio, Kohler, 2014).

The development and use of sensors has allowed robots to move more precisely and safely, both in the plane and in three-dimensional space, alone or in collaboration with other robots. Although the most used robot is the one on a fixed basis[4], the experiments span also on the use of robots that can move on ground tracks or sky tracks. These systems allow the use of heavy and large machinery, thus expanding the range of action of the robotic arm. They are widely used in the production of prefabricated elements, they allow to accurately place the rods of a complex frame and sometimes they can drill holes for the predisposition of the connectors, as in the case of Gradual Assemblies - Gramazio Kohler Research[5], a summer pavilion installed at the Swiss Institute in Rome. Over the years sensors have helped to improve the autonomy of the robots in the recognition of the modelling material and the surrounding environment. Today there are numerous research projects that investigate the design and production of building components through the mobility of robots. The most common are the robotic arms installed on a mobile base, generally operating in a specific field, therefore, for the deposition of plastic material such as fibre-reinforced concrete or clay, or even for the dry assembly of aggregated granular materials.

The experimentation on mobility extends with wall climbing robots, that are able to move on vertical surfaces without the aid of automatic pulleys placed on the top of the walls and they can monitor or assemble elements. Recently there are assembled ones also by drones, especially for finite and standardized elements: although the degree of precision and control is not yet comparable to that of a robotic arm, the employment prospects are varied, especially for in situ activities, such as monitoring and moving materials.

Robotics makes it possible to intervene directly on assembly and, therefore, also on the morphological processing of the element and its connection method, increasing the use of traditional materials and overcoming the consolidated construction typologies through the use of innovative and performing materials.

---

4 A fixed base robot is a robotic arm which, during operations, is stuck on the plane; its freedom degrees are inherent in the structure of the arm.

5 The design and production of beams and the assembly of the partial frames were fabricated at the Robotic Fabrication Laboratory (ETH Zurigo, 2018).

Automation is therefore contributing to rewriting constructive language in architecture: «through the robot, digital reveals its hidden constructive nature and thus leads to a vital continuation of the constructive tradition in architecture in the information age» (Gramazio, Kohler, 2008).

While the machine tool and the mechanization process have distanced the industrial production from the handicraft one, now the automation through the robotics represents a process able to bring them closer together.

The flexibility of contemporary work tools "destandardizes" (Ciribini, 1984) production and the structural components are made for specific uses and no longer interchangeable. Thus, "the culture of assembled products in relationships"[6] that is the joint design research, changes. In fact, the design of standardized and modular elements aimed at an industrialized flexibility, that is a reproduction in serial form of adaptability.

Konrad Wachsmann, during the years of collaboration with Walter Gropius for the project of the Panel Corporation, had long worked precisely on the connection system useful to guarantee the interchangeable character of the structural rods for the realization of housing units. In fact, the target was to create a universal connector able to make the use of the structural element flexible and therefore transformable. In this way both the connector and the beam could be standardized products and therefore exploit the industrial process.

From the multiform and adaptable joint, to place constructive elements with greater flexibility within a system, the design moves on to the joint realized exclusively for a specific use: today flexibility is instrumental and the production is therefore adaptable.

This transformation[7] is aimed at more complex processes, such as those for structural components: «in technological terms, the post-industrial product tends to be customized according to use and not by virtue of destructive and inessential differential valuations» (Ciribini, 1984). The robotics for the production lines could therefore help to configure a "new" form of prefabrication, or at least to overcome its current connotation, that is assimilated to the idea of standardization and the possibility of reducing the costs of setting up a building artefact.

Instead, the same character of "flexibility" is standardized, not so much in the configuration of the element but in that of the instrument, that is potentially programmable and adaptable to production needs.

---

[6] Guido Nardi (1992) distinguishes the culture of the internal product and the culture of the products assembled in the relations, which respectively deal with production techniques and assembly techniques.

[7] Giuseppe Ciribini (1965) describes the transformation of the machines used for the production of building components in relation to the degree of human autonomy. There are 10 classes (from A0 to A9), which can be summarized in 3 macro categories: machine tools and semiautomatic machines (A0, A1, A2); machines with the ability to repeat production cycles, such as transfer and CNC machines (A3, A4 A5, A6); machines capable of "devising" and replacing the human intellect (A7, A8, A9).

The flexibility of the tools becomes over time an ideal field of research, through which to investigate the relationship between matter and construction: from the early years of 2000 there is a growing number of university research units that investigate digital manufacturing in architecture, additive and subtractive, and related experiments on the assembly. The use of robotic arms has also increased to test manufacturing and assembly activities in the construction field. Thanks also to international funding programs, machinery testing laboratories have been created in the territory, such as FABLAB. Although in some cases it is difficult to clearly define the research sector, it is possible to outline for each centre a tendency of research, linked to technologies and materials to be processed. A geography of automation is thus reconstructed, recalling a concept that preceded mass production, that is the geography of machines (Marchis, 1994): different tools according to the company and the geography of the place, the machines are created ad hoc to respond to specific needs, so the machines reflect a cultural identity.

Conclusions

In a scenario where industry and craftsmanship find a common denominator in the new automated production systems, the designer summarizes a primary role as a fundamental actor of the same multidisciplinary dialogue that has always distinguished him, but today it is carried out by other means.

This process at the same time involves a precise upstream prefabrication, in which every element and connection is designed and determined, and the flexibility in the arrangement of the elements that had been promoted by the industrialization and the componenting of the Sixties[8], is overcome.

Now the architect must find a way to take manufacturing techniques back.

Production is defined as truly innovative only when the use of digital tools is again supported by the material culture of the architect, capable of transforming a mechanical gesture into an act of ingenuity.

Automation helps to redefine the interaction with the material and in this transformation the designer must keep his sensitivity, the care for material planning, without blindly giving into instrumental innovation. Only in this way the material can return to respond to the needs of the architectural project, before those of automated production, so the prefabrication can be freed from the market prospects and adapt to social needs.

---

[8] At the 4th edition of the SAIE of Bologna, in 1968 the exhibition “The componenting” was organized by Franco Faccio, Enzo Fratelli, Pietro N. Maggi, Giuseppe Turchini, Mario Zaffagnini (published E.A. Fiere di Bologna).

References

Carpo, M. (2011), *The alphabet and the algorithm*, The MIT Press, Cambridge, MA.

Ciribini, G. (1965), "Dal concetto di industria alla produzione industrializzata di beni edilizi", in Blachère, G. (ed), *Industrializzazione dell'edilizia*, Dedalo Libri, Bari, pp. 17-39.

Ciribini, G. (1984), *Tecnologia e progetto: argomenti di cultura tecnologica della progettazione*, Celid, Torino.

Gramazio, F., Kohler, M. (2008), *Digital materiality in Architecture*, Lars Müller Publishers, Baden.

Gramazio, F., Kohler, M. (2014), *Robotic Touch. How robots change architecture*, Park Books, Zurigo.

Lilley, S. (1957), *Automation and social progress*, Lawrence & Wishart, Londra.

Marchis, V. (1994), *Storia delle macchine. Tre milleni di cultura tecnologica*, Editori Laterza, Roma.

Micelli, S. (2011), *Futuro artigiano*, Marsilio, Venezia.

Nardi, G. (1994), *Le nuove radici antiche*, Franco Angeli, Milano.

PART 2.

QUALITY OF THE PROJECT, QUALITY OF CONSTRUCTION
TECHNOLOGICAL INNOVATION AND ICT FOR THE BUILDING PROCESS

2.1 DIGITAL INNOVATION AND DESIGN COMPLEXITY

Eliana Cangelli, Valeria D'Ambrosio**

Abstract

Industrial production, from its origins, has allowed the acceleration of activities and processes in numerous fields, speeding not only the movement of capital, goods and information, but also the creation of value. In the face of the great potential for transformation due to industrial revolutions, the value of the processes has not affected only the economic component but has invested the spheres of ethics and society, modifying, through the incidence and effects of innovations, uses, consumption and lifestyles. The developments of contemporary production methods schematically identify continuity models in modernisation or, on the contrary, transition scenarios towards other models (from time to time defined as post-industrial, post-modern, etc.). Innovation is associated with a gradual transition to dematerialised and destandardised processes, as well as differentiated from conventional industrialisation due to continuous innovation strategies in relation to the creation of new products, markets, needs, design concepts.

Keywords: Technological design, Building process, Digital tools, Technological innovation, Design complexity

New design dynamics

Current modalities for the production of the project, of the elements of innovation and of the interactions with the great contemporary themes have changed, in recent years, the horizons of its conception and its development.

The widening of the field of action and the increase in the complexity of the project are due, on the one hand, to requests in the areas of sustainability, the reduction of energy needs and energy efficiency in the integrated system of open space buildings, on the other hand to the evolution of the concept of urban systems and parts of the city, both for new projects and in the redevelopment and regeneration of buildings (Perriccioli, 2016).

* Eliana Cangelli is an Associate Professor at the Department of Architecture and Design of Sapienza University of Rome, Italy, eliana.cangelli@uniroma1.it.

* Valeria D'Ambrosio is an Associate Professor at the Department of Architecture of the University of Naples Federico II, Italy, valeria.dambrosio@unina.it.

The reference to the evolution of new technologies completes the meaning of a design tool that is increasingly interacting with other skills, with wider contexts and with the challenges of modernity.

The production of the project also tends to change on the client's front: the conventional one is almost folded back on itself, and public entities are not always able to effectively and consistently set the strategy for the future of cities; more and more often the convergence between public and private and between research institutions and local administrations presents a component of greater dynamism. Within this evolving scenario, the transformations of the construction and labour market determine structural changes in the conventional relationships and contents of the project, which takes advantage of new job prospects, focusing on the requalification and regeneration of territories and urban areas. The project is addressed with attention to the most advanced contexts and business realities, implementing a transition from a scenario in which the concreteness of architecture was generally connected to construction companies, a central subject in the construction process, towards a new reference made up of the manufacturing companies of systems and components that carry out deep research and updating activities. The influence of the work due to industrial producers directs the project towards new scenarios for innovation, inevitably less marked in the case of construction companies. The manufacturers of industrialised components and systems are in a certain sense the new engine of innovation, contributing to the evolution of the project in terms of performance, therefore more measurable, in the effects as in the fallout, compared to artisanal and empirical procedures (Torricelli, 2011).

Placing the project in an area of greater awareness with respect to the performance that it must offer, opens up to a field in which the project produced to offer operating instructions responds to the panorama of certifications that are now increasingly indispensable in the Italian and above all European regulatory framework. From this point of view, many companies that work in the field of energy efficiency of buildings as well as in the system component, to give concrete examples, are fundamental for the technological transfer of know-how that has a deep impact on the quality of the project (Arthur, 2011).

Today, the development of new design dynamics cannot remain entirely within self-referential mechanisms, but it is necessary to balance the intuitions and design concepts with the inputs that come from the construction industry, and to work in the field of technologies that become an intellectual resource for the project (Losasso, 2017).

Performative design and local contexts

In this new phase of project production, the inputs of construction industry and other sectors ensure that the creative process can be better focused and open to new horizons. The needs of the inhabitants can receive a concrete response through the use of performance-qualified industrial production.

A further qualification factor is the new design scenarios according to a technical evolution linked to the relationship with territorial contexts (Anderson, 2012).

If on the one hand, in fact, a great ability to dialogue with the international and European design experience is needed, it is also necessary to have the ability to understand that each project must have a relationship with the context in which it operates. The context is not only environmental based but also focused on local resources and production conditions.

It is necessary to be able to conceive and produce the project from a broad perspective, in which relationships are not rigidly localistic but capable of bringing back to the local scale the experiences and examples carried out in larger areas: only in this way a real project transition feed new scenarios for its innovative production. The evolution of the design processes towards those digital processes in which the so-called enabling technologies take a leading role, leads to activate numerous innovative strategies for the purpose of space/time compression. The effects of this action can constitute a value for the overall development of the company in the transition from a standardised production to an on-demand and personalised production based on an open and flexible design. This basic tendency does not have linear trends and introduces, with respect to conditions of greater stability and certainty, performances and new values such as instantaneousness and transience, as well as the request for flexibility and rapidity in responding to changes.

The potentials of innovation

Innovation in the field of production of the project is thus inserted into a moment of socioeconomic and cultural transformation, in which technology prompts revisions and new solutions with respect to pre-existing situations, through the adoption of new systems and criteria. In the field of the technological design of architecture, innovation today requires grappling with the new scenarios imposed by the digital revolution and by the themes of industry 4.0. The complexity of the themes relating to the production of the project is in fact to be set against the aspects of the impacts of the so-called fourth industrial revolution. Microelectronics and ICT have effectively modified the physical and social context we live in, but above all have changed the relational and behavioural models, and therefore our interaction with the environment.

The fourth industrial revolution has broadened the ability to acquire information, to implement simulations, and to verify and assess complex questions, thus stimulating the creative process. While the first industrial revolution had introduced a fundamental aid for reducing the physical force employed in production processes, the fourth industrial revolution directly supports our cognitive sphere, thus augmenting the ability to acquire and process information.

The issues at play are many, as are the innovations involving both the field of the project, and that of the construction of architecture.

These innovations include artificial intelligence, augmented reality, the internet of things, open source platforms from which to draw and at the same time enter information, digital traceability, robotics, and 3D printing, as well as new products and new materials. These are elements that modify both the cognitive process and the design and construction process, but also that of control and management in the use phase, by being able to re-enter the information relating to monitoring in the project development phase.

The practical applications show, for example, how the use of a tool like BIM permits a real time interaction among the various skills within the project, and a no longer empirical systematisation through the onsite verification of the different systems that allow the buildings to be made and to function, and how the mode of transmission of the project's operating instructions changes, as it transitions from static, two-dimensional representation "on paper" to a dynamic representation of a virtual 3D model. BIM, GIS, parametric software, and virtual simulations are some of the tools that now contribute towards the production and representation of the project. However, while not limiting them to the sole dimension of production of the project, the innovations impacting the field of carrying out the project, of the construction of architecture and therefore of the work site must not be neglected either. A new mode of prefabrication, "industrial mass customisation", prototypical industrialisation, onsite production, offsite manufacturing, and 3D printing is outlined, and it seems clear today that the adjective "industrial" effectively has a new connotation (Butt, 2012).

The term "industrial" in fact, is no longer automatically associated with mass production and with the homologation of architecture, but rather with extreme destandardisation, with prototyping, and with the possibility of industrially producing unique and customisable products. Lastly, the final phase of the process, impacted by the new technologies, is the use phase, in which the tools of predictive simulation broaden the detailed monitoring possibilities and allow their outcomes to be inserted as early as the design phase.

Complex design vs artisanal design

All these innovations come up against the environment and socioeconomic arrangements (just consider the green economy and the circular economy), grappling in the end with society, both in terms of direct involvement and participation, and in terms of spreading the outcomes of this revolution.

This, then, is a complex picture, in which it seems difficult to put the various tiles in order, in which everything is fleeting, even if placed in relation to the others. It is in fact impossible to build an organic, logical, deductive picture. The concept of a network of complex relationships, of interactions that skip the knots, is absolutely in line with the framework of knowledge and innovations in the field.

When dealing with scenarios in profound evolution, the themes of technological research record underlying conceptual and operative permanencies: the spread of technical information, knowledge transfer and skills in developing or in building the project, the development and monitoring of the performance of the architecture project, the innovation of the technology transfer, and the hybridisation and modification of construction techniques. As things currently stand, although there is a broad debate in terms of research and experimentation, widespread building production in Italy continues to be of the traditional type, and of very low quality. The task of the technological area consists, perhaps, precisely of transferring the information and new potentials of construction to the building industry (Menges, 2011).

Today, in fact, we are on the one hand witnessing an experimentation taking place through the performance of complex projects, in which there is a strong economic investment. This involves the structure and form of the organisations that produce the project, able to offer increasingly innovative services in support of architecture, albeit developed mainly for types that do not belong to the Italian context. On the other hand, the experimentation, more wide-spread and more detailed, of certain vanguards is highlighted, attempting in effect to make these innovations available to society and proposing constructions in which the relationship between costs and design creativity, between costs and knowledge, is inversely proportional: on the one hand, costs are reduced, and on the other the development of an ability to design and to identify new solutions emerges.

The contribution of technological research

In such a complex framework, what can the contribution of research be? What can the innovations on building production be? The risk academia runs is that research will not be incisive, and will be limited, de facto, to describing a process in progress without seeking to govern it, in which innovation risks being confused with the instruments that serve to produce it. The risk is being unable to provide incremental and significant results that can change the scenario of the relationship between production and design in the contemporary world.

The research contributions presented at the session of the conference "La produzione del progetto – Qualità del progetto e qualità della costruzione. Innovazione tecnologica e ICT per Il processo edilizio" ("The production of the project – Quality of the project and quality of construction. Technological innovation and ICT for the building process") are reassuring testimony for that which research into the technology of architecture is called upon to develop.

In the contemporary world, technique stops being an object chosen by society, but is the setting in which it acts and in which behaviours are determined that transform human action. From being a means, technique tends to become an end, which is to say a complex system interacting at a number of levels with the society that guides its purposes through factors of mediation. The aspect outlined by numerous authors, relating to the social consequences of technology, requires being articulated differently within socio-technical systems, in which human and technological components operate symbiotically towards a generative purpose. In the era of the gradual prevalence of digital technologies, the purposes of the technology of architecture are to be sought within the ability to guide complex systems towards horizons of meanings and towards purposes that supplement new prospects of responsibility and of awareness for the built environment.

References

Anderson, C. (2012), *Makers: The new industrial revolution*, Crown Business, New York, USA.

Butt, N.T. (2012), "Mass Customization in Home Industry", in *Proceedings of the CIB – IAARC W119 CIC 2012*, Workshop: Advanced Construction and Building Technology for Society, Laboratory of Building Realization and Robotics, Technische Universität, München, Munich, DE, pp. 27-32.

Losasso, M. (2017), "Between theories and practices: culture, technology, design", in *Techne*, n. 13, Firenze University Press, Firenze, pp. 9-13.

Menges, A. (2011), "Sistemi semplici – Capacità complesse. Processi integrativi di morfogenesi computazionale in architettura", in *Techne*, n. 2, Firenze University Press, Firenze, pp. 68-77.

Perriccioli, M. (ed), (2016), *Pensiero tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano

Torricelli, M.C., (2011), "Technological design – research and practice in the architectural project", in *Techne*, n. 2, Firenze University Press, Firenze, pp. 16-23.

2.2 PROJECT PRODUCTION AND DIGITAL CULTURE

Mario Losasso[*]

Abstract

Digitisation will guide the project towards new space-time concepts and significant transformations of the built environment, affecting both the contents of the project, and the cognitive and operational processes in a transformation from linear to recursive, interactive, interoperable ones. With enabling and communication technologies, technological design can play an important role with the revival of intellectual and operational originality that is at the base of the foundation of the discipline. Decentralised conditions and collaborative actions represent the mirror of an evolving reality, in which the predictive value introduced by the enabling technologies will have to succeed in translating itself into value not only productive and semantic but also ethical and social.

Keywords: Industry 4.0, Technological design, Built environment, Generative design

The field of technological research in architecture is configured in an increasingly rooted way in the built environment, as a testimony to the interscale and multisectoral interest of research, whose extended collocation is articulated from the scale of the object of use to the settlement, from the productive and material to the intangible field and to the interactions with the cognitive and socio-economic sphere. The distinctive factors of research in the technological field - which can be summarised schematically in those of a procedural, systemic, demand, performance and experimental nature - while their general values persist, inevitably tend to develop according to broader views linked to contemporaneity. The technological and environmental disciplinary component thus becomes the bearer of an innovative vision of the entire existential space in everyday life and, therefore, extends its range of action to the entire area of the built environment (Del Nord, 2016).

Taking an interest in the widespread anthropised component of human settlements in relation to environmental aspects is a fundamental topic full of perspectives, which allows to reposition some peculiarities of research and distinctive disciplinary elements, relating them to new profiles of competences and to innovative technical and scientific work addresses.

---

[*] Mario Losasso is a Full Professor at the Department of Architecture of the University of Naples Federico II, Italy, losasso@unina.it.

In the recent years, the evolution of the concept of environment has led to the transition from an anthropocentric level in the globalisation of "objective" modernity to that of multidimensional phenomena inserted in a context of interdependence between environment, habitat and socio-economic components. The new meaning of the environmental dimension had the role of inducing the overcoming of the contrast between the illusion of the global as a rigid horizon of modernity and a retrotopian return (Bauman, 2017) to the local seen as historicism, nostalgia and an identity enclosure to defend (Latour, 2018; Jullien, 2018).

Many authors today are researching the critical issues deriving from the reduction of the project horizon towards the inability to elaborate the future. The new references of the production processes of the project risk accentuating the relativism of positions that, in the final analysis, turn out to be non-responsible in such a way that the pervasive power of technology tends towards real nihilism (Masullo, 2016). If modernity has used technology to define projects that express a connection between time and imagination, what is at risk in the period of the contemporary "after the modern" classically understood, is the loss of meaning conveyed by the void that leaves nihilism. Bauman warns against the fact that today there is a deficit in the vision of the future, replaced by a constant and risky nostalgic perspective towards a past that is very close to the figure of the simulacrum (Bauman, 2017).

In the contemporary world, the pervasiveness of weak thinking that leads to the paradoxical slogan that "there are no facts but only interpretations" has deprived reality and the elements of objectivity of power, arriving at what is defined as the post-truth era. Constructing partial truths, viral, hardly refutable as information circulates faster than its possible verifications, break into pervasive digitalisation modifying the cultural and operational environment in which the contemporary project is placed. However, the digitalisation of the fourth industrial revolution makes us understand how planning can be immersed in new space-time concepts that could significantly substantiate the next transformations of the built environment. From this point of view, the contribution of technological research to the architectural project becomes relevant, since the current transition affects both the contents of the project and the cognitive and operational processes, favouring a tendential transformation of the linear ones and adherents to neo-positivist conceptions of new processes and recursive, interactive, interoperable and heuristic structures.

In research, the environmental field now incorporates conceptual components - from settlement principles, to the culture of living and social behaviour - and operating components, placing the techné in the enlargement of the socio-technical sphere, in which the technique itself represents an announced exogenous evolution of sensory and instrumental organs of individuals (Lyotard, 1987).

The transformation of the field of technologies for architecture is of significant impact, if the digital revolution expresses its dimension of thought and conception of the world rather than that of the only instrumental components represented by enabling technologies. Technological thinking expands its dominion in reference to the quality of the project and in relation to ICT innovation. The development of science and technology, in the contemporary society that advances towards the new paradigm of digitalisation, are part of the great development of the socio-technical system.

Jean-François Lyotard in the 80s had already predicted the trend of a future that would overcome the fixity, the permanence of boundaries and separations through a concept of "post" that would not have been a «movement of come back, of flash back, of feedback, in short, a movement of repetition»: the new scene that is taking shape identifies the cerebral cortex - the most complex organisation known in the evolutionary stages of life - like the entity that would have generated "machines" as its extension, predicting that the network they would form would be «like a second more complex cortex» (Lyotard, 1987).

In the crisis of the liberal professions and of the construction sector, the projection of the building cycle trends in 2020 predicts interesting spaces for those technological design skills that mainly concern innovation, energy and digitisation. The new operational spaces can be traced back to the genetic matrix - of an experimental, innovative and prefigurative kind - of architectural technology. This scenario is decidedly interesting for the project's prospects, although numerous approaches are still developed today according to categories in which rigid lines of demarcation prevail, in addition to non-communicating systems structured by "protected enclosures" (Baricco, 2018). This conceptual distortion still induces the idea and the linear supply chains to prevail over the contents and production procedures of the project while the implications of experimental "doing" in the conception of the project are marginalised, resulting mainly in "service". In a renewed systemic conception in which generative processes prevail over the stationary state of choices and information, architectural technology can best express its ability to be a synthesis between multiple fields of knowledge and multiple operational scales. An integrated and dynamic approach, as well as systemic and procedural, characterises the emerging scenarios of digitisation through enabling technologies. Internet of Things, simulation, modelling, big data, open data, digital fabrication are the enabling technologies most closely linked to a vision of architectural design in the digital age. Within the evolution of the relationship between science and technology, the integration of key enabling technologies raises the field of action of technologies that become a medium between systems (Cantrell and Holzman, 2016).

Enabling technologies allow a synthetic understanding of reality, expanding the built environment towards scenarios of a world hybridised with reactive and sensitive technologies as responses to variable inputs.

The categories of real and virtual tend to coincide in a single reality: what is immaterial is a piece of reality as much as what is material and technologies become elements of mediation between multiple data, multiple elements and multiple conditions. The innovative scope of the socio-technical transition leads from a conventional building system set up in its components (building process, resources, project, etc.) to a generative system in which there is no opposition between artifacts and nature but an interdependence between multiple agents, that exist in a living environment and must find an inevitable point of balance and synthesis (Latour, 2018).

Today the elements of communication - emblematically condensed in the Internet of Things or in wireless networks - support pervasive technologies, while the space-time barriers that form the basis of linear processes or conventional circular processes begin to be eliminated. The great mobilisation on digital issues does not exclude the concrete risks connected to the production of a project that loses its certain connotations, thanks to the introduction of "dynamic" conditions. Landing in a generative field induces a transition from reassuring key words such as functions, fullness, stability or permanence to other concepts expressed by terms such as exploration, dispersion, volatility, trajectory, movement, impermanence (Baricco, 2018).

In the world of Internet of Things it is necessary to understand how in the project it is possible to appropriately manage a growing quantity of data without getting trapped or avoiding to fall into an excess of information that can induce the zero degree of recognisability (Baudrillard, 1980). Information objects and systems, deriving from ICT enabling technologies that are integrated with each other, pick up behaviours that also reveal activities that have not been guessed or imagined. A reality that is not always known breaks into everyday life, showing the need to govern it through measurements and processing of knowledge. In the production of the project, architectural technology can be configured both as an instrumental factor but above all as a factor capable of developing innovative cognitive governments of the project and as an intermediary with reality. Interoperability is followed by the interconnection that from static conditions turns into dynamics, breaking down space-time barriers and determining responsive technologies, aware and endowed with social and environmental responsibility. The technological design of architecture in the 4.0 industrial scenarios intercepts new ways of producing the project through large amounts of data in feedback loops, according to continuous and non-static data flows, from which it is possible to deduce new qualities and new organisational capabilities of the design system (Cantrell, Holzman, 2016). Systemic logic is managed not only through analytics but, above all, through computational design processes, a modified design that can interact with digital fabrication. In this way the field of the project domain is expanded, which is projected to manage the construction phase, from 3D printing to robotization in production and assembly, which sees its impact and realization times significantly reduced.

In the new digital manufacturing methods, the optimisation of the use of materials in their multiple combinations is incorporated in a hybrid phase between architectural design and manufacturing design, according to an extension of the design phase to the production and assembly phases, thus implementing phases that were once separate and, in perspective, are ever more interdependent.

One of the next challenges will be the redefinition of a new material culture no longer linked to conventional industrial production but to digital technologies that frame multiple phenomena (for example in the development of projects with sensors systems) through actuator elements, in which the conditions of inhabiting culture are combined with the conditions of producing projects, systems and components. The multidimensional space can occupy a relevant centrality, or rather that of a space dense of phenomena, relationships, components and devices. With enabling technologies and communication technologies, a new condition of the architectural project is defined, in which technological and environmental design can play an important role by reproposing the intellectual and operational originality that were at the basis of the discipline foundation.

After prefiguring and framing scenarios in the context of contemporary narratives, a future of "intelligent machines" is interconnected with digital systems. For a long time, the coexistence of representative effectiveness and analogic components may remain alongside like digital types. Projecting towards dynamic conditions, we understand how architecture will have to give back to design complexity, as result of combinations between quality of knowledge and multiple interdependencies. Decentralised conditions and collaborative actions will be the mirror of an evolving reality, in which the predictive value introduced by the enabling technologies must be able to translate itself into a value not only of productive and semantic but also of ethical and social aspects.

References

Baricco, A. (2018) *The Game*, Einaudi, Torino.

Baudrillard, J. (1980), *Della seduzione*, Cappelli, Bologna.

Bauman, Z. (2017), *Retrotopia*, Laterza, Roma-Bari.

Cantrell, B., Holzman, J. (2016), *Responsive landscapes. Strategies for responsive technologies in landscapes architecture*, Routledge, Denver.

Del Nord, R. (2016), "Potenzialità dell'area tecnologica in tema di ricerca progettuale", in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano.

Jullien, F. (2018), *L'identità culturale non esiste*, Einaudi, Torino.

Latour, B. (2018), *Tracciare la rotta*, Cortina, Milano.

Lyotard, J.F. (1987), *Il postmoderno spiegato ai bambini*, Feltrinelli, Milano.

Masullo, A. (2016), *Stati di nichilismo*, Artstudiopaparo, Napoli.

Fig. 1 - Pervasività dei big data.

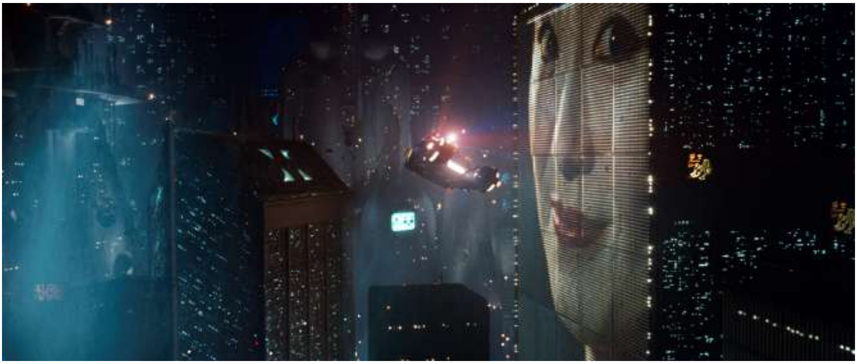


Fig. 2 - Blade Runner, 1982. Urban paysage.

2.3 IS BIM AN INNOVATION?

Daniel Hurtubise[*]

Abstract

The building sector, in all its components, promotes the construction of buildings that aspire to new functionalities and better performance; this has led to many transformations of languages and techniques that have now become stylistic figures typical of the contemporary world. The instruments of support for the project have evolved to an even greater extent. Among these, for its ability to have an innovative impact on the projects, there is certainly the Building Information Modeling, BIM. The contribution proposes a critical reflection on the theme, analysing the main operational innovation guidelines that the sector pursues in this field. From real time rendering to computational design, from virtual reality to augmented reality, from data analysis to data exchange, up to generative design.

Keywords: Digitisation, Information, Knowledge, Innovation, Enabling technologies

Basic concepts

"Innovation" can simply mean "a new idea, a new device or a new method". It is also often defined as the application of better solutions to meet new needs or market demands. In the construction field, we have always seen the construction of "buildings" that aspire to new functionalities and better performance. From man's first dwellings, from caves to wooden structures and so on to the present day. In this sense, however, the idea of living has not changed. The needs have remained the same, the only aspects that have actually evolved are the tools, materials, techniques. If we relate this reflection to BIM, then we can certainly say that it is configured more as an evolution than a revolution.

Before going any further, however, it is important to pay attention to some statements, often not understood by many professionals working in the field:

- a 3D model is not a digital model (a 3D model does not include building data);
- a digital model is not BIM (BIM means a process realised through a series of tools).

---

[*] Daniel Hurtubise is VDC/BIM Manager at the Renzo Piano Building Workshop of Paris, France, dhurtubise@rpbw.com.

Having better clarified the concept of 3D, it is important to underline other terms that the construction industry often uses considering them as significant innovations, the 4D and 5D dimensions. However, no project has ever been built without a chronoprogram (4D); similarly, no project has ever been built without an accurate cost estimate (5D).

Alongside these, however, in recent times, two other dimensions are emerging: the 6D (as-built) and the 7D (management and maintenance) that are joining the already widespread 2D and 3D. In this case as well, therefore, it can be reiterated that the approach at the base of BIM is configured more as an evolution than a real revolution. For what has been said then it seems legitimate to ask whether BIM is a tool that can change the architect's working method.

While most projects still require the same contractual documents (printed sheets of paper, later signed), it would seem clear that the answer is "no, the working method has not changed". True, BIM has not changed the type of contract documents, so far, but it has drastically changed the way they are produced; BIM has transformed the tools used. The construction industry will be able to take this opportunity to increase design quality through better coordination, for example. Is it not the role of the architect to coordinate all the disciplines involved in the building process? Why do we seem to keep forgetting about it?

Comparing systems

In order to highlight the benefits of BIM, it is useful to compare two projects. These are two universities built in France: the same type of documents to be delivered, the same composition of the design teams but one (Amiens) managed for the part concerning the graphic elaborations with CAD, the other (ENS) instead developed using BIM and Revit software.

The idea behind this comparison is to shift the focus to the IT tool used to realise the project rather than the BIM process itself. The data shown in the table refer to one square meter of the project, in order to make the analysis of the differences between the two elaboration phases more objective and, mainly, between the working method adopted and the consequent results.

DATI	AMIENS (AUTOCAD)		ENS (REVIT)	
Surface	38 000 m²		64 000 m²	
Elaborate graphic for detailed design	152	(0.004/m²)	500	(0.008/m²)
Number of files	1.549 dwg	(0.041/m²)	39 rvt	(0.0006/m²)
File size	2.96 gb	(0.08/m²)	3.89 gb	(0.06/m²)

The comparison shown in the table shows how the use of a digital model has made it possible to produce a project certainly less impacting in terms of the amount of processing and less articulated from an operational point of view, probably even qualitatively better with the same resources employed.

Technological innovations

Given that BIM is already widely used, which technologies can then be considered truly innovative?

Real time rendering is the first on the list. To date it is fast, simple, accessible and reliable. It is no longer just a presentation tool but a design tool. There is no longer any contraindication to the adoption of this technology in the design phase. Tools such as Enscape (www.enscape3d.com) allow you to display most digital models with textures and shadows of the rendering model.

Computational design refers to the use of computational strategies in the design process. Grasshopper together with Dynamo are the leading tools of this new frontier for the elaboration of architectonic ideas. These new technologies allow to manipulate data and geometries as never imagined before. Anyone currently using Rhino or Revit can begin to approach computational design in a very simple way.

Both tools, Grasshopper and Dynamo, are free, open source and interoperable, i.e. they can be linked to the most popular digital modeling technologies.

Virtual reality - another technology that is becoming established - is understood as the simulation of an image in a 3D environment, physically "interacting" through the use of special electronic equipment, such as a helmet with integrated screen or gloves equipped with sensors. Tools such as Enscape (www.enscape3d.com), allow the possibility to convert the digital model into augmented reality in a few seconds, as long as they are equipped with special hardware systems whose cost is becoming progressively more affordable.

Augmented reality is instead a technology that superimposes a digital image on a user's real-world visual experience, thus creating a composite image. This technology seems to be better suited to the construction site rather than the design phase. The possibility to convert a digital model into augmented reality (AR) is not as simple and cheap as for VR. In any case, it seems that the direction towards which the research is moving is to make AR itself more and more widespread and accessible for a growing number of users and operators.

The term *data analysis* refers instead to the process of verification, control, transformation and modelling of the "data" that aims to obtain information and processes aimed at governing design choices.

Data analysis allows the reading of data through different graphical interfaces. The data can thus be used to predict future design scenarios and share ideas in a more comprehensible way than using alphanumeric tables.

All this can be obtained, on the one hand, through technologies such as PowerBI or Tableau, on the other hand, through the connection of the generated data to graphical interfaces (UI) that allow the understanding and sharing of design choices.

Data exchange is the process of transforming structured data according to an initial pattern into data based on a desired pattern.

In this way the resulting scheme will be a faithful representation of the source scheme. This is one aspect of BIM that will undergo most transformation in the near future. The days when entire data sets (files) were exchanged will be long gone, to the benefit of cloud solutions where only what is relevant can be "synchronised". Google had already launched a similar service, "Flux", now no longer usable. On the contrary, other technologies such as Speckle (www.speckle.works/), open source, or Autodesk Quantum point in this direction.

Finally, *generative design* is the technology that combines design goals and constraints into automated algorithms, providing, in response, several possible solutions to the given problem.

Still far from being widespread, "generative design" has made significant progress in recent years.Technologies such as TestFit (www.testfit.io) or Hypar (www.hypar.io) allow the user to enter a series of constraints that the system will use to generate a series of optimal solutions to solve the problem posed.

I conclude with a quote from Randy Deutsch: «Architects do not produce buildings, they produce a set of instructions for the making of buildings».

Nothing prevents us from using different tools or processes as long as the aim is to obtain the desired and necessary set of "instructions".

2.4 TECHNICAL INNOVATION AND GIS TO QUALIFY RENOVATION PROCESSES

Giovanna Franco, Simonetta Acacia**

Abstract

Digital technologies can contribute to improving the quality of interventions on the existing heritage, following principles of "organisational sustainability". These ameliorate the way information is managed, also considering its variability through time, during the various process stages (planning and scheduling, design, execution and later management of the whole life cycle), and they also reduce the many levels of "uncertainty" characteristic of this sector of activity. The study submitted here refers to the application of Geographic Information System technologies to information management in projects involving conservation and promotion of cultural heritage owned by the University of Genoa.

Keywords: Digitalisation, GIS, Management, Quality, Architectural Heritage

Cultural heritage, sustainable development and digitalisation

Many view the cultural heritage of Italy as a potential engine for the national economy: however, it requires important actions in terms of applying protective measures, maintenance, reuse and smart management, to be carried out, one hopes, in efficient and effective ways.

Article 29 of Legislative Decree 42/2004, the Code of cultural heritage and landscape, laid down the premises for a fundamental innovation, based on the idea that conservation of cultural heritage can be obtained through consistent, coordinated and planned work involving study, prevention, maintenance and care. Later cultural and legislative productions gave body to this idea, developing it in relation to the architectural heritage (Ministerial Decree 154/2017, article 3, Public works involving cultural heritage).

The management of intervention processes on built environment, whether of ancient or recent formation, presents various degrees of complexity compared to new buildings; these depend on the need to:

---

* Giovanna Franco is a full Professor at the Department of Architettura and Design, University of Genova, Italy, francog@arch.unige.it.

* Simonetta Acacia is a Research Fellow at the Department of Architettura and Design, University of Genova, Italy, simonetta.acacia@edu.unige.it.

- manage numerous items of information, of various origin and kind, which can be implemented and can change over time;
- organise such information and its variability during the study and design phases, on site and during later management of the assets;
- establish the proper relationship between various kinds of information and refer them to places, recording the variations which projects and work cause on them;
- make it possible to use such information in open decision processes which cannot be determined in advance;
- schedule preventive and necessary maintenance after the intervention.

In this context, recourse to ICT (Information and Communications Technologies) may be an important advance, not only culturally but also in operational terms. ICT, properly adapted and implemented, can contribute to raising the quality levels of the whole intervention process (renovation, qualification, reuse, maintenance, etc.) set up according to principles of organisational sustainability. IT systems for data management have so far been designed, structured and used mainly to design, set up sites and manage new constructions. Therefore, while the construction industry in Italy is quickly moving forward toward obligatory application of digital information modelling in public contracts for new buildings (Ministerial Decree 560/2017), these tools are still insufficiently employed for interventions on existing buildings. This lends support to the suitability of intensifying applied research, adapting existing technical tools to cultural needs dictated by the specific features of stratified items. The reference framework therefore picks up the challenges of our times, establishing relations among goals of promotion of the architectural heritage; improvement of the management process through use of ICT; adaptation of practices of conservation, maintenance and reuse to what is expressly required for public works; development of digitalisation processes of the Public Administrations and digitalisation strategies in the construction industry.

Data culture in the digital era: advantages and possible risks

We can find certain analogies between the paradigmatic assumptions of the digital area – especially of data-driven strategies – and processes for intervention on built environment: significance of the data, their reading and interpretation during the initial strategy defining phase, the logic of the relationship among the data. Furthermore, digitalisation of the processes of knowledge gathering, planning and implementation offers indisputable advantages: it can in fact positively affect conditions of measurability and transparency and the qualification of the planning, programming, monitoring and control phases, as well as cutting down complexity of administrative steps, allowing actors to take decisions consistently, rationally and more responsibly, and limiting risky situations related to the many levels of uncertainty[1]. The interest with which people look at the potential of digital tools however, must not be uncritical, but should involve awareness of certain risks tied to data overload and redundancy, the search for impossible completeness ("exasperation" of the analytical phase); information density not set out according to hierarchical levels (data "flattening"); the risk of falling into mechanistic and deterministic processes when managing the data for purposes of intervention. Computational logic, on the contrary, requires a selective rather than exhaustive approach, probabilistic rather than deterministic, capable of managing simultaneously and dynamically several alternatives at once, establishing a relational logic based on specific contexts and needs.

Adapting the means to the end: managing precious heritage with GIS tools

On such premises, the most recent research, involving the multidisciplinary group headed by the post-graduate programme in Architectural Heritage and Landscape of the University of Genoa has been oriented towards the construction of digital tools for managing interventions on the historical heritage of monuments belonging to the same University, providing support to technical professional skills involved in such activities. Starting out from two symbolic buildings (the complex of the Albergo dei Poveri and Palazzo Belimbau[2], the 17th century Palazzo dei Rolli[3]), digital platforms were built in GIS environment designed on the basis of the unique and non-standardisable features of these assets (Franco, Babbetto, 2016; Acacia, Casanova, 2015; Musso, Franco, 2014).

On a purely technical and professional level, the creation of a specific platform in GIS environment, intends to:

---

1 See the report of the Parliamentary Commission of Inquiry into the Level of Digitalisation and Innovation of Public Administrations 2017.

2 Research on these complexes were financed through various channels. In 2011, two different agreements were signed between the Department of Major Projects and Safety of the University of Genoa and the Post-Graduate School in order to launch studies and research needed to define and implement a strategic plan for complete reuse of the Albergo dei Poveri, currently on free loan to the University. In 2013, the research group received funds from the Ministry of University within the framework of the Research Projects of Significant National Interest for application of a BIM model to historical heritage. In 2013, the Liguria Regional Government funded a research project on a feasibility study for energy efficiency of the Albergo dei Poveri. Finally, in 2017, an implementation agreement was stipulated between the Construction Development Area of the University and the Post-Graduate School in order to carry out the study required to transform the monumental rooms of Palazzo Belimbau – belonging to the University – into a museum.

3 The Palazzi dei Rolli, belonging to the UNESCO World Heritage sites, are a group of noble palaces which, in the days of the old Republic, on the basis of an extraction by lot from places of accommodation (the "rolli") were assigned to host great personalities on state visit to Genoa.

- create an information system, based on the many existing isolated and thematic data banks, to consult/acquire data of various kinds;
- identify and support analysis of the problems associated with safety of users and of places, facilitating definition of the best strategies for improvement, reduction and mitigation of risks (including environmental risks);
- minimise unexpected events which inevitably accompany any project or site working on existing items and the ordinary management of building;
- cut down operating time and costs during the working life (ordinary and extraordinary maintenance, re-functionalisation, regulatory adaptation...);
- avoid excessive and unsustainable (or unmanageable) levels of discretion of choice during the planning/authorisation phase of interventions, also by the entities responsible for safeguarding the assets;
- provide useful contributions to the development of intervention protocols on the assets being examined, which can be used by those responsible for them.

Creation of an information system for historical architectural heritage: methodology and steps

GIS technology arose in the context of geography as a set of tools designed to collect, file, study, process and show spatial data about the Earth (Department of the Environment, 1987). Its application to architecture, and more specifically to historic buildings, therefore demands adaptation, starting from the map used as a base: geographical maps must in fact be replaced by one of the possible plane representations of architecture, that is horizontal and vertical sections, with a greater level of detail. The various geometrical entities making up the map are associated to various data/attributes which are organised in tables (Manuale utente di QGIS, 2018). To achieve effective management of a large mass of complex data, it is advisable to make use of a spatial relational DBMS (Data Base Management System) (Casagrande et al., 2012).

This choice, associated with the adoption of a dedicated server, allows one to abandon local work in favour of remote work, thus allowing for updating and consultation by more than one user (also simultaneously) and managing access to data according to security levels tailored to the kind of user. Furthermore, the database can be consulted not only via a graphic interface such as a specific GIS software, but also using various applications (Acacia et al., 2016), not necessarily graphic. When building the information system for the assets of the University of Genoa, use was made of free and open-source software such as PostgreSQL (as DBMS), with its spatial extension PostGIS, and QGIS (as GIS application), ensuring total interchangeability among the systems (Casagrande et al., 2012) and the possibility, in a near future, of publishing the projects as webGIS.

Research was done in the following steps.

Selecting and gathering data. Data concerning quantity, quality and documents were gathered, the outcome of archive research with collection of documents, photographs, iconographic material concerning: the construction and later maintenance phases; longimetric, topographic, photogrammetric and laser scanner survey campaigns (with two-dimensional representation and three-dimensional modelling); spherical panoramic shooting, to allow virtual navigation in augmented reality; investigations on the material nature and construction of the assets and diagnostic campaigns, represented in special maps and three-dimensional modelling which show the state of conservation, the level of material decay and the structural reliability of individual parts or whole systems; identification and location of risk factors, structural and tied to the conditions of conservation of the spaces; investigations into the internal and external systems of accessibility, vertical distribution systems, also with reference to fire prevention regulations and escape routes (with identification of unsuitability and needs); identification of the decorations and movable items contained inside the area and the results of diagnostic investigations; energy audit (conditions of environmental comfort, identification of dispersive elements and of items of thermal behaviour which can be improved); identification of deficits in systems and technology; identification of the best kind of conservative interventions and improvements in view of the new requirements associated with use (including systems)[4].

Requirements of the GIS platform and of intended use. Identification of the purposes of the platform itself, of the main ways of running searches, for example in a diachronic or a synchronic key, and of user profiles (to define different levels of accessibility to data depending on the kind of user and prevent information overload). Definition of search keys according to the main questions which arise, not only and not specially to increase knowledge, but also and mainly for aims of conservation and maintenance and operational purposes in general. By way of example only, before deciding which operations to carry out in order to apply ensure safety of the roof, one has to cross data about the material nature of the roof, its state of conservation, its static and structural layout, its exact historic context, in order to make suitable judgements and balance interventions (aimed at providing maximum protection to the parts which have the greatest value in terms of historical evidence).

Data modelling. On the base of the semantic property of the data and taking into account the rules of the relational model, first of all those of integrity (Atzeni et al., 2014), architectural complexes have been broken up into hierarchical levels, in order to file and connect data to each other, from a set level (for example the floor or vertical service, to rooms or groups of rooms) down to an elementary sub-level (a pillar, a window, etc.) (Acacia, Casanova, 2015).

---

4 Some data cannot be used directly staying within the GIS software, but require connection to outside applications; this happens for example when consulting immersive spherical shooting, to view photos from close up or digitally acquired archive documents.

In the same way, data coming from the investigations of various kinds described above are organised, identifying for each a uniform data class, associated with a table, a unique key allowing one to connect it to other tables (Atzeni et al., 2014).

Conclusions: building an interoperable open access platform

Spatial relational databases built for the University's architectural heritage are a very useful tool; however, their use is confined to the context of education (technical professional skills developed at the post-graduate programme) and practical operation (technicians of the University offices). What can be developed in the near future will be a webGIS system, an interoperable open access platform to make available to an extended community a rich heritage of information and technique concerning the monumental buildings belonging to and used by the University of Genoa. This platform will allow for free access, providing virtual tours, based on the data contained in the various repositories, allowing the user to move inside historical buildings. Making such an architectural heritage universally accessible and outlining efficacious protocols for its conservation and use, physical and thanks to digital and multimedia technologies, can in fact contribute to research, documentation, promotion and transmission of the cultural, material and immaterial heritage of the Genoese and Ligurian community, but also to its safeguarding and management, including measures for protection and mitigation of environmental risks.

References

Acacia, S., Babbetto, R., Casanova, M. (2016), "Condivisione di dati ed informazioni tra BIM e sistemi informativi", in Della Torre, S. (ed), *Built Heritage Information Modelling/Management BHIMM*, Imready Srl, Milano, pp. 148-155.

Acacia, S., Casanova, M. (2015), "Un sistema informativo per l'Albergo dei Poveri di Genova", *il Progetto Sostenibile*, n. 36-37, pp. 184-191.

Atzeni, P., Ceri, S., Paraboschi, S., Torlone, R. (2014), *Basi di dati: modelli e linguaggi di interrogazione*, 4th ed., McGraw-Hill, Milano.

Casagrande, L., Cavallini, P., Frigeri, A., Furieri, A., Marchesini, I., Neteler, M. (2012), *GIS Open Source. GRASS GIS, Quantum GIS e SpatiaLite. Elementi di software libero applicato al territorio*, Dario Flaccovio Editore, Palermo.

Department of the Environment (1987), *Handling Geographic Information. Report of the committee of Enquiry chaired by Lord Chorley*, HMSO, London.

Franco, G., Babbetto, R. (2016), "Albergo dei Poveri di Genova": dalla programmazione alla gestione, *Facility Management*, n. 31, pp. 37-43.

Musso, S.F., Franco, G. (2014), "The "Albergo dei Poveri" in Genoa: conserving and using in the uncertainty and in the provisional", in Della Torre, S. (ed), *ICT per il miglioramento del processo conservativo*, proceedings of the International Conference "Preventive and Planned Conservation", Monza-Mantova, May 5-9, 2014, Nardini Editore, Firenze, pp. 51-62.

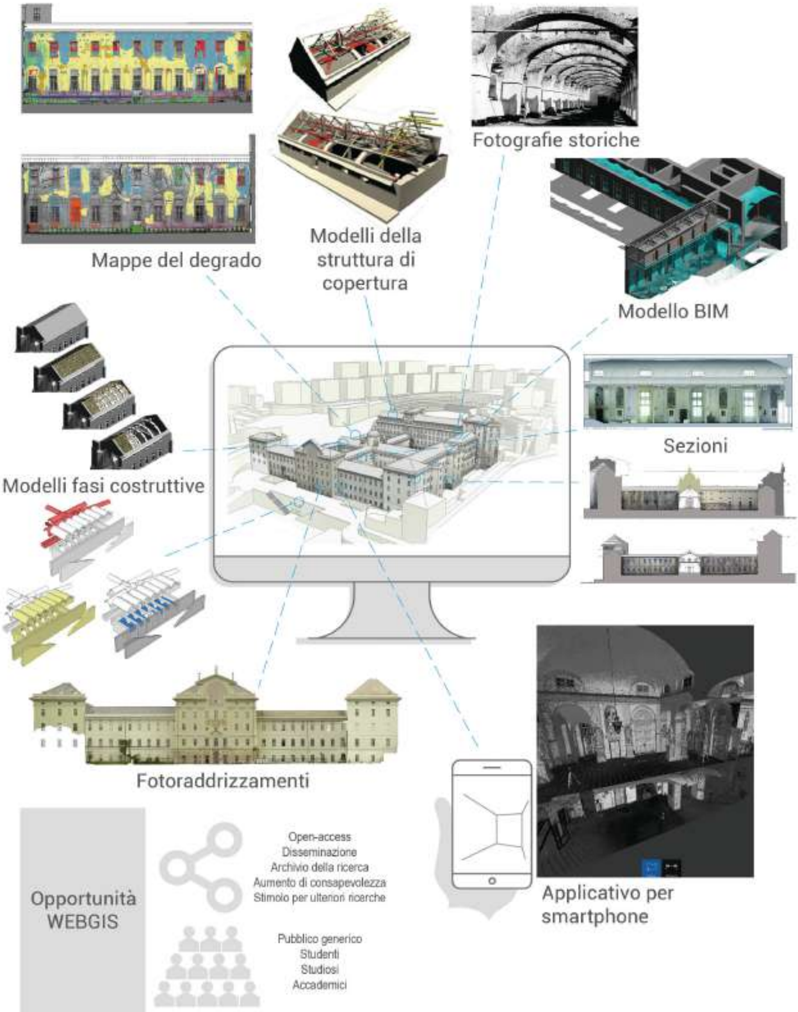


Fig. 1 - The numerous and heterogeneous data collected during the research carried out on the Albergo dei Poveri in Genoa were organized within a database that can be consulted in a GIS environment and connected to a three-dimensional BIM model (image processing by Elena Macchioni).

2.5 WHICH INVISIBLE TECHNOLOGY? METADATES FOR THE RETROFIT OF HISTORIC BUILDINGS

Marta Calzolari[*]

Abstract

The energy recovery of historic buildings is made particularly complex by two critical issues, in addition to the due respect for the principles of protection. The first is the lack of real data on the energy behaviour of the historic envelope, in the absence of a systematic performance survey to create design guidelines. The second is linked to cultural aspects that, as immaterial and "invisible", are difficult to quantify and govern within current management processes, characterised by huge amounts of information made available in the form of numbers. The paper aims to investigate the use of the current digital tools in the retrofit interventions of historical buildings, as a solution for overcoming the two delineated criticalities.

Keywords: Historic buildings, Energy retrofit, Key enabling technologies, Metadates, Invisible technology

The recent revolution in the design and management process

In the past, the prestige of buildings was associated above of all with the client's one; in recent years, however, the «bigness» (Favole, 2017) of the designers gave prestige and fame to the building. Today, in a reverse trend, the value of the building is often associated also with a quality label (sustainability certificate, certificate of energy performance, certification of the used materials). Thanks to the recent innovation of the construction process we are experiencing the rapid replacement of the traditional hierarchical management system: in a parallel with industry, the old structure, characterised by a precise distinction of roles with a top down coordination, as in the Taylor-Ford model (Butera, 2017), is abandoned for a new reticular system in which the result of the process is the interpolation of data, scenarios and strategies.

This trend results in models of intervention where everything is related to reference targets, performance levels, quantifiable data, which allow to choose analytically the best solutions in terms of benefits/costs, according to a binary process, through the use of Key Enabling Technologies.

---

[*] Marta Calzolari is a Research Fellow and Adjunct Professor at the Department of Architecture of the University of Ferrara, Italy, marta.calzolari@unife.it.

Projects are more often based on codified solutions and on standards (related to performances and rules) to be reached.

In the recent revolution of the process (planning and decision-making, as well as management) the operative tools have changed. Therefore, innovation is no longer just the result of the discovery or development of new techniques but above all is determined by the way new enabling technologies are used as elements of mediation, due to a specific need. They become means to prefigure a perspective view of the architectural project (Losasso, 2018).

The research sector is dealing with increasing attention to the elaboration of sophisticated management models with which to interpret the complex construction styles, typical of today's construction sites, and to efficiently use the new materials and the innovative techniques.

L'Internet of Things per il recupero energetico degli edifici storici

The new project management system is offering interesting results for the new construction sector. The question about the influence of the use of these "digital" systems on the processes, still extremely "analogic", of energy retrofit of historic heritage is now interesting, and probably urgent. In fact, the use of Internet tools is frequently associated to the management of cultural heritage, in particular as regards to the improvement of users' fruition, for the increase of the tourism sector, or for the conservation and restoration activities. Assuming the use of these digital processes for the design of energy recovery interventions is still rare, in particular for the choice of intervention strategies or materials and technologies to be used.

The historic buildings have been able to be resilient to the changes over the centuries, but it is necessary to understand how they can react to current decision-making processes. The issue is addressed on two different, but interconnected, thematic levels, which result in a double difficulty in dealing with awareness and respect, but also with the necessary courage, with the theme of the retrofit of historic buildings. The first complication depends on the fact that standardised solutions are not always feasible for the historic buildings and, in many cases, real data and reference targets, that can enter the design platform to best address the intervention, are not presented in an organic form, as for the new buildings. An example, well known to energy retrofit experts, is the text of Law 90/2013 (in implementation of Directive 2002/91/EC, relating to energy efficiency in buildings) in which we read that buildings regulated by the code of the cultural heritage and landscape are excluded from the application of the decree only in the event the judgment of the competent Authority believes that the compliance of requirements implies a substantial alteration of their character or appearance with particular reference to historical, artistic, or landscape profiles (article 3, point 3).

The legitimacy and the limits of the intervention depend, therefore, on the opinion of the Authority, but the lack of a quantification of the level of possible unsustainability of the designed solutions is evident.

Designers have to work with current digital tools, capable of processing simultaneously large amounts of data, but without actually having information to enter into the system, either as input data - the energy behaviour before intervention - both as reference target and abacus of compatible solutions, specifically verified for the historic building. Anyway, for a correct intervention of retrofit of historic buildings, I propose to fill this gap by making use of the tools of the current project production process (sensors, domotics, IoT).

A solution is to set up the design operational databases by monitoring significant historic buildings, selected from those still to be restored, to obtain information on their real energy behaviour before the intervention, and among the already renewed ones, to quantify the performance of buildings during the using phase and to verify the difference between the result obtained from the analytical simulation and the effective influence of real transitory phenomena (users, climatic factors, etc.).

HeLLo[1] project is an example of this possible approach because it aims to detect the hygrothermal behaviour of some types of historic envelope before and after the application of the insulating material (internal coat) to provide professionals, invited to visit the monitoring laboratory and to learn about the tested technologies (participation and dissemination of results), an instrument of knowledge of historic buildings useful to increase awareness for the design of the retrofit intervention. The long-term result of the research aims to create a database of technological solutions, tested and verified specifically for the historic buildings, which is still lacking.

The collection of this information could help to create databases that are constantly updated thanks to the collection of new data, that are targeted to the peculiarities of historic buildings and calibrated on their potential improvement. For example, a sensor system applied to the building with user-friendly interface may increase user awareness (key concept of the smart environment) and it can start a process of constant adaptation between the historic building and the users.

These onsite surveys (environmental monitoring and material analysis) do not need, in fact, only to understand the trend of the envelope's hygrothermal curve or the efficiency of the plants, but also preparing plans to adapt the building performance to the real use by different categories of users.

---

1 *HeLLo - Heritage energy Living Lab onsite*, H2020 - MSCA-IF-2017-EF - Marie Skłodowska-Curie Individual Fellowships. 1/10/2018 - 30/09/2020. Team Host Istitution: Research Centre Architettura>Energia (Prof. P. Davoli, Dr. M. Calzolari) in collaboration with Prof. F. Conato and Arch. V. Frighi, Department of Architecture, University of Ferrara and with Eurac Research Bolzano (Dr. E. Lucchi). Supervisor: Prof. P. Davoli. Marie Curie Researcher (fellow): Dr. Luisa Dias Pereira (Portugal).

Thus, a constant resilience between building and users (through project solutions) is created, and it is possible to trigger an inverse process of adaptation of users to the building (through education to the use of spaces).

This mechanism can lead the users themselves, indeed, to modify the current canons of comfort, looking for a slow, but constant, reconciliation with the past living habits. Moreover, as more frequently recognised, the use of the Internet of Things can be particularly important and useful in the maintenance processes of monumental buildings (for example for the conservation of the artworks or of the decorative setup). The real-time measurement of indoor climate conditions helps, in fact, making a more efficient prevention, quickly detecting any unforeseen hazardous situations or dangerous conditions (for example water losses or condensation).

The archiving and processing of the collected data can also be useful in the long term to create predictive models through statistics and scenarios to anticipate the emergence of problems in the future, based on a deep, consolidated and systematised experience. Although surveying and monitoring systems produce a significant amount of data (thermal transmittance, surface temperature, humidity values, etc.), this information can become a decisive tool for the management of the intervention, only if they are used to study project's solutions, calibrated on the historic building, and not if they remain mere information collected in a digital archive.

The transformation of these "Big Data" into design solutions is the main task of the architect who must continue to manage the process "from the top", precisely because, having replaced the hierarchical sequence with the network, the ultimate goal of the intervention, that aims to enhance the architectural characteristics of the historic building, cannot be lost, because of the fragmentation of the project and the exclusive focus on the performance/quantity aspects of the building. The builders/architects of the past, or congregation components, handed down knowledge to posterity: so it was possible to distinguish the ones who "knew how" from the ones who had not any education and the construction knowledge was based on this system. In the digitalisation era we constantly rely on machines, but they cannot process some information. For example, they are not able to face completely new situations that are not already "in the system". Therefore, to take advantage of enabling technologies, intended as elements of mediation to realise the architectural project, the development of the typically human ability to make connections between concepts that are different and distant, for creating new thoughts (and therefore solutions) never faced before, is necessary (Rinaldi, 2017). Indeed, on the one hand, we urgently have to associate a "datum" with the planning rules, to take decisions that are not arbitrary, assuming that this datum will have numerical substance, but on the other hand this datum will be inexorably linked to a non quantifiable substance, characteristic of historic architecture, which only human knowledge can identify and connect.

This datum, in fact, depends on the other complex issue, still the subject of extensive debate, linked to the project of retrofit of historic buildings. In the case of historic buildings, non-quantifiable values are involved, such as the result of history, of historic-artistic features to be listed, which can not be inscribable to an analytical database: in a word, the result of "culture". The quality of a work of architecture, even more if it is a listed building, depends on this cultural added value linked to the concept of «invisible technology» (Sinopoli, 1997; Kelly, 2011), made of immaterial characters as what we now call "Big Data", but still hardly confined within a precise performance framework.

As Kelly states (Kelly, p. 12), in recent years we are in fact used to deal with invisible and immaterial technology (as software or the use of the internet). However, this is not a new trend because the past technologies that have revolutionised history have often been immaterial, like the alphabet or the Consti-tution. These inventions, as well as the cultural result of human evolution, enter rightfully into all the cultural aspects to be handed down through the current enabling technologies, since the recent design revolution mainly concerns the «digitalisation of the knowledge» (Cerri, Cattaneo, Terzi, 2017). Therefore, the overcoming of the concept of «naked technology» (Colony, 2002) is necessary to enrich the naked technology of cultural heritage and of all information not referable to bits but regarding the complex of values linked to knowledge and to society, to the handed down expertise, to study, to the sensations and emotions that we already recognise to historic buildings through protection. It is necessary to codify the environmental, functional and maintenance metabolism of these buildings, and all the other invisible metadata.

An interactive and open database of knowledge for the retrofit of historic buildings

Data links, to be inserted into the network (of knowledge, but also the more operative of process management), can be created by studying the real historical processes, interpreting them in the most precise way through the convergence of heterogeneous data and extracting some «patterns of repeated events» (De Biase, Pievani, 2016, p. 28) from the multitude of stories. This method makes data available to be involved in the project, in a sort of «taxonomy of monuments» (Maietti, Medici, Piaia, 2017).

Progressively it is necessary to collect and transform in the current communication and work systems as much information as possible on historic buildings, to create a "knowledge database".

The process consists in replacing information with knowledge, meaning the latter as a new awareness, and in making it accessible and open through the database. This digital archive must include aspects related to:

- semantics: the style elements, the morphology, the architectural vocabulary of the elements to trace them and, in the case of intervention, valorised, restored and not lost (Maietti, Medici, Piaia, 2017);
- temporal dimension: the historical and morphological evolution of the building during its life cycle, the transitions and variations in use;
- materials and construction techniques: collecting information on their chemical-physical composition, the way in which they were created and used, the techniques for restoration and conservation is necessary, since there is no manufacturer certificate or the traceability of past products;
- the energy performance, to be able to know and quantify the strategy to enhance it in the design phase with the aim to abandon the current habits to refer to non-targeted design standards;
- opinions, feedback and preferences of end users, detected through surveys and questionnaires, video and sensors;
- the restrictions and rules imposed by the Authority for the protection of built heritage;
- examples of design solutions that are suitable and acceptable for different types of historic building, as a guideline for future interventions.

The portal can be configured as an interactive, additive and open catalogue for the management of all this information that can be easily obtained, in a flexible and shared process. The functionality of this smart system is potentially multiple: spreading information on cultural heritage even to not specialised figures, providing an instrument for planning restoration and valorisation procedures for historic buildings and for giving the possibility to plan extremely specific interventions thanks to a wide experience of real data.

An interesting example, although still limited to the geographical area of Campania, is DATABENC[2], created with the aim of create an integrated platform made up of rules, procedures, good practices and technologies, responding to the smart European model environment, able to help solving some critical situations in which the cultural heritage of the area is concerned.

According to Carr (1961), someone says that facts speak for themselves: but this is obviously false. Facts speak only when the historian makes them speak: historians arbitrarily determine which facts of the past turn into historical facts according to their own biases and agendas.

Just as the historian uses facts as a means of telling the history, the architect, put in the condition of possessing these metadata, can use them as a way to interpret the architecture of the past. Enabling technologies must be used to increase awareness and knowledge, making them as much as possible widespread and shared, so that history can be more or less subjectively understood from different and multiple points of view.

---

[2] http://www.databenc.it/wp/distretto/.

This «invisible technology» can become manifest through the project: metadata is the clue, while the person who reads and interprets this information has the opportunity to write history.

References

Butera, F. (2017), "Lavoro e organizzazione nella quarta rivoluzione industriale: la nuova progettazione socio-tecnica", *L'Industria Rivista di economia e politica industriale,* n. 3, Il Mulino, Bologna, pp. 291-316.

Carr, E.H. (1967), *Sei lezioni sulla storia*, Einaudi, Torino, pp.15-16.

Cerri, D., Cattaneo, L., Terzi, S. (2017), "Industria 4.0: una rivoluzione anche nella progettazione", available at: www.industriaitaliana.it (accessed 08/08/18).

Colony, G. (2002), "Naked Technology", available at: https://www.forrester.com (accessed 09/08/18).

De Biase, L., Pievani, T. (2016), *Come saremo*, Codice Edizioni, Torino.

Kelly, K. (2011), *Quello che vuole la tecnologia*, Codice Edizioni, Torino.

Losasso, M. (2018), "Innovazioni per l'ambiente costruito: tecnologie abilitanti e qualità del progetto", speech at the conference "La produzione del progetto", UNIRC, Reggio Calabria 14-15/06/2018

Maietti, F., Medici M., Piaia, E. (2017), "An inclusive approach to Digital Heritage: preliminary achievements within the INCEPTION project", *Proceedings of GCH 2017 - Eurographics Workshop on Graphics and Cultural Heritage*, Graz, Austria, 27-29/09/2017, The Eurographics Association, Goslar, Germania, pp. 145-150.

Parlamento Italiano (2013), Legge 90/2013 "Disposizioni urgenti per il recepimento della Direttiva 2010/31/UE del Parlamento europeo e del Consiglio del 19 maggio 2010, sulla prestazione energetica nell'edilizia per la definizione delle procedure d'infrazione avviate dalla Commissione europea, nonché altre disposizioni in materia di coesione sociale", available at: http://www.bosettiegatti.eu.

Parlamento Europeo (2002), Direttiva 2002/91/CE "Sul rendimento energetico nell'edilizia", available at: http://efficienzaenergetica.acs.enea.it.

Rinaldi, A. (2017), "Il futuro per gli architetti è incerto e in salita? È necessario cambiare atteggiamento, riappropriarsi della dimensione sociale, essere capaci di anticipare il cambiamento anziché subirlo", available at: http://www.infobuildenergia.it (accessed 09/08/2018).

Sinopoli, N. (1997), *La Tecnologia invisibile. Il processo di produzione dell'architettura e le sue regie*, Franco Angeli, Milano.

2.6 IDENTITY CARDS FOR MULTI-LAYERED DISTRICTS. BIM/GIS INSTRUMENTS FOR THE DESIGN OF SMART CITIES

Saveria Olga Murielle Boulanger, Rossella Roversi**

Abstract

Thanks to the significant development of digital technologies, the contemporary city is dealing with the topic of the smart city, in which complexity and multiplicity of systems are read and managed through the Information and Communication Technologies (ICT) and the Internet of Things (IoT). The present contribution aims at analysing the complexity of the project in multi-layer urban systems (Acierno 2015) through a methodology that exploits the potential use of systems such as BIM, GIS, Envimet and CityGML. Their application in urban district-level project management is a less investigated area than the single-building scale, so it has been tested through a simulation aimed at the regeneration project of an existing district.

Keywords: Smart city, Urban regeneration, Interoperability, Urban districts, Performance indicators

Introduction

The necessity to answer to different pressures, such as climate change, migrations, new technologies and increasing fuel poverty, leads a reflection on the building-district system to understand the multiple relations between the dimension of the building and the district one. The single building, in fact, is included inside dense urban systems which are composed by a multiplicity of sub-systems linked together: other buildings, energetic infrastructures, mobility infrastructures, services, social dynamics. All those layers increase the complexity making the urban system overlapped and interlinked systems of systems to which urban planning is asked to answer.

This research tries to understand how all those layers create complexity and how it can be managed in order to achieve a more efficient urban regeneration through a deeper knowledge on districts.

* Saveria Olga Murielle Boulanger is a Research Fellow and an Adjunct Professor at the Department of Architecture, Engineering and Architecture School, Bologna University, Italy, saveria.boulanger2@unibo.it.

* Rossella Roversi is a Research Fellow and an Adjunct Professor at the Department of Architecture, Engineering and Architecture School, Bologna University, Italy, rossella.roversi@unibo.it.

In the meantime, the increasing penetration of digital technologies is asking cities to face complexity with the use of digital technologies and innovative devices.

The new standards of BIM and GIS are some of the most promising as they can contribute to the management of a big amount of information, evolving in time. The main objective of this research is to investigate the multi-level nature of urban existing districts with the aim of increasing their comprehension by exploiting BIM and GIS potentialities for urban regeneration.

Multi-level nature of districts: relations inside the built environment

The renovation of the existing building asset is a key challenge for the EU, to meet the ambitious goal of decarbonisation (Antonini et al., 2017).

Working on district dimension, in fact, allows to maximise impacts and to include in-depth reflections about how single actions can influence the whole system. Single buildings, in fact, have a strict and mutual relation with the district as they influence the district but are also influenced by it.

The major layers of relations can be: transport/mobility infrastructures; energetic networks; green and blue networks; natural ecosystem; social/anthropological relations; urban microclimate. The word "district" refers to an urban area with different specificities. The debate about the identification of its key component is wide and extended in time.

It is often identified as an administrative area as well as an area recognised by its inhabitants for variable reasons. Inside this research the district is defined as an intermediate urban dimension between city and buildings, being recognisable by its citizens; having a minimum physical dimension for implementing projects; having a recognised relevance in respect of the whole city; and being mixed-use or settled into a specific function (e.g. residential, commercial, etc.). Assuming the multiplicity of levels of complexity requested to designers when planning regeneration actions, the integration of this complexity inside new software seems interesting and necessary.

Interoperability between BIM and GIS to represent urban complexity

The smart city concept integrates multiple items in a vision that includes Information and Communication Technology (ICT) and Internet of Things (IoT) as tools, fitting to manage the complexity of data and information aimed at urban planning and management (Jin et al., 2014).

The availability of advanced ICT systems allows collecting, analysing and sharing historical and current data, both geometrical and semantic ones, at macro and micro scales and spatial based.

Although a single tool able to run this huge and heterogeneous mass of data still does not exist, ICT can visualise simultaneously different issues and uncover their underlying conditions (Allegrini et al., 2015).

This can help the planners to identify and prioritise the main related data and to find out cross-domain strategies, functional to the smart transformation of cities or their parts. Relating to this topic, GIS and BIM are two critical technologies: both domains try to standardise architecture and processes but do not have the same goals.

GIS (Geographic Information System) interprets reality by layering information and integrating them with relative geographic location trough geolocation, using real world coordinates. It is mainly used in the presentation of the urban and territorial scale; it is more useful for 2D geometry modelling and provides mechanisms of representation differentiated in topic and levels of detail (LoD).

BIM (Building Information Modeling) allows the creation of an informative model that digitally represents physical and functional features of an object during all its life cycle. It integrates in a single 3D model, shared among all the operators, architectural, structural, plant, energy and management information. BIM has been associated to other simulation software that, for example, can predict the effect of retrofitting measures on existing buildings.

The optimisation in the use of energy is one of the key elements of a smart city. The availability of tools for surveying, monitoring and controlling the consumption of a building allows the collection of data and the implementation of aware and virtuous containment measures. Likewise, at the district level, information on environmental characteristics and energy consumption can be obtained in real time through a network of sensors. In this framework, making it possible to extrapolate an overall picture and exchange information from different types of devices that generate heterogeneous outputs, has become a strong need (Ronzino et al., 2015).

In general terms, the development of middleware technologies, bridging different operative systems, database and apps born with different goals, can lead to software and data interoperability, allowing layered, interrelated and upgradable representations. Once interoperability is reached, the information obtained from the various sources can be linked and inserted into a “smart digital archive” from where they can be retrieved and implemented by stakeholders (Wolisz et al., 2014).

Integrated BIM and GIS platforms applications for a multi-level understanding at the district scale

The integration between GIS and BIM is an important area of research that has produced numerous studies and applications, especially since 2008.

According to the most complete review of research products on the topic (Ma, 2017), most of them are about buildings (73%), while the rest are dedicated to infrastructure (12.2) and urban districts (14.6%)[1].

As the analysis of the state of the art on the integrated application of BIM and GIS has shown, the research directions were mainly oriented towards energy and thermal issues.

Applications concerning topics like urban regeneration, risk response, protection of heritage mostly concern single buildings or their summation. Furthermore, the district scale has been little investigated.

The integrated management of neighbourhood dynamics implies the dealing with a reat amount of information, behaviours and variables that must be recorded, cross-checked, connected. The availability of ICT infrastructure and tools, as the result of an effective integration of BIM and GIS capable of managing data at different scales, is a key factor.

However, the great amount of data needs the attribution of an architecture that allows their organisation, their reading according to the specific stakeholder interest, and must be able to represent in a simple and effective manner the complexity that characterises urban environments. The present research proposes a methodology that integrates the BIM and GIS systems as functional to the knowledge of the multi-level dimension of an urban portion, identified in the district.

The last purpose is to develop technological and methodological tools for the designing, simulation and verification of urban regeneration programmes. As part of the present research, a methodology for assessing the level of smartness that characterises a portion of the city and the potential improvements resulting from regeneration actions and projects has been developed.

Identity cards for the district scale: integration between modelling and key

The research, which is a continuation of a PhD thesis completed at the University of Bologna, develops a methodology of analysis and regeneration planning for existing districts, based on the use of Key Performance Indicators (KPIs) as instruments for gaining a deep insight. A selection of KPIs has been defined and it is composed by 11 key indicators.

This first selection defines a quick analysis, while 100 KPIs are provided within the research for an in-depth analysis. Table 1 gives an insight on the 11 main KPIs. Table 2, instead, defines how indicators have been identified, using the methodology of DPSRI (Driving, Force, Pressure, State, Impact, Response).

---

1 Regarding Italian research, a major project, that assumes the district scale, is the European project DIMMER (District Information Modelling and Management for Energy Reduction). It was coordinated by Politecnico di Torino. Osello, A. et alii (2014).

INDICATORS	UNITS	DESCRIPTION
Energy consumption of buildings	kWh/m^2y	Evaluation of energy consumption for thermal need for the average of buildings, divided into the main functions (residential, tertiary, enterprises, commercial).
Percentage of renewable energy used for the built environment, on the total energy consumption (both electric and thermal).	%	A percentage of renewable energies on the total energy consumption is required.
Buildings density and canyons geometry	m^2/km^2	m^2 of buildings on the total km^2 of the selected area. The canyon geometry is a qualitative analysis of the main canyons geometry
Anthropogenic heat	W	Calculation based on the thermal conduction of building envelope.
Evapotranspiration ratio	%	Percentage of impervious surfaces on total selected area. The data come from a spatial analysis.
Thermal comfort	PMV index	Thermal perception of a group of people in a selected area, calculated through the Envimet software
Distribution of vegetation	qualitative	The distribution of vegetation is evaluated on the basis of a spatial analysis.
Air pollution	n°(d)	N° of days in which the presence of particulate is higher than the international limit.
Green public transport penetration	qualitative	Qualitative analysis based on a map of the district.
Presence of ICT devices	qualitative	N° of systems into the whole district, with the specification of the use of these systems.
Innovative environment	qualitative	Qualitative analysis, giving an insight of the presence of cultural, creative environment.

Tab. 1 - Key Performance Indicators (KPIs) for the district description.

However, the main objective of this research is to understand how the knowledge on districts (e.g. trough the KPI investigation) can be used in collaboration with GIS and BIM software packages.

In order to achieve this goal, a real case study has been selected for testing the possibility of merging all those information.

The selected case study is the Bolognina neighbourhood, a big area in the city of Bologna, inside the Navile district. Currently, the district is home to around 35,000 inhabitants. Even if the presence of green is sufficient, the dense urban tissue is leading to increasing climatic challenges, mainly linked with resilience and shock and stresses reaction capacity. Into this contest, the research opted to simulate a KPI based analysis, with a 3D modelling in CityGML by using trial versions of Sketch Up Pro and Place Makers and using Open Street Map as source of GIS data. The modelling will be enlarged in future researches, by using other software and full versions. However, this first attempt gave the possibility to deepen the reflection on the multi-layer identity of districts and on the possibility to include a wide panel of information in such digital systems.

CHAL- LENGE	DRIVERS	PRESSURES	STATE	IMPACT	RESPONSE
Climate Change	Energy con- sumption	GHG Emissions	Built environ- ment energy consumption Renewable energy rate Public transport pene- tration	Urban heat island High consumption and high expenses for energy Fuel poverty Air pollution	Energy man- agement sys- tem Energetic plans for dis- trict develop- ment
	Resource de- pletion				
	Resilience Comfort	Urban Heat Island	Urban energy balance Anthropogenic heat Evapotranspi- ratio Albedo Thermal perception Building density	Discomfort GHG Emissions Health Air pollution	Distribution of vegetation District moni- toring Resilience plan Impervious surface control Water cycle and resources management plan
		Water cycle		Runoff Drough Safety	

Tab. 2 - DPRSI (Drivers, Pressures, State, Impact, Response) analysis, applied to the Bolognina case study.

As showed in Figure 1, these instruments can include information composing Identity Cards of buildings. The main benefits can be the following:

- to share information on single components of the built environment in order to maintain an updated database during the time;
- to share information related with components performances and their changes in their own history (from cradle to grave);
- to share a comprehensive district analysis able to create a system of information on a smart database, interoperable and queryable by different professionals;
- to collect and share the wide range of analysis provided by all the different professionals (e.g. engineers, architects, policy makers, sociologist, etc.).

Conclusions

The research shows interesting elements for its pursuing.

As previously assessed, the research on an integrated platform between BIM and GIS still needs experimentations and validation.

Through the simulation inside these software, the research aimed to test a first solution, finalised at understanding the functions and future development potentialities.

The combination of GIS and BIM instruments can create 3D drawings at district levels able not only to visualise and communicate design decisions, but also to create ID cards full of information, studies and analysis able to influence and direct the planning. Then, the integration of these information at the district level put the attention of designers not only to the single components of the built environment but to the existing relations among single elements and to the interdependencies among them. Nevertheless, some barriers are evident:

- the difficulty in finding all necessary information at the district level. The applied modelling of this study relied mainly on open data information which are still lacking and partial. The presence of local complete databases could increase the usability of these systems;
- urban regeneration, as defined into this study, needs to focus on the multiplicity of properties of buildings which lead to challenges when actions are needed, as well as the necessity for using data that sometimes are not open source for privacy problems (e.g. energy consumption raw data);
- the use of KPIs foresees the presence of a big amount of information which are actually not often easily available;
- the use of these software is still not extensively spread in all scientific domains dealing with the built environment (e.g. social studies).

References

Allegrini, J. et alii (2015), "A review of modelling approaches and tools for the simulation of district-scale energy systems" *Renewable and Sustainable Energy Reviews*, vol. 52, pp.1391–1404.

Antonini E., Gaspari J., Boulanger Saveria, O.M. (2017), "Multi-layered design strategies to adopt smart district as urban regeneration enabler", in *International Journal of Sustainable Development & Planning*, 12, n. 8, pp. 1247-1259.

Balducci, A., Fedeli, V. (2007), "Tracce di quartieri", in *Territori della città in trasformazione. Tattiche e percorsi di ricerca*, Franco Angeli, Milano.

Del Giudice, M., Osello, A., Patti, E. (2014), "BIM and GIS for district modelling", *Proceedings of 10th European Conference on Product & Process Modelling*, 2014, Wien, pp. 1-5.

Jin, J. et alii (2014), "An Information Framework for Creating a Smart City Through Internet of Things", *IEEE Internet of Things Journal*, vol. 1.2, pp. 112-121.

Ma, Z., Ren, Y. (2017), "Integrated Application of BIM and GIS: An Overview", *Procedia Engineering* 196, pp. 1072 – 1079.

Osello, A. et alii (2014), "BIM e GIS per la metodologia DIMM(ER)", in Giandebiaggi, P., Vernizzi, C. (eds), *Italian Survey and International Experience*, Gangemi Editore, Roma, pp. 975-982.

Ronzino, A. et alii (2015), "The energy efficiency management at urban scale by means of integrated modelling", *Energy Procedia,* 83, pp. 258-268.

Wolisz, H., Böse, L., Harb, H., Streblow, R., Müller, D. (2014), "City district information modeling as a foundation for simulation and evaluation of smart city approaches", *Building Simulation and Optimization Conference*, UCL, London, UK.

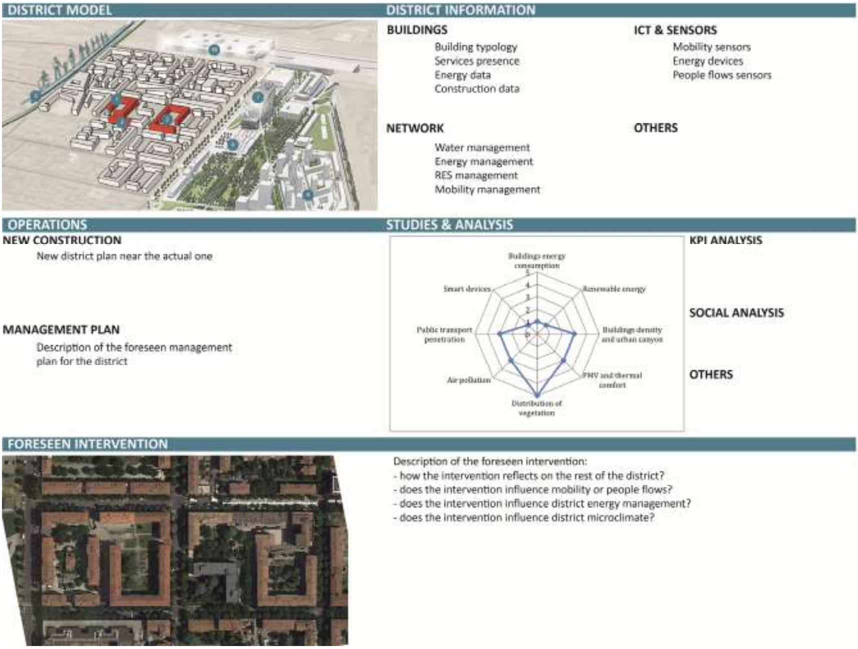


Fig. 1 - District Identity Card simulation.

2.7 MULTI-CRITERIA ANALYSIS METHOD FOR THE PRELIMINARY DESIGN OF A HOSPITAL STRUCTURE

Salvatore Viscuso, Milan Dragoljevic*, Alessandra Zanelli**

Abstract

As a part of the schematic design for a new regional hospital in Lanciano (Chieti) that should replace the old one, a BIM-based work methodology was implemented according to the new organisational and project management methods, in compliance with the IFC standard. The use of BIM process allowed combining qualitative and quantitative assessments for a set of information (parameters) shared on the same platform (federated model), with a lower degree of errors than a traditional approach. The methodology was developed through a collaborative synergy between the design teams and facility managers, which provided valuable inputs on the management of health, energy and logistics services of hospital buildings, aligned with the international quality standard for the certification of healthcare facilities.

Keywords: Building Information Modeling, Healthcare Design, Design Optioneering, Design for Assembly, Design for Manufacturing

Introduction

The recent development of connection features between information and parametric models has created diverse options for the use of digital modelling for building parts and components.

The parametric design for the different phases of the construction process, the on site data visualisation deriving from the model using specific visualisation tools and the facility maintenance associated with the model are just some of the potential uses of BIM-based processes (Vanossi, Imperadori, 2013).

This paper aims to outline the advantages offered by digital interoperability in connecting specialised skills that are needed to design complex buildings such as hospitals. Currently, the difficulties to successfully integrate BIM pro-

---

* Salvatore Viscuso is a Research Fellow at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, salvatore.viscuso@polimi.it.

* Milan Dragoljevic is a PhD Student at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy,milan.dragoljevic@polimi.it.

* Alessandra Zanelli is a full Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, alessandra.zanelli@polimi.it.

cesses and the construction stage are directly related to the number of participants in the project.

In architecture, the contemporary trend is to design a building with a compositional or technological originality that distinguishes it as an identifying sign within a specific place. The challenge is now represented by the difficult task of managing a huge amount of data and requirements in the planning phase, often impossible to systematise if not through a predefined organisational approach (Ciribini, 2016). Furthermore, in order to achieve a real synergy between the interoperable BIM design and the production at the various scales of the project (technological systems, technological subsystems, components or technical elements), it is not possible to ignore cloud environments for organising and sharing the project milestones and upgrades, as required by recent standardisation rules[1].For the schematic design of the new hospital centre in the city of Lanciano (1st DEA level with 218 beds and a net area of about 50,000 m^2), the workflow started from ruleset needed to link between BIM models, corresponding to a level of development equal to a LOD 200, with the internal decision-making process of construction companies, thus involving designers, cost estimators and facility managers. The modelling - in separated files - of the architectural and structural elements made it possible to adopt, in the definition phase of the sanitary space planning and of the external envelope packages, a multicriteria strategy, that considers more options in the search for optimal solutions as the function of predetermined criteria.

Definition of the project requirements

The preparation of the process had as its first major step the definition of the project requirements. Their identification was fundamental, as it made possible defining the final objectives to be reached and correctly setting the models and identifying the parameters that allowed optimisation of the design scenario that best meets the objectives (Deutsh, 2011). An incorrect setting of the requirements could nullify all the modelling work done later. In accordance with a typically top-down decision-making process, a series of macro-categories or criteria for project control were defined, including the budget, the technical-construction feasibility, the internal distribution and the thermo-acoustic performances linked to the hypothetical building envelope options.

---

[1] The data sharing platform was presented in a defined manner in the British technical standards (PAS 1192 series), where it took the name of the Common Data Environment. This concept was subsequently taken as the part of Italian standards of the UNI 11337 series, where it assumed the name of "Ambiente di Condivisione Dati", briefly indicated with ACDat. In particular, it is widely discussed within the UNI 11337-5 and UNI/TR 11337-6 standards, which are dedicated to the specifications of the drafting of the information documents.

Their definition was carried out in close collaboration with the company's technical designers and also through some briefings involving suppliers and sub-contractors (Holzer, Downing, 2010).

Modelling parameters

The definition of requirements through BIM information parameters, in compliance with the Industry Foundation Classes (IFC) standard defined by UNI EN ISO 16739:2016, has allowed the connection between project objectives and digital modelling. The type parameters, related to the numerous rooms and the main components and technical elements of the project, were organised into predefined property sets (P-sets), each specific for every project requirement, in order to systematise the multidisciplinary skills of the designers and technicians involved. P-set sharing enabled generating integrated design, particularly identifying and solving overlaps and conceptual interferences between different operators and designers. The model - containing geometric and informative data - was conceived as an incubator from which to extract complete and reliable results, in compliance with the know-how of the actors and the whole design team (Arlati, Viscuso, 2018). For each parameter an ideal value for this project was identified, obtained through a series of interviews with the company technical operators involved in the design process. For defining different spatial and distribution scenarios and performing multi-criteria analysis on them, special attention was given to the indications provided by the facility managers, above all to identify the requisites necessary for a possible Joint Commission health accreditation.

In order to evaluate the surfaces and volumes needed for building up the entire hospital equipment, the main data (surfaces, distances, daylight, airlight etc.) related to the various activities constituting the new hospital were considered: all medical and surgical specialties, diagnostic equipment and robotic equipment, without neglecting everything related to management-related activities, such as laundry, sterilisation, and catering. For a balanced pre-dimensioning, all human activities related to reception and waiting were also considered, such as commercial activities, banking services, as well as all the babysitting services, gyms, etc. (Carpman, Grant, 2016).

Each health function was studied, in the first analysis, evaluating all the interactions necessary within each department.

This study therefore represented the basis for the development of a subsequent level for each department's distribution. Moreover, since it is no longer sufficient to give only a quantitative response to the requests of a health and technical nature, one of the main objectives of the intervention was the qualitative development of the spaces and, therefore, the search for the humanisation of the hospital environment.

In defining the parameters and the premises for the new hospital, we opted for new performance requirements for hospital stays, proposing to bring the standard of hotel comfort even in the workplace: hotel technology and comfort become the new, real and contemporary references of today's needs within the spaces and health facilities (Capolongo, 2012).

Regarding the definition of packaging sets, a library of materials was modelled, containing the parameters necessary for the multi-criteria evaluation of the various design options. The library has collected the data provided by the designers and suppliers interviewed and can be connected to any IFC model that will be executed later. The P-sets have been associated with XML sheets that can be shared between the designers and the company suppliers, in order to obtain a simple tool for the evaluation of the different project scenarios by the project stakeholders. In that way, a new working method was implemented that keeps in digital memory the parametrised libraries of materials and technological components. The transfer of data from the XML sheets to the room's abacus and the material libraries was possible through the appropriate connection between modelled objects and parameters, realised through a special Autodesk Dynamo script. Putting an informative database into modelled objects means inserting "business intelligence" and allowing communication with other subjects, even non-technical and non-specialist. The modelled objects have been linked to the relative product data sheets, accessible by the direct link to the order server. The database, owned by the client, will go to populate sensitive information, such as the costs and time taken to create the packages, the model that will be a "neutral" or "partially neutral" geometric entity until this information is transferred to it.

Modelling alternative designs

Modelling, both of parametric and object type, is performed following a criterion of the disciplinary subdivision. Another possibility, discarded because of the excessive stress that the hardware would suffer, could be the multidisciplinary modelling in a single environment, which, in the case of a subdivision into parts of the model, would have compromised some analysis possibilities based on the unity of the same. In order to ensure maximum interoperability among all the designers involved, the central models were shared on a cloud-based platform that offered a file hosting service and automatic synchronisation of local files via web. The discipline-based models were modelled separately at different thresh-olds of development. Initially three LOD 100 volumetric models of conceptual masses were created, useful for distributive analysis of the divisions for the 3 different project options proposed, and for the verification of internal paths (sanitary, clean, dirty). The LOD 200 architectural and structural models were realised, related to the design option that was more appropriate in relation to health requirements. The models were brought together in a coordinated model. Using review tools (clash detection) made it possible to resolve physical interferences and project nonconformities - minimum areas of the premises, the width of the escape routes, distances between the departments, air-light relations - linked to the current regulations (code checking).

Checking and optioneering

The multi-criteria analysis phase allowed the input of the data extracted from the model in the decision-making process, with reference to the themes defined in the initial requirements. For the extraction of the data resulting from the informed modelling, the dynamic links for reading and writing data, previously realised in Autodesk Dynamo, were used.

For the visualisation of the data, numerous XML sheets have been created with specific graphs for each criterion of project analysis (budget, process industrialisation, internal distribution, thermal and acoustic performance), without the end users having direct access to the model.

The first level of evaluation addressed the different combinations in the organization of the parametrically reconstructed departments in the LOD 100 volumetric models, according to an analysis that considered more important criteria, including the parametric realisation costs and the possibility of organising the construction site by phases of gradual demolition of existing hospital buildings, and the simultaneous construction of the new hospital in stages (Zhang et al., 2016).

The criteria considered in this first phase were therefore multidisciplinary, ranging from the information of an exclusively compositional nature to technical-realization and economic aspects.

Once the LOD 200 geometric model of the optional design solution was completed, the different housing packages - parametrically populated with the data inserted in the material library - were automatically connected to the calculation engines of Autodesk Green Building Studio for the definition of their thermal performance and acoustics, thus optimising the decision-making process in the choice of casing solution (Tronchin, Manfren, 2015).

Other uses of the model

Special attention is paid to the extraction of traditional graphic drawings (plans, elevations, sections, three-dimensional views, etc.) by setting up a customised view template for each discipline and consequently, for the stakeholders involved in the decision-making process. The organisational methodology has also allowed the use of digital models for verification of the manufacturing of technological components and the in situ construction process.

Like the Design for Assembly (DFA), a design theory that, in the construction sector, can be associated with the optimisation of the construction phases of prefabricated systems, the Design for Manufacturing (DFM) has assumed, on the prefigured procedural level, strategic importance for the industrial production of the main technological systems of the new building (Das, Kanchanapiboon, 2011).

This led to the creation of a digital continuum between design and manufacturing that allowed, for example, to digitally visualise the site's spatial-temporal organisation, such as the gradual demolition of the existing hospital pavilions and the manufacture, in two distinct phases, of the new building; or plan the assembly of prefabricated components, such as reinforced concrete structural elements (on-site assembly) and ventilated facade modules (off-site assembly).

The modelling and the dimensioning of the structural model utilised load combinations that included the seismic action according to current legislation. The structural BIM model was analysed with the help of the KARAMBA 3D calculation software, a finite element structural analysis application operating in Rhinoceros Grasshopper. The frame structure in prefabricated reinforced concrete elements was schematised with hinges (that do not transmit momentum stresses between the connected elements), while the constraint at the base of the pillars is a joint. Material, dimensional and mechanical characteristics were appropriately assigned to each structural element. The possibility to parametrically manage the calculation inputs has made it possible to improve the sizing of the individual elements, verifying them in the various load combinations. From the architectural and structural models, a detailed Quantity Take-off was obtained, useful for carrying out both the parametric evaluation of construction costs and a first object-oriented cost estimation.

Conclusions

The integration of the BIM modelling into a complex process, such as that of the preliminary design of a hospital unit, underlines the potential application that lies behind the interoperability between the Model Authoring and Coordination of the project, that were, up to a few years ago, delegated to the purely geometric field, and the most common 2D drawing tools (DWG files) and calculation tools (XLS, XML, XTML files).

In particular, the parametrisation of the project, that is an intrinsic feature of digital modelling, represents an appropriate tool in the optioneering support to the decision-making process, as it allows extracting multiple solutions starting from a single model (Bragadin, Kahkonen, 2013).

The experience under examination shows that the planning of a work methodology is an essential condition for obtaining the data necessary for the pursuit of the objectives.

An underestimation in the planning of the process, or the minimum requirements needed for the advancement to a subsequent state of work, can nullify the effort that involves the construction of the BIM models for separate disciplines, which would not have a return of investment in geometric modelling alone (Ciribini, 2016).

References

Arlati, E., Viscuso, S. (2018), "La modellazione Digitale nel processo di intervento edilizio", in Cabiddu M.A., Colombo M.C. (eds), *Appalti Pubblici*, *vol. 9 - Riserve, Varianti, e Strumenti di Precontenzioso*, Collana Norme& Tributi, Il Sole 24 Ore, Milano, pp. 183-202.

Bragadin, M.A., Kahkonen, K. (2013), "Innovation in construction project control", proceedings of the *ISTeA conference 2013: ICT, Automation and the Industry of the Built Environment: from the Information Exchange to the Field Management*, Milano, October 3-4, 2013, Maggioli, Santarcangelo di Romagna, pp. 138-157.

Capolongo, S. (2012), *Architecture for flexibility in healthcare*, Franco Angeli, Milano.

Carpman, J.R., Grant, M.A. (2016), *Design That Cares: Planning Health Facilities for Patients and Visitors*, 2nd Edition, Jossey-Bass, San Francisco.

Ciribini, A.L. (2016), *BIM e digitalizzazione dell'ambiente costruito*, Grafill, Palermo.

Das, S., Kanchanapiboon, A. (2011), "A multi-criteria model for evaluation design for manufacturability", *International Journal of Production Research*, vol. 4, n. 49, pp.1197-1217.

Deutsh, R. (2011), *BIM and Integrated Design: Strategies for Architectural Practice*, 1st edition, John Wiley & Sons Inc., New Jersey.

Holzer, D., Downing, S. (2010), "Optioneering: A New Basis for Engagement Between Architects and Their Collaborators", *Archit Design*, n. 80, pp. 60-63.

Tronchin, L., Manfren, M. (2015), "Multi-scale analysis and optimization of building energy performance - Lessons learned from case studies", *Procedia Engineering*, vol. 118, pp. 563–572.

Vanossi, A., Imperadori, M. (2013), "BIM and optioneering in dry technology small-scale building", proceedings of the *ISTeA conference 2013: ICT, Automation and the Industry of the Built Environment: from the Information Exchange to the Field Management*, Milano, October 3-4, 2013, Maggioli, Santarcangelo di Romagna, pp. 53-65.

Zhang, C., Zayed, T., Hijazi, W., Alkass, S. (2016), "Quantitative assessment of building constructability using BIM and 4D simulation", *Open journal of civil engineering*, n. 6, pp. 442-461.

2.8 TRASPARENCY IN MANAGEMENT AND CIRCULARITY. BLOCKCHAIN AND THE PRODUCTION OF THE PROJECT

Cristina Fiore, Daniele Iori*, Giuseppina Vespa**

Abstract

The adoption of blockchain within a BIM-based working environment sets a whole new frontier for collaborative design, by means of combining the digital model with a series of interconnected ledgers of data provided by several users within a P2P network. A technology that is able to ensure transparency, traceability, consensus and inalterability could finally overcome the trust-related issues that arise while managing a centralised BIM model, supply chains or relations among professionals, administrators, clients and suppliers. Tools such as smart contracts and material passports running on a public ledger would bring substantial benefits to the production of the project, in terms of streamlining administration procedures and increasing the circularity potential of products.

Keywords: Building process, Transparency, Smart contract, Traceability, Circularity

Introduction

ICT (Information and Communication Technologies) have been gradually included in the construction process, channelled mostly into the BIM environment. Similarly, the introduction of SCIT (Supply Chain Information Technologies), such as blockchain, data analytics, IoT, artificial intelligence, etc., are being engaged by several manufacturing industries and service providers, radically boosting their efficiency and competitiveness.

Blockchain is a public digital ledger, shared, decentralised, permanent and encrypted. Specific rules make it safe and unalterable (except in case of changes authorised by the network). The network consists of a chain of blocks containing multiple transactions, which are controlled and approved by nodes, each one containing the whole archive of the blocks and their contents.

* Cristina Fiore is a PhD student at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, cristina.fiore@uniroma1.it.

* Daniele Iori is a PhD student at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, daniele.iori@uniroma1.it.

* Giuseppina Vespa is a PhD student at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, giuseppina.vespa@uniroma1.it.

Even though the AEC sector shows a certain unresponsiveness towards digitisation, the scientific debate foresees with growing enthusiasm the benefits which would rise if the construction process was to open up to such innovative technologies. Integrated design, which has been around in the construction industry for a decade already, mostly due to implementation of BIM, is about to upgrade to level 3.0. Although collaborative design brings about all the benefits of a shared digital working environment where different actors operate, it also brings about trust-related issues. Such issues will be amplified the more the BIM model becomes unified, without a hierarchy-based control structure, and subject to simultaneous interactions by various users. In this regard, the blockchain technology 2.0 reveals its broader versatility not only in financial operations, but as a platform for trustful interactions between professionals and customers in any sector which involves the exchange of valuable objects, services or information, thus requiring operations of recording, tracking and verification. The blockchain could provide benefits for the construction process that are mainly managerial, and partially intersecting the BIM workflow. They translate into major transparency in procedures and logistics (through the introduction of smart contracts[1] and the optimisation of supply chains), and major traceability of the flows of materials and components. The blockchain, by allowing to transmit automatically and securely the data regarding the project and its progress to all stakeholders and third parties, such as lenders, insurers and governmental authorities, would ease processes such as contracts, supply agreements and procurements, often exposed to miscommunication, overwork or recourse to legal actions. Furthermore, associating the BIM model to a blockchain as a widespread infrastructure, would grant accessibility for the partners of the project, and the transcription and storage of the operations affecting the model and more generally the life of a building and its components, from the design stage to the contract, implementation, maintenance and final disposal, with interesting prospects for increased circularity.

The adoption of blockchain as a means for transparency

The construction process in its different phases implies a number of relationships between operators, professionals, suppliers, customers, and public administrations. The BIM model is an ideal platform for managing and sharing the information regarding the project, but some issues remain open, such as data relia-

[1] The term "smart contract" was introduced in the 90s by computer scientist Nick Szabo. He defined it as: "a computerised transaction protocol that executes the terms of a contract. The general objectives are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimise exceptions both malicious and accidental, and reduce the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitrations and enforcement costs, and other transaction costs".

bility, accessibility and governability by all stakeholders, and the attribution of legal responsibilities and intellectual property, all of which undermine management transparency throughout the production of the project.

Blockchain technology introduces a brand new contract system, which is tam-per-proof and allows stakeholders to access, update, manage and coordinate transaction logs in real time, within a shared peer-to-peer network, which is able to validate and record all operations immutably. Such system ensures a form of mutual control, that eliminates the need for a central control unit. “No one can unilaterally take actions on behalf of the community” (Sun, Yan, Zhang, 2016). These forms of contractual arrangements are called smart contracts and are gaining increased importance due to their versatility in several applications: stipulation, negotiation, award, construction, payment, and final check. Each smart contract registers the agreements between the parties by binding each one in a shared network visible to everyone. The contract allows also the immediate verification of the results, activates automatically the payment, and enables each new step through the whole construction process. Due to its being a shared network, each person/group/institution is controlled by the other participants in the process, which are controlled in return. The resulting mutual control among the participants, which makes the system reliable, is made possible by the way the technology operates: every version of every single operation carried out by the participants within the network will remain there, indelible and immutable.

By adopting smart contracts, the construction process could gain numerous advantages in terms of greater governability, transparency, protection against infractions, simplification of procedures, and reduction of mediators. In this regard, smart contracts signed during different phases of the process would include conditions which relate to a corresponding virtual BIM model of the intervention. Some experimentation has already been conducted: a first attempt to integrate blockchain technology to BIM, for example, was attempted by the French start up “Bimchain.io”. It developed plugins for BIM platforms with common workflow tools to facilitate computational and financial operations, ensure total transparency in budget management and attribute responsibilities to the parties, cutting on external resources such as lawyers and administrators, with immediate savings in terms of costs and time (Koutsogiannis, Berntsen, 2017). «The goal is to create a new collaborative process that fills the gap between 3D digital modeling and formal and legally binding paper processes» to «allow a fully contractual 3D model, full of validated and certificated data» (Cousins, 2018).

The scientific community is currently investigating the application of blockchain in the supply chains sector to guarantee major transparency. In case of complex projects, the product management could be eased if all the data regarding each product were collected, shared, carefully reviewed by the participants of the chain, and permanently stored within a widespread network, subject to indirect control by the participants themselves.

The blockchain would free the supply chain from the need of external companies that provide centralised data storage and management. At the same time, the presence of the registers and their supra-partes condition would make the supply chain more efficient, as it would be possible to foresee the consequences of any decision, even the most isolated, on the overall functioning of the chain (Abevratne, Monfared, 2016).

The adoption of blockchain as a traceability tool

The UN goals for a sustainable development demand from the construction sector a more rational use of raw materials, by means of reintroducing waste and by-products into the production chain, in order create closed-loops cycles for the biological and technical nutrients that make up buildings[2].

Currently the main barrier to recovery and reuse of components and materials that come in use during the various phases of a building's life cycle (production, use, maintenance and disposal) lies in the difficulty to trace and identify such components and materials.

> «There are billions of products being manufactured everyday globally, through complex supply chains that extend to all parts of the world. However, there is very little knowledge of how, when and where these products were originated, manufactured, and used through their life cycle» (Abeyratne, Monfared, 2016).

The European research project BAMB[3] is investigating a new notion of buildings as "banks" that store materials for a finite period of time, as a new way of interpreting the value of materials, which does not fade when a building's useful life is up. Material passports are increasingly gaining attention as tools to track the identity, origin and conditions of use of materials and components that constitute buildings, in order to facilitate the assessment of their residual properties and reuse potential. «Value of these materials can be allocated for reuse, resale and/or recycling. The material passport gives materials an identity and value» (Bokeloh et al., 2017).

Although material passports bring forward a whole new idea to centralise information regarding the physical attributes and life-cycle records of materials (origin, supply, installation, certifications achieved) it is mandatory that such information is reliable and unalterable.

---

[2] UN SDG 12 targets sustainable production and consumption.

[3] The EU H2020 Project involves 15 partners from 7 European countries, and focuses on enabling a systemic shift in the building sector by creating circular solutions. www.bamb2020.eu Material passports describe all the information about a building's components, regarding manufacture, assembly and use phase, in order to help the final user assess the reuse potential of the components and conduct a selective demolition with minimum landfill disposal and maximum recovery of products, materials and MPS.

Blockchain technology would fill the current gap in terms of trustworthy recollection of the history of materials and components, from production to disposal, by providing a distributed and tam-per-proof ledger to record permanently, validate and allow access to information provided by all the actors of the construction process (suppliers, contractors, owners, construction and demolition companies, etc.). The breakthrough of blockchain lies precisely in the substantiation of open-source information, in terms of: confidentiality, ownership rights, non-repudiation, proven origin, traceability of changes, and possibility to integrate ledgers coming from various parties and to keep an overall, supra-partes account.

Lastly, material traceability through the use of blockchain technology would help tackle the major challenge of launching a widespread market for secondary materials and components, so as to fully implement circularity in the construction sector, and «to enable circular loops, to connect demand and supplies, and to handle, store, and manage huge quantity of data that a circular economy requires» (Pomponi, Moncaster, 2017). Current platforms trading in recovered materials operate mainly on a local scale. Widening their scope to an actual recovery market requires the adoption of platforms such as the blockchain technology to record on a large scale data about materials and suppliers that is coordinated, updated, accurate and reliable.

Conclusion

Blockchain technology is poised to radically transform society, even though, apart from cryptocurrencies in the financial field (Bitcoin and others such as Ether, Ripple, Cardano, etc.), future scenarios of application to other fields are still mostly hypothetical, and practical applications embryonic.

The purpose of this contribution is to provide an overview of the possible innovations that could be envisaged for the construction industry as a result of blockchain applied to the construction process, in times of crisis when a more collaborative approach is strongly called for.

The construction sector is known for delays in payments and scarce productivity which have impacts, in terms of time and costs, on the whole implementation of any building. The spread of blockchain and smart contracts as means of traceability would bring about substantial benefits for the construction process, although all the above mentioned applications are still under study and present many obstacles. The adoption of material passports that rely on blockchain technology by the construction industry could help qualify in detail each material of a building and prepare its future release on the market of recovered materials, although such outcomes strongly depend on the definition of common reference standards among industry professionals, first at a European and then at a national level.

The fragmentation of the European agenda on circularity and the resistance of the construction industry to digitalisation currently stand in the way.

Lastly, blockchain technology integrated with Building Information Management would turn the traditional 3D model into the main shared digital container of information regarding a building and its components and devices, from the design to the execution, use and disposal phase.

An advanced BIM model that is reliable and extended to a building's entire life cycle opens new prospects for circularity not only for new buildings, but also for the built patrimony subject to requalification and restoration interventions, which usually require information that is hard to obtain, fragmented and impossible to code quickly. As live BIM models (Arup, 2017) capable of interacting with IoT, sensor data and other devices would enable a vision and control over buildings no longer as built but real-time. They would provide up-to-date data on the condition of structures, MEP and energy consumption, and allow the identification and planning of the necessary maintenance operations, clearly reducing time and costs.

Disrupting the construction process with blockchain implies a challenge: the construction sector is required to bounce forward in terms of informatisation to match other production sectors; enterprises in the sector will have to shift from their centralised private ledgers of information to distributed, transparent and public ones; lastly professionals and operators will have to gradually invest in more powerful equipment, in order to bear the weight of computational operations that blockchain in conjunction to BIM would imply, with substantial costs in both economic and energetic terms.

A paradigm shift in the management of architectural design and construction implementation is inevitable, and being the advantages offered by blockchain largely positive, a renewed and brighter future for the construction industry can be foreseen.

References

Abeyratne, S.A., Monfared, R.P. (2016), Blockchain ready manufacturing supply chain using distributed ledger, *International journal of research in Engineering and Technology*, 05(09), pp.1-10.

Arup (2017), *Blockchain Technology: How the Inventions Behind Bitcoin are Enabling a Network of Trust for the Built Environment*, London.

Barbosa, F. et alii (2017), *Reinventing Construction: A route to higher productivity*, McKinsey Global Institute.

Bokeloh, P., Krayenhoff, A., Menkveld, N., Raes, J., Schotsman, H. (2017), "*Prinsjesdagrapport 2017, De Cirkel is rond: De circulaire toekomst van Nederland*", ABN AMRO, Amsterdam.

Cousins, S. (2018), "*French start-up develops Blockchain solution for BIM*", available at: http://www.bimplus.co.uk/news/french-start-develops-blockchain-solution-bim/.

Koutsogiannis, A., Berntsen, N. (2017), "*Blockchain and construction: the how, why and when*", available on: http://www.bimplus.co.uk/people/blockchain-and-construction-how-why-and-when/.

Pomponi, F., Moncaster, A. (2017), "Circular Economy Research in the Built Environment: A Theoretical Contribution", *Building Information Modelling, Building Performance, Design and Smart Construction*, Springer Verlag.
Sun, J., Yan, J., Zhang, K.Z.K. (2016), "Blockchain-based sharing services: what blockchain technology can contribute to smart citie", *Financ Innov*, 2(1), pp. 26-34.
Swartz, L. (2017), "*Blockchain Dreams: Imagining Techno-Economic Alternatives After Bitcoin*", in Castells, M. (ed), *Another Economy is Possible: Culture and Economy in a Time of Crisis*, paperback, Polity press, Cambridge, pp. 82-105.
Szabo, N. (1995), *Smart Contracts Glossary*, available at: http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_glossary.html.

2.9 NATURAL VENTILATION AND CFD IN THE SPACE OF THE HISTORIC CITY: THE QUALITY OF URBAN DESIGN

*Gaia Turchetti**

Abstract

Attention to the design process must necessarily include the living space at different scales, not only the individual building, but the entire urban space. In this process, which goes from the design phase to the construction, use and disposal phases, the climatic theme must also be included, in order to achieve a condition of balance between situations of comfort and discomfort. Starting from the porosity of the architectural organism, the focus has therefore been on natural ventilation as one of the factors that affect the urban climate, opening a parenthesis on the potential and limitations in the use of CFD, for the diagnosis and prognosis of the urban project in a specific field of investigation: the historic city.

Keywords: Natural ventilation, CFD Computational Fluid Dynamic, Urban microclimate, Historic city

The quality of the urban organism

As Ciribini writes (Bosia, 2013), in a gestaltic vision of everything, "every phase of the building process is a project", the quality of which is to be found in every level and at every scale of the living space, from the single building to the "urban space", the place of urban sociality. A "cyclical" process, therefore, in which it is necessary to include also the climatic problem that, at an urban level, is more relevant to the central fabrics of cities, today the most vulnerable ones as a result of continuous processes of urbanisation.

Starting, therefore, from the porosity of the architectural organism, we wanted to focus the attention on the potentiality and limits of natural ventilation as the engine of the process of "microclimatic mending" at the base of every transformation, analysing with a critical eye possible design effects in relation to a specific field of investigation: the historic city.

Obviously, the choice of this field of investigation has involved not only a critical rereading of already consolidated knowledge on the theme of ventilation in urban areas - which is mainly different from other disciplinary areas - but has also revealed the dual need to calibrate existing instruments and, in

* Gaia Turchetti is a PhD at the Sapienza University of Rome, Italy, gturchetti.arch@yahoo.it.

some cases, to define new ones that, unlike the former, are better suited to describe the considered urban reality, wondering how much the specificity and methods of use of these instruments affect the correspondence to the real data, what is their reliability degree and how they relate to the project timelines.

It is clear that for an exhaustive picture the difficulty is in taking into consideration several competing factors both at a climatic and morphological level - not only in relation to the air masses - which are closely connected and often difficult to calculate, and translate them into useful data at a practical level, i.e. aimed at improving the encountered crisis situations.

Historic city: fluid-dynamic computation in complex space

Investigating the physical phenomena related to urban ventilation is an extremely complex operation. Today, however, the use of microscopic CFD (Computational Fluid Dynamic) models allows us to discretise the real data on increasingly smaller and more precise geometric meshes, based on the subdivision of space into control volumes (cells) and on the application of fluid motion equations for each cell. The term "micro" precisely depends on the construction of these basic elements, the size of which is such as to consider, within each cell, the constant value of the examined quantity (De Santoli, 2011). Their structuring into more or less complex meshes (structured, unstructured or hybrid/adaptive) allows us to shape the model according to different spatial definitions.

Nevertheless, these tools, although they undoubtedly help to speed up and economise the calculation processes of the microclimatic aspects related to ventilation - offering us, if integrated in complex models, a holistic reading of the environmental problem -, on the other hand present some pitfalls.

The accuracy of the model, in fact, must be calibrated according to the results that are to be obtained taking into account that there is a directly proportional relationship between the size of the cell and the complexity of the calculation of the model, poised between the risk of simplifying or complicating too much the calculation, where you want to define grids as dense as more accurately responding to the real data. The operation is, therefore, delicate and involves, first of all, the identification of the answers that are sought through this process, keeping in mind the simulation objectives in the data setting, and aware that if the question is not well formulated, the answer will not provide useful terms to elaborate reasoning (Calcerano, 2014).

The whole procedure is a "process in a process" that, in order to reach the desired quality, must be guided by a critical evaluation of the results that the tool - as such - offers, results that must necessarily be compared and validated in the various steps and scales of the project.

The experience of the operator in evaluating the spatial definition of the model, the choice of an appropriate accuracy level, and not least the collection and use of input data to be entered, is therefore fundamental.

However, by analysing in detail all sides of the city, we could easily ask ourselves how and to what extent these limitations derived from instrumental and functional needs affect the correspondence of the model to the real data and what is the maximum degree of simplification that can be achieved without compromising the reliability of the answer, a question that acquires a greater emphasis if we approach the analysis of historical fabrics, which draw their strength from the complexity of their development. Starting, therefore, from a review of the main scientific results on the use of CFD models in the urban environment, the research briefly presented here, wanted to critically reread them in relation to the needs of investigation of particular urban areas, those of the historic city, assessing their potential and limitations, aware that a CFD analysis cannot be detached from a morphometric investigation or even less from a direct data examination, by virtue of a necessary knowledge of the fabric and the trend of flows, fundamental to implement those simplifications necessary to the computational process. The first step was to select the most appropriate calculation model for the survey needs, capable of providing information not only on the individual building but on a larger urban scale. The choice fell on the Envi-Met[1] software which, according to a survey conducted by Y. Toparlar, B. Bloken, B.Maiheu, G.J.F. van Heijst (2017), is one of the most used software in the investigation of the urban microclimate, because - although in the evaluation of some factors, such as ventilation, the accuracy of the model (unlike dedicated CFD software) is in the order of one metre - allows an organic reading of all the competing factors, necessary to intervene in a space, the urban one, where it is precisely the confluence of flows of different nature (anemometric but also radiative, anthropogenic, etc.) to define the comfort. On the side of scientific research on the specific theme, it is also revealed in parallel that there are few, albeit interesting, international studies that pose these questions, and that investigate the different responses that the computational model provides in relation to different types of building density. A study conducted on the city of Bilbao by Juan A. Acero and Karmele Herranz-Pascual (2015), using the Envi-Met program as the software of reference, has shown that there are differences between simulated data and data measured in situ, recording values of wind speed underestimated in the fabrics of the city’s historic centre and overestimated in the expansion areas of the nineteenth and twentieth centuries[2].

---

1 Created in 1993 by Prof. Michael Bruse, Envimet is an environmental and microclimatic simulation software that is based on a three-dimensional model and is able to reproduce the microclimatic and physical behaviour of urban areas.

2 «In this study, modelling techniques have been compared with micrometeorological measurements in Bilbao carried out during three days covering typical summertime weather conditions (overcast, partly covered and clear sky days)» (Acero, Herranz-Pascual, 2015).

The comparison carried out on the city of Bilbao has shown that in the calculation of the wind speed and the average radiant temperature there may be significant differences that will affect the reliability of the simulated model and the definition of the various parameters and indices. Specifically, the researchers indicate three main problems, the first related to the difficulty of forcing the simulation with data such as wind speed and radiation, which take into account the daily variations of the phenomenon, the second concerns the inaccuracies in the calculation of radiant flows, relevant for the estimates of the average radiant temperature, the third refers to the spatial resolution of the model which may in some cases be a limitation for a detailed definition of the morphological aspect of urban elements and therefore their influence in climatic variables. The study then assessed what the recorded difference between real and simulated measurements could be in the specific case of the city of Bilbao, warning the future user of the recorded deviations. The findings of the three previous points are also confirmed in the studies of B. Blocken (Blocken et al. 2012), in which it is revealed the need to evaluate ventilation on the basis of different directions and not only with the use of a single parameter. Similar studies were also conducted with comparable results on different urban realities, including the area of Nanaimo[3] in Canada and Changtown in South Korea (Park, Tuller, Jo 2014), as also reported in Salata, Golasi, de Lieto Vollaro, de Lieto Vollaro (2016).

Starting, therefore, from the above mentioned researches, where we can see a difficulty in calculating the software related both to the spatial conformation of the model and to a definition of flow direction and intensity, we have chosen to analyse these specific problems in relation to complex fabrics of the Italian city, taking as a case study the historic city of Rome.

The first and fundamental phase of this survey involved the comparison between the results of the first simulations[4] and the data recorded in situ thanks to a series of measurement campaigns carried out in selected areas of the capital during the spring-summer periods of 2016[5].

From the numerous simulation tests carried out on five[6] of the selected areas it was revealed - in line with the other investigations mentioned - an underestimation of the intensity parameter of the flow, which varies between 0.1 and 1.3 m/s, with an average value of 0.8 m/s.

---

3 Taking into consideration the study carried out on the Canadian settlement of Nanaimo, an average value of -0.52 m/s was estimated as the difference between the actual data and the data simulated by the Envimet software.

4 Also, for the research presented here was used the software Envimet version Pro V4.2.

5 The measurement campaigns were carried out under the supervision of the CNR-IDASC “Orso Mario Corbino” Institute of Acoustics and Sensors, where a period of functional research training was carried out.

6 The selected areas are: the site of Piazza Borghese, Rione Campo Marzio; the site of Piazza dell’Immacolata, Quartiere San Lorenzo; the sites of Via Boncompagni and Via Piave, Rione Ludovisi; the site of Piazza delle Cinque Scole, Rione Angelico/Regola.

Analysing where and with what possible logic the peaks of lower and higher intensity in the model are recorded and comparing these values with the real ones, it can be noticed that it is not only the dimensional ratio of the building that is affected, but also, and in some cases - primarily - the direction of the flow set in the model and the fabric orientation with respect to the point of entry of the flow itself, which is more evident - although not constantly and with many irregularities - for fabrics with a more regular mesh (referred to as type B fabrics, i.e. areas of urban renewal/expansion of the nineteenth and twentieth centuries more or less compact). In type A fabrics, on the other hand, (i.e. areas of medieval origin or of Renaissance expansion and modern pre-unification) it is more difficult to define a general criterion justifying this discrepancy in the intensity value. This depends mainly on a combination of factors - not least the thermal factor[7] - which vary from fabric to fabric, and the potential of the software to simulate a flow in a given urban fabric and with relatively low intensities. However, it appears as a general data an underestimation of the intensity value in both type A and type B fabrics, given that this does not conflict with what was reported in the study on the city of Bilbao, mentioned earlier, because, if we stop to analyse the nineteenth and twentieth centuries expansion fabric of the Spanish city, in relation to the points selected by scholars, we realise that it corresponds more to an image of urban suburbs and not to the image of the consolidated districts of “our” historic city. Therefore, the underestimation of the intensity data for the historic city is confirmed, while in order to confirm or not its overestimation we should extend the measurements to peripheral areas of the Capital, where the dimensional relationships and especially the continuity of the built fronts present other characteristics compared to the fabrics analysed so far. Including the limits and potential of this computational tool, and testing it in relation to the specific urban fabric of the Capital, we have come to the definition of a calibration factor that - by implementing the above mentioned studies and working on the entire process of the model construction - allows to reduce as much as possible the discrepancy between real data and simulated data recorded for historic fabrics, obtaining in many cases an average improvement of the response in terms of 20-30%. Although we are aware that the calibration factor in its current state of definition needs further refinement, which is possible with a subsequent work on the algorithms underlying the calculation processes, we are nevertheless certain of the importance of its definition. A difference in the estimation of the ventilation factor - and not only -, which can reach, as estimated, very high values, can compromise a correct reading and understanding of the possible benefits of the anemometric factor both in the condition prior to the project and in the definition of intervention

7 It should be noted that, considering how the movement of flows is influenced by the thermal balance of the urban reservoir, some parameters relating to the prevailing materials have been calibrated, to render them more in line with the real data, without this, however, resulting in a sufficient variation of the parameter sought.

scenarios (always due to the fact that even a wind in a gust or breeze regime can determine interesting microclimatic improvements of the analysed reservoir) as well as altering the comfort indices calculation (Santamouris, 2007).

Conclusions

This brief discussion is not intended to and cannot provide but a brief overview of part of the conducted research, with the aim of activating, even in the Italian landscape, an interesting debate on the use of computational simulators in the complex field of urban fabric. The aim is to underline how an indirect analysis such as the CFD cannot be released from a direct evaluation of the site and the real data. Just the necessary knowledge of the fabric and of the changes in the trend of the flows deriving from its variations, is a fundamental step of that process of simplification, necessary to optimise the computational analysis, which is and remains a useful tool for the comparison between several scenarios of intervention, in a systematised process of the "in progress" project production knowledge.

Acknowledgements
This article is taken from the research work conducted by Gaia Turchetti, PhD, entitled "Natural ventilation in the historic city. Methodologies and tools for the speditive evaluation of the ventilative factor for the improvement of the comfort conditions of the open space", supervisor Prof. L. Cupelloni, outside consultant and associate CNR-IDASC Prof. I. Di Menno Di Bucchianico, as part of her PhD in Planning, Design and Technology of Architecture -curriculum Environmental technology design (XXIX cycle), Sapienza University of Rome, coordinator Prof. F. Tucci.

References

Acero, J.A., Herranz-Pascual, K. (2015), "A comparison of thermal comfort conditions in four urban spaces by means of measurements and modelling techniques", *Build.and Envir.* vol. 93, pp. 245-257.

Blocken, B., Janssen, W.D. et alii (2012), "CFD simulation for pedestrian wind comfort and wind safety in urban areas: General decision framework and case study for the Einhoven University Campus", *Envir. Mod. and Software*, vol. 30, pp. 15-34.

Bosia, D. (2013), *L'opera di Giuseppe Ciribi*ni, Franco Angeli, Milano.

Calcerano, F. (2014), *Technological design for bioclimatic architecture. Strategies and natural ventilation systems for passive cooling in environmental and energy retrofit in the Mediterranean climate*, PhD Tesis PDTA. Sapienza Università di Roma.

De Santoli, L. (2011), *La ventilazione naturale: il moto naturale dell'aria per il controllo delle condizioni ambientali*, Flaccovio, Palermo.

Park, S., Tuller, S.E. et alii (2014), "Application of Universal Thermal Climate Index (UTCI) for microclimatic analysis in urban thermal environments", *Lands.and Urban Plan*., vol. 125, pp. 146-155.

Salata, F., Golasi, I. et alii (2016), “Urban microclimate and outdoor thermal comfort. A proper procedure to fit ENVI-met simulation outputs to exerimental data”, *Sust.Cities and Society*, vol. 26, pp. 318-343.
Santamouris, M. (2007), “Heat Island Research in Europe: The State of the Art”. *Advances in Building Energy Res.*, vol. 1 (1), pp. 123-150.
Toparlar, Y., Bloken, B. et alii (2017), “A review on the CFD analysis of urban microclimate”, *Renew.and Sust. Energy Rev.*, vol. 80, pp. 1613-1640.
Tucci, F. (2012), *Atlante dei Sistemi Tecnologici per l’Architettura Bioclimatica. Ventilazione naturale negli edifici / Atlas of Technological Systems for Bioclimatic Architecture. Natural Building Ventilation*, Alinea Editrice, Firenze.

2.10 DECISION-MAKING IN DESIGN OF CIRCULAR BUILDINGS. INFORMATION ON MATERIALS IN BIM TOOLS

Paola Altamura[*]

Abstract

The growing EU push for the implementation of the circular approach in the building sector induces to rethink the way in which data on materials are collected, shared and used, making them usable in tools that facilitate design and decision-making for resource efficiency. In fact, current support tools do not allow easy access to data on materials in all phases of the life cycle / construction process. This contribution focuses on the importance of integrating datasets on the materials of existing buildings ("Material Passports", BIM models obtained from surveying with drones) and user supplied information ("harvest map", boosted with BIM-GIS interoperability) in new methodologies, integrated with LCA and BIM compliant, able to support the design of "circular buildings".

Keywords: Building materials, Circular buildings, Material Passports, Harvest map, BIM-GIS interoperability

Introduction

The present contribution reflects on the complexities introduced in the design process by the need of a closed-loop use of materials in the transformation of the built environment. This area of interest, explored from different points of view in theoretical and experimental research activities carried out on the Roman context[1], is specifically put in relation, here, to the central role of the availability of information on materials in the support tools for design and decision-making. The background is that of the innovation of ICT tools to support the improvement of the quality of construction. The vision is that of the development of circular buildings[2] through the use of a network model, in which all waste materials available at a local scale are potential resources for the project.

---

[*] Paola Altamura is PhD and Lecturer at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, paola.altamura@uniroma1.it.

[1] Cf. Baiani, S., Altamura, P. (2018), "Superuse e upcycling dei materiali di scarto in architettura: progetto e sperimentazione", *Techne*, n. 16, Firenze University Press, Firenze.

[2] «Dynamic and Circular Building is shaping the world of tomorrow. The world in which building demolition and construction waste is Design Mistake» Durmisevic, E. (2015), *Dynamic Architecture*, introduction chapter, University of Twente.

Context: implementing circular economy in the built environment

The growing EU push for the implementation of circular economy to the built environment (EU Circular Economy Action Plan[3] and Circular Economy Package, 2018) aims to increase the use of reclaimed, recycled, reused materials in one of the sectors with the highest consumption of raw materials[4].

At the national level, the main driver is the mandatory nature of GPP (Green Public Procurement) for interventions on public buildings, pursuant to the New Procurement Code (Legislative Decree 50/2016) which requires the adoption of CAM (Minimum Environmental Criteria) (DM 11/10/2017), requiring a minimum recycled content of 15% on the total weight of the materials used.

A very limited target, which does not recognize the higher value obtainable from the valorization of materials with superuse (reuse) and upcycling (recycling) strategies, representing however a turning point for Italy.

The EU research guidelines (Work Program 2018-20 of H2020) focus on circular economy practices in urban regeneration processes, exploitation of by-products, promotion of sustainable processes of production, recovery, reuse and recycling of construction materials. Thus, a specific field of investigation for Architecture Technology opens up in relation to the impacts of this approach on the quality of the project, but above all on the design and building process, stressing the need for adequate information and decision support tools. In this field, the specific research objectives are: to support decision-making processes on materials with methods and tools aimed at forecasting and comparing the outcomes of design choices; to enable the measurement of the resource productivity level of buildings for an effective decision-making; to allow collaborative interaction between the different actors in the building supply chain aiming at a real implementation of the circular approach.

Integrating life cycle and building process, redefining the decision process

The building process in the holistic vision cradle to cradle is intended as a global process of transformation, which must respond to the requirements of quality and eco-compatibility. In this sense, in respecting the urgency to reduce the consumption of raw materials, the level of energy embodied in building materials and the volume of waste produced, the design process is enriched by the introduction of superuse, remanufacturing and upcycling practices of building materials and components.

---

3 COM/2015/0614 final, *Closing the loop - An EU action plan for the Circular Economy*.

4 EU consumed 1,200-1,800 million tonnes/year of construction materials for new buildings and refurbishment between 2003 and 2011 (Ecorys (2014), Resource efficiency in the building sector, Final Report for DG Environment). Decreasing until 2013, the figure began to grow again with the gradual recovery of the building sector.

Consistently, the decision-making for the selection and procurement of materials, in the different phases of the building process, assumes specific characteristics: anticipation of the choices on materials at the early stages of the design process; introduction of a territorial survey for the research of materials available on a local scale; insertion of spatial and temporal dimensions in the procurement; iteration of the decision steps and the relative need for information; need for a structured interaction between the actors of the supply chain in all phases. In the relationship between the life cycle - of the building structure and of the materials that compose it - and the design process, the aim of implementing a closed-loop use of construction materials gives back a central role to the phase of materials selection and to decision-making processes affecting their efficient use: on the one hand, by limiting their use (reduction), on the other, avoiding their transformation into waste (prevention, reuse, recycling).

This change leads us to rethink the way in which the data on materials are collected, shared and used, making them usable in tools that facilitate design choices and decision-making for resource efficiency. In order to obtain the greatest environmental, social and economic value possible from materials, it is necessary to allow an effective and organic management of the considerable amount of information needed to carry out the design choices.

State of the art: support tools for the selection of building materials

The identification of sustainable building products and reclaimed materials on a local scale is essential to reduce raw materials consumption and the impacts due to production and transportation. Today, this activity is supported by:

- tools for the environmental certification at the product level (EPD, Ecolabel, Remade in Italy, Plastica Seconda Vita) and at the production chain level (BES 6001, FSC, PEFC, concrete Responsible Sourcing Scheme);
- guides for the selection of new and reclaimed materials based on a synthetic evaluation of environmental impacts (for example the Green Guide to Specification supporting BREEAM protocol) or a more comprehensive one (SIMA Pro, Athena Impact Estimator for Buildings, CES (Cambridge Engineering Selector), IMPACT (Integrated Material Profile and Costing Tool));
- databases of ecological/recycled materials (Matrec, Material Connexion).

Yet there are many choices to be made in relation to the implementation and assembly of materials and components for the purpose of their future disassembleability and recovery. Therefore, given the complexity of the decision-making process, tools providing transparent information on products' environmental characteristics represent a limited support for designers. Instead, simple and targeted methods and tools, BIM compliant, are needed to forecast and compare the outcomes of different design choices on materials in terms of resource productivity, enabling an informed and effective decision-making.

However, despite the rapid development of research on BIM tools, today only few tools focus on the end-of-life phase (Shawky et al. 2017), such as mathematical models to assess deconstruction potential, based on variables such as the type of material, the connections between the various elements, the volume of materials and the spatial position of the element (Akinade, 2017).

Therefore, the limits of the aforementioned tools are represented by a partial approach to eco-compatibility, which does not situate the products within the life cycle of the building; a reduced interoperability with design tools; the impossibility of comparing different design solutions. Instead, easy access to non-spatial data related to materials in all phases of the building life cycle and in all building process steps (basic information that can be acquired during production, supply and installation procedures, maintenance, technical options at the end of useful life) represents the first indispensable element in order to allow the actors involved in the management of materials to enhance their potential through closed-loop strategies.

Innovation in methods of collecting information on building materials

A crucial point in the development of integrated support tools for the circular approach is represented by the need to have specifically generated datasets on the materials of existing buildings, integrated with user-supplied information on waste materials available at the local scale. An important opportunity is represented, in this sense, by the possibility of collecting data on existing buildings on a large scale (size, typology, construction techniques, constituent materials) and making them easily accessible. This is the case of Metior 4SMB[5], a web platform based on BIM models of existing buildings, created by transferring Big Data collected through drone building surveys. The platform is conceived to allow the client to evaluate alternative scenarios of transformation/demolition, based on the potential of reusing/recycling materials, as well as to support the digitalization of waste management procedures.

Other types of tools allow collecting and sharing information on the stock of waste products suitable for use in construction (waste, surpluses, defective products, demolition materials) deriving from the industry, but not necessarily from construction sites. Among these tools allowing the bottom up collection of datasets, harvest maps (and the relative open source GIS platform), collecting waste materials sources available in the vicinity of building sites, are aimed at the project definition and populated by different stakeholders. However, the databases thus generated should be made interoperable with other tools to facilitate the design and decision-making process.

5 Developed by Geoweb SpA with the University Roma Tre and the support of ANPAR (Italian Association of Producers of Recycled Aggregates).

BIM-GIS interoperability: potentialities for the circular approach

In this sense, if GIS represents a useful tool to allow the localization, selection and procurement of reclaimed materials in the nearness of the building site, the interoperability with BIM systems can help to make the research phase of reusable materials, preliminary to the project itself for "circular buildings", more rapid and therefore practicable. This is due to an effective exchange of information, coming from various static and dynamic "data source", between different applications. On these potentialities, some reflections have been initiated, for example, on the possibility of creating a DIM (District Information Model) integrating BIM and GIS 3D modeling, in order to collect data on energy consumption and make them available in real time[6]. Likewise, as inserting the construction site in the context allows a greater and more immediate understanding of the interactions between building and environment (natural and built), the BIM-GIS interoperability offers the possibility of directly obtaining information on the material resources available in the context. Thus, in relation to "circular buildings", BIM systems offer the opportunity to make the relevant information available when it is more necessary (conservation in time of data on materials). So, as the model represents a picture of the existing materials and their circular potentials, the BIM-GIS combination becomes a powerful tool for interpreting buildings - especially if conceived for disassembly - as "material banks", in an urban mining perspective.

New scenarios: Materials Passports, BIM Resource Productivity tool

In this scenario, lastly, research focuses on the importance of including information on materials (collected with tools such as those mentioned above) in new methodologies, at the building level, integrated with LCA (Lowres, Hobbs, 2017) and compatible with BIM, able to support the decision-making processes on materials and to allow to measure the level of resource efficiency of building products. A significant example is represented by the H2020 Project BAMB (Building as Material Banks, 2015-19)[7], working precisely on the development of Materials Passports, electronic data sheet, which can be incorporated into BIM/LCA applications, on single materials, illustrating their main features: composition, conservation status, function, past uses, maintenance, disassembly guidelines, recycling options, reuse potential.

---

[6] See the FP7 Project DIMMER (District Information Modelling and Management for Energy Reduction), http://www.drawingtothefuture.polito.it/projects/dimmer/ (accessed 18/07/2018).

[7] Involving 16 partners in 8 EU Countries: EPEA Nederland, BRE, IBM, University of Twente, Technical University of Munich, Ronneby Kommun, Vito, Zuyd Hogeschool, Vrije Universiteit Brussel, Sarajevo Green Design Foundation, University of Minho, Sundahus, Aurubis, BAM Construct UK and Drees & Sommer, https://www.bamb2020.eu/ (accessed 18/07/2018).

The Materials Passports tool, which can be used by all the stakeholders involved in the building process, aims exactly at documenting and tracing the circular potential of materials, providing information not limited to their composition (Luscuere, 2017). The Material Passports also represent a market-place mechanism to encourage the closed-loop use of materials: «this is done by adding a new value dimension to materials quality [...] based on the suitability of materials for recovery and reuse as resources in other products and processes» (Hansen et al., 2012).

In particular, the BAMB Project tries to include these passports in a BIM tool using the LCA methodology to assess the level of resource efficiency and its potential increase. In fact, firstly the Project has delineated a Design Protocol for Dynamic and Circular Buildings, identifying design principles and indicators, translated into projects and pilot constructions. In parallel, it has developed a Building Level Integrated Decision-Making Model, a methodology that allows to evaluate buildings from the point of view of resource productivity on the basis of the materials adopted and of the design choices made to maximize their reusability. A subset of the model will be translated into a prototype of a BIM compliant tool on resource productivity, in order to verify how the evaluation and decision model can help users make design choices optimizing the reversibility of buildings through the different phases of their life cycle. The BIM Resource Productivity Prototype will allow to access data from BIM/CAD models and combine them with BAMB generated datasets and other external/user supplied data.

Thus, a resource productivity data layer, displayed in 3D form, will be added to the building model, allowing to assess the potential for reusability of the building and its components at the changing of design choices.

Research perspectives and system implications

With reference to the framework outlined above, different perspectives for research in the field of Architectural Technology open up: the development of methods for assessing resource productivity at the building level; the construction of specific materials datasets at the local level and the validation of tools that allow their use in the project management in all phases of the building life cycle; the verification of the feasibility of circular buildings, with respect to national construction methods and regulations; the assessment of the standardization potential of construction methods based on superuse and upcycling, beyond the experimental logic.

In conclusion, among the system implications deriving from the implementation of the closed-loop approach in the terms described above, first of all there is the need to adapt the building supply chain, with integration of interaction methods and procedures supporting circular processes.

In this sense, the *Centro Materia Rinnovabile* is developing a project on a Collective Construction System[8], aiming at activating regulated and predictable agreements and economic transactions at the national level to put circularity into practice. Secondly, but of primary importance for the disciplinary scientific field, there is a clear need for specific education at the II and III academic level and in continuous training for professionals (Project and Tender Manager). In particular, the scientific in-depth analysis of these themes, starting from the doctoral training path, opens up possibilities for research and insertion in the production context[9], demonstrating the significance of the topic and the urgency of the organization of a structured research area, with insights and research applied to the local scale, but with network collaboration.

References

Akinade, O. (2017), "BIM-Based deconstruction tool. Towards essential functionalities", *International Journal of Sustainable Built Environment,* vol. 6, issue 1, pp. 260-271, available at: https://www.sciencedirect.com/science/article/pii/S2212609016301030 (accessed 18 July 2018).

Hansen, K., Braungart, M., Mulhall, D. (2012), "Resource Repletion, Role of Buildings. Introducing nutrient certificates aka materials passports as a counterpart to emissions trading schemes", in Meyers, R. A. (eds), *Encyclopedia of Sustainability Science and Technology*, Springer-Verlag, New York, NY.

Lowres, F., Hobbs, G. (2017), "Challenging the current approach to end of life of buildings using a life cycle assessment (LCA) approach", in *Advances in Recycling and Management of Construction and Demolition Waste*, Proceedings of the HISER International Conference, Delft, pp. 247-250, available at: http:/www.hiserproject.eu/images/mat_na_strone/Proceedings-_HISER_Conference.pdf (accessed 18 July 2018).

Luscuere, L.M. (2017), "Materials Passports: Optimising value recovery from materials", Proceedings of the Institution of Civil Engineers - Waste and Resource Management, vol. 170, issue 1, pp. 25-28, available at: http://dx.doi.org/10.1680/jwarm.16.00016 (accessed 18 July 2018).

Shawky, A., Durmisevic, E., Marzouk, M. (2017), "BIM-based Integrated Project management for Reversible buildings", in *Vital Cities and Reversible Buildings,* Proceedings of the 3rd Green Design Conference, Mostar, pp. 36-41.

8 *Centro Materia Rinnovabile*, Project "Construction and infrastructure sector towards circular economy", https://www.centromateriarinnovabile.it/edilizia-e-infrastrutture-verso-economia-circolare/ (accessed 18 July 2018).

9 See the business project developed by the author with the architects G. Chiummiento and M. Cutini, Atlante Inerti Project, http://atlanteinertiproject.yolasite.com/ (accessed 18 July 2018).

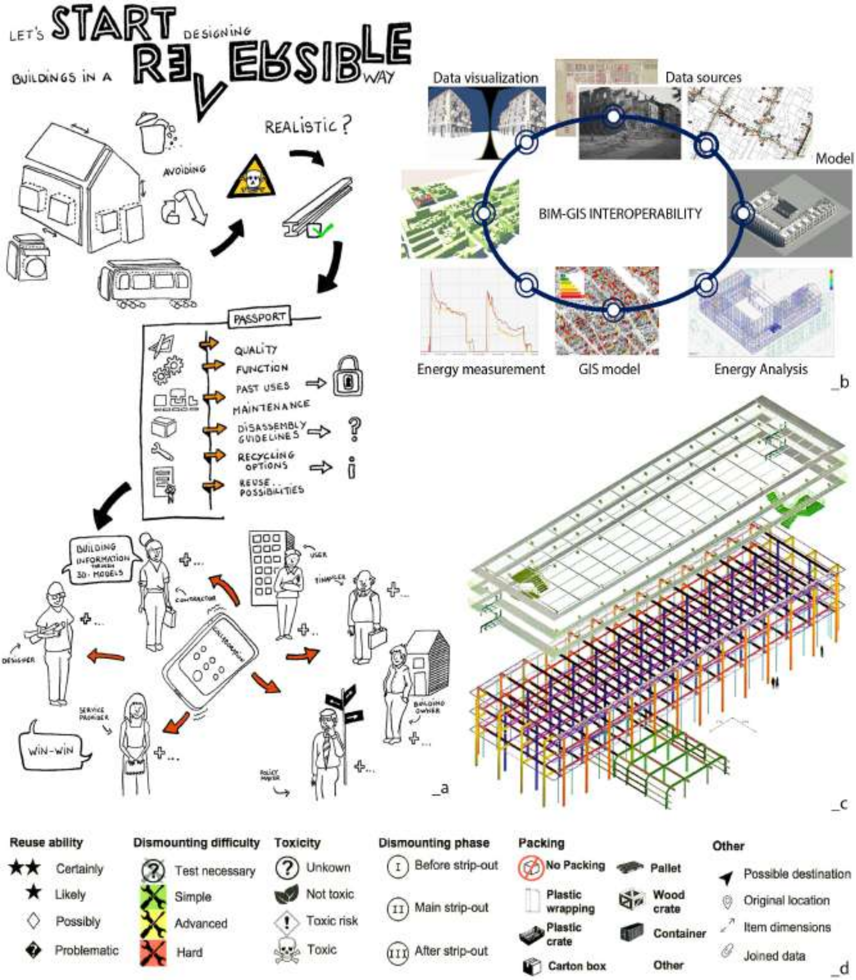


*Fig. 1 - In the construction process based on the circular use of materials, a shared use of information on materials is necessary (a) a high potential is inherent in BIM tools especially through interoperability with GIS mappings (b) use of BIM for existing buildings (c) makes it possible to identify and catalog the building components that can be recovered for reuse (d). Sources: image **a**, BAMB EU Project, video "Building As Material Banks: a vision", https://www.youtube.com/watch?v=3EKddd_dAt0; image **b**, DIMMER EU Project, Polito; images **c**, **d**, Ghyoot, M., Devlieger, L., Billet, L. and Warnier, A. (ROTOR) (2018), Déconstruction et Réemploi. Comment faire circuler les éléments de construction, PPUR, Losanna.*

2.11 TRANSDISCIPLINARY AND SHARED METHODOLOGIES FOR THE DESIGN: INPUT DATA IDENTIFICATION

Lucia Martincigh, Gabriele Bellingeri*, Chiara Tonelli*, Lucia Fontana*, Marina Di Guida**

Abstract

Today architecture design must develop complex and integrated solutions to solve urban and building issues. It is therefore important to adopt conducive methodologies and technologies to enhance material and immaterial infrastructures, by computerising processes and considering users' needs regarding the performance of buildings in use. The aim is to improve the use of resources and people's life quality. The research uses a transdisciplinary approach, already tested in two university case studies, that is based on the contextual analysis and evaluation of objective-quantitative and subjective-qualitative aspects, in order to understand the correspondence of the satisfaction and importance levels expressed by users with the detected situation and the priority actions to be implemented.

Keywords: Transdisciplinary approach, Objective-subjective analysis, Assessment protocol, University sustainability, Assessment in use

Introduction

The global challenges, set by the current economic, environmental and socio-anthropological crisis and by the increasing growth of the digital world, ask architecture design to seek and acquire a renovated cultural identity. New lines of thought are undermining both classic linear and modern circular systems and are pushing society towards a network system, characterised by complex, interactive and interoperable structures (Codeluppi, 2012).

* Lucia Martincigh is a Senior Professor at the Department of Architecture, Roma Tre University, Italy, lucia.martincigh@uniroma3.it.

* Gabriele Bellingeri is an Associate Professor at the Department of Architecture, Roma Tre University, Italy, gabriele.bellingeri@uniroma3.it.

* Chiara Tonelli is an Associate Professor at the Department of Architecture, Roma Tre University, Italy, chiara.tonelli@uniroma3.it.

* Lucia Fontana is an Associate Professor at the Department of Architecture, Roma Tre University, Italy, lucia.fontana@uniroma3.it.

* Marina Di Guida is Research Fellow at the Department of Architecture, Roma Tre University, Italy, marina.diguida@uniroma3.it.

The use and total integration of digital technologies in the design and production processes of physical assets have introduced the fourth industrial revolution (Schwab, 2016); the concept of ICT (Information and Communication Technologies) has replaced the IT one that characterised the third industrial revolution; precisely, the introduction of the communication has made technologies become more pervasive and responsive, not only in the sense of "respondents" but also of "reactive" and "aware". The rationale is systemic and the reference paradigm is cyber-physical: information systems interact dynamically with the surrounding real world, according to a human centred approach, in which the human component is integrated into the process and occupies sociotechnical spaces and the cyber component works with it through systems of context aware sensors.

The architecture design, and in particular its technological-environmental component, mediating between several operational scales and working with a holistic and heuristic vision, can succeed in structuring materially both the relationship between science and real life and the transition from living the perceived physical space to living the network hyperspace. The goal is to improve people's quality of life, by optimising the use of resources and reducing consumptions and impacts, also as a result of the responsibility to be taken towards future generations. This can only happen, on the one hand, by working on processes innovation and computerisation through intelligent and active tools (devices, systems and materials), on the other hand, by placing the user, with his needs, at the centre of all the phases of the process (conception, construction, control and validation), with the dual purpose of proposing appropriate solutions and avoiding the onset of behaviours dangerous for the environment, the buildings, themselves. Also, at regulatory level, the last European directive on energy efficiency 2018/844/EU has introduced the "intelligence indicator", a tool for measuring the buildings ability to improve their interaction with the network, by adapting consumption to users' real needs.

The research approach

The research, aiming at identifying intervention guidelines, focuses on the deepening of a methodology for the assessment of some aspects of environmental sustainability and the related perceptions as experienced by users. The dual aspect of the research, objective and subjective, led to the adoption of a transdisciplinary method: the working group is, in fact, made up of researchers belonging to Architectural Technology and Building Physics and takes advantage of the Environmental Psychologists' contribution. The chosen field of application and experimentation concerns university buildings. By now, it is a consolidated concept that education and training play a fundamental role in the transition process towards sustainability (UNESCO, 2014).

University, in particular, has significant responsibilities: on the one hand, it must incorporate the concept of sustainable development, both in teaching and research activities and in being an example of sustainability, representing a "showcase" and a "living lab" (Vezzoli, Penin, 2006); on the other hand, it can spread the concept of sustainability into the society through the experience of people who, living in its facilities daily, will probably develop some awareness, leading them to make similar choices outside university too.

The research is organized according to two development lines that, starting from the same assumptions, aim at defining possible actions, that are shared with the occupants and are apt to make the spaces more sustainable.

The first research line concerns the tweaking and testing of a protocol, that was elaborated in a PhD thesis in the Department of Architecture of Roma Tre University, for assessing University sustainability. The second line deals with the application of a method (already elaborated in European and national research works one of the authors was responsible of), that is based on the contextual analysis and assessment of objective/quantitative (techniques of instrumental survey) and subjective/qualitative (techniques for detecting users' perception and behaviour) aspects.The research, as a whole, refers to the Post-Occupancy Evaluation (POE) procedures, which, on the one hand, assess building quality by measuring performance, on the other hand, aim at increasing users' and managers' awareness and participation by their direct involvement (Prieser, 1995). In this sense, these procedures are essential for the maintenance of all three components of sustainability in a building (Meir et al., 2009).

The assessment protocol

The sustainability assessment protocol was built using an inductive method.

Through the analysis of criteria within existing protocols[1] and through a comparison with parameters drawn from literature and legislation, performance indicators were defined, to be used as a base for evaluating sustainability in a university complex. Six macro-topics (called themes: buildings and open space; users; use of resources and recycling; mobility and transport; management and organization; teaching and research) are organised, according to a hierarchical tree structure, in 24 criteria that include 73 indicators. Themes, criteria and indicators are all defined, but can be used according to the level of detail to be achieved. The protocol is elaborated in two versions:

- a brief one, made only of themes and criteria, for a broad initial analysis, which aims to highlight strengths and weaknesses and to obtain indications for further targeted enquiries;

[1] Buildings sustainability certification protocols (Itaca, Leed, Breeam, Dngb, Hqe, CasaClima Nature) and main systems for assessing university sustainability (Ui Green Metric World University Ranking, Stars, Aishe, Iscn-Gulf) were considered.

- an extended one, including the indicators evaluating performances, for an in-depth analysis, which has the aim of elaborating a structured judgment, that is based on more data of various kind, collected by using diversified methodologies.

The indicators are of status and transformation, for evaluating the current situation and providing, at the same time, indications to improve it. Individual forms have been drawn up for all the indicators; they include the specification of calculation methods, quantitative or qualitative threshold values, the weight of the indicators within the protocol and their score, attainable depending on the achievement of a specific level of performance.

The scores of the individual indicators make it possible to define a final overall score concerning the university sustainability level in relation to five different scenarios; this overall score can be improved by taking the actions planned to get the most out of each indicator.

So far, a first pilot application of the short protocol has been carried out at the Department of Architecture of Roma Tre University, housing teaching and administration, that is located in the former slaughterhouse of Rome.

Later on, as regards the extended protocol, only one of the sustainability aspects analysed in the protocol has been faced, carrying out an enquiry on comfort; the enquiry, that is hereafter described, represents a test field of the method for the other aspects that will be faced in the following research phases.

The objective-subjective analysis

The field enquiry, that explores the aspects of indoor and outdoor environmental comfort further, deals with both the measurement of physical quantities and the detection of the related users' perceptions and behaviours.

The methodology used in this phase derived from the one developed and tested in the European research "ASI - Assess implementations in the framework of the Cities of Tomorrow", whose objective was to analyse and evaluate the effects that implemented actions have on citizens' quality of life and their influence on the promotion of people's behavioural changes in favour of more sustainable mobility systems (Martincigh, 2009).

The working group adapted this methodology to make it consistent with the specific research topic, then tested and fine-tuned it further.

From the quantitative viewpoint, a plan for gathering objective data, using probes of the Department Laboratory of Building Physics and Technology (LIFT&T), was structured; from the qualitative viewpoint, a questionnaire for detecting users' perceptions was developed, taking as reference the adaptive comfort theories (Humphreys, Nicol, 1998) and the questionnaires on the IAQ - indoor air quality (Zagreus et al., 2004).

This methodology was applied in two case studies, both premises of the Department of Architecture of Roma Tre University, that are different in terms of construction, building typology, architectural characteristics and building systems:

- the historical premises, where now the teachers' studios are located and postgraduate teaching takes place: a historic building of the seventeenth century, in the central district of Monti;
- the new premises, where classrooms, offices and facilities for the students are located: a complex of nineteenth century industrial sheds of the former Rome slaughterhouse in Testaccio, under refurbishment since 1999.

In the first case study, the survey was carried out in May 2013, in offices and classrooms; the outcomes of this experience were presented at national and international conferences and published as conference proceedings, chapters in scientific essays and articles in specialised journals (Martincigh, 2016).

In the second case study, the campaign is still ongoing; the survey was carried out in April and July 2017 and in March 2018 in one of the sheds used for teaching, housing five floor-to-ceiling classrooms. First, the building data, of architectural (plastered tuff walls and pitched roofs with tiles) and technological (heat pump system with radiant floors) kind have been collected. Objective aspects concern the measurement of environmental parameters (indoor and outdoor temperature and relative humidity, indoor air velocity and pressure, CO_2 emissions, light level, sound pressure) taken in two significant points. In each classroom, during the surveys, questionnaires were administered to the occupants (teachers and students); these concern personal perceptions related to six fields of enquiry: environmental, thermal and acoustic comfort, natural ventilation and light, air quality.

For each question occupants were asked to indicate the degree of satisfaction and importance by using a Likert scale; these data were elaborated and represented in a Cartesian plane, used to read the least satisfying and most important aspects. In case of dissatisfaction, the possible causes and potential physical discomforts were investigated. While users were responding to the test, their behaviours were observed.

The comparison between the actual situation (objective data) and the perceived situation (subjective data), core of the methodology, makes it possible to define the actions to be implemented as a priority, from the architectural (technical measures, components and systems) and operational (management and usage ways) viewpoints and the strategies to make users aware of their behaviour consequences on comfort and consumption. For making this comparison, it was necessary to normalise the obtained data, comparing them to ranges of reference values (thresholds deduced from scientific literature, national and international technical regulations and effective previous research), which make possible to evaluate both the performances and the requirements as "low"-"medium"-"high".

The objective survey by a continuous monitoring

The point surveys described above are substantiated and integrated by the results of a year-long monitoring, which uses a network of environmental sensors and energy metering points. At the moment, two classrooms are object of this monitoring activity: one in the shed that is involved also in the qualitative and quantitative survey, and one that is located in another shed, recently renovated, which has different architectural features and technical systems (two floors and all-air conditioning system).

The sensors, equipped with a radio technology that enables us to have sensors without batteries and maintenance-free, are: open/closed sensors for doors and windows, thermal sensors and light detectors; they measure air temperature, relative humidity, the temperature of wall surfaces, internal and external brightness; the values of internal CO_2 and VOCs. Furthermore, in order to continuously monitor electrical energy consumption, measurements were taken: voltage; frequency; active, reactive and apparent power; power factor and consumed energy. A programmable logic controller has been provided to support the monitoring system in order to acquire and historicise the data to be used for the analysis of consumption and the evaluation of comfort parameters.

The monitoring, even if carried out only in two rooms of the Department, makes it possible to acquire and schedule data for establishing a link between energy consumption, comfort conditions and users' behaviour. In the future, the monitoring system will be provided with other sensors and integrated with new BMS (Building Management System) functions such as: management and control of lighting, ventilation and air conditioning.

Digitalisation

Both the point survey campaigns and the year-long monitoring foresee the use of IT systems, that are connected to the network and open to elaboration and shared consultation. In the case of the point survey, the measuring of objective data takes place simultaneously with the online administration of the questionnaires to users, who, in real time, receive the test on any device connected to the network (PC/tablet/smartphone), simply providing their e-mail address. While users are responding by "clicking" the answers on their touch screen devices, choosing from predefined drop-down menus, operators can view the entire process, verifying the answers in real time, on a single file, which is then modified and shared between all the operators through a cloud computing system.

In the meantime, objective measurements are stored in the internal memory of the probes data-loggers, then the data can be downloaded on PC stations via USB or via wi-fi, through a web interface.

Continuous monitoring involves recording the measurements by a software that saves the data in real time, as well as the history of the various detected parameters, and draws graphs of the individual and aggregated data.

Soon the results of the monitoring will be shared on the Department and University websites to inform the whole academic community about the outcomes of this work, to make it to feel responsible for the topic at hand and part of an overall project, where the occupants become actors.

Conclusions

All these investigations made it possible to identify the main areas of action and the order of priority to be followed in the successive stages of in-depth analysis. Several feedbacks have been obtained from: the experimentation of the short protocol, the qualitative and quantitative campaigns and the continuous monitoring. The aim is to refine the developed tools in order to continue applying the short protocol, in the medium term, and its extended version, in the long term, to all the University Departments. In addition, the point survey, which concerns only the comfort issues to date, will include the other aspects of sustainability addressed in the protocol, with the aim of integrating more and more the two phases, which appear distinct to date.

As regards actions for the sustainability improvement, the research focused above all on the development of a bottom up process, in which small actions, taken together, can improve the university quality level. The aim, in a following phase, is to implement a top-down approach, which envisages the adoption of institutionalised policies and overall strategic actions for continuous improvement. This can only happen if one succeeds in achieving a perfect synthesis between the computer-automated component of the new technologies, which pervades every system, and the human component, which remains anyway the focus of all processes. It is therefore necessary that the designer be increasingly aware of the project, first from the cognitive and then from the operational viewpoint, and face the expectations and perceptions of the end-users, in order not to run the risk that these new tools, being not adequately managed, remain purely an end in themselves and do not produce the innovation they carry.

References

Codeluppi, V. (2012), *Ipermondo. Dieci chiavi per capire il presente*, Laterza, Bari, I.

Humphreys, M.A., Nicol, J.F. (1998), "Understanding the adaptive approach to thermal comfort", *ASHRAE Transactions*, n. 104, pp. 991-1004.

Martincigh, L. (2009), *La mobilità sostenibile: un toolbox per la valutazione dei progetti/ Sustainable mobility: a toolbox for design assessment*, DEI, Roma, I.

Martincigh, L., Bianchi, F., Di Guida, M., Perrucci, G. (2016), "The occupants' perspective as catalyst for less energy intensive buildings", *Energy and Buildings*, vol. 115, pp. 94-101.

Meir, I., A., Garb, Y., Jiao, D., Cicelsky, A. (2009), "Post-Occupancy Evaluation: an inevitable step toward sustainability", *Advances in Building Energy Research*, vol. 3, pp. 189-220.
Prieser, W.F.E. (1995), "Post Occupancy Evaluation: how to make building work better", *Facilities*, vol.13, n. 11, pp. 19-28.
Schwab, K. (2016), *La quarta rivoluzione industriale*, Franco Angeli, Milano.
UNESCO (2014), *Shaping the Future We Want. UN Decade of Education for Sustainable Development - 2005-2014. Final report,* UNESCO, Paris.
Vezzoli, C., Penin, L. (2006), "Campus: lab and window for sustainable design research and education. The DECOS educational network experience", *International Journal of Sustainability in Higher Education*, n. 7, pp. 69-80.
Zagreus, L., Huizenga C, Arens E., Lehrer, D. (2004), "Listening to the occupants: a Web-based indoor environmental quality survey", *Indoor Air,* vol. 14, n. 8, pp. 65-74.

2.12 GIS A TOOL FOR 20TH CENTURY ARCHITECTURE. FROM THE TERRITORY TO THE BUILDING SCALE

Marta Casanova, Elena Macchioni*, Camilla Repetti*, Francesca Segantin**

Abstract

Management, organization, and dissemination of data represent today one of the main topics of heritage protection and enhancement. Through four case studies, this contribution describes the use of GIS (Geographic Information System) applied to 20th century architecture, as a tool for critical analysis of data and their possible use for the design phase. The examination of the case studies highlights opportunities and limits of a peculiar use of GIS in the field of 20th century architecture, taking into consideration its specific features. Investigations developed at territorial, urban and building scale demonstrate GIS strengths and weaknesses for the improvement of projects on existing buildings.

Keywords: GIS, Geographic Information System, 20th century architecture, Database, Georeferencing

GIS applied to 20th century architecture

The knowledge of built heritage as the starting point for a conscious project, be it of maintenance, conservation, or transformation, always requires a critical analysis of heterogeneous data that must be accurately organized and classified. During the 20th century, the quantity of architectures built, and the amount of archival data and documents produced was the largest ever.

The great number of constructions and the enlargement of the heritage definition not only arose new considerations and problems in the conservation field, but also implied an increase in the production of documents related to architectural projects.

* Marta Casanova is a PhD student at the Department of Architecture and Urban Studies, Politecnico di Milano, Italy, marta.casanova@polimi.it.

* Elena Macchioni is a PhD student at the Department of Architecture and Urban Studies, Politecnico di Milano, Italy, elena.macchioni@polimi.it.

* Camilla Repetti is a PhD student at the Department of Architecture and Urban Studies, Politecnico di Milano, Italy, camilla.repetti@polimi.it.

* Francesca Segantin is a PhD at Department of Architecture and Design, University of Genova, Italy, francesca.segantin@virgilio.it.

The unprecedented technological evolution of the last century allowed the diffusion of new tools, often developed in other areas and for different purposes, in the field of architectural knowledge and planning.

For example, photography became an instrument for representing architecture: a work tool for planning (photomontages and photographic processing), documenting construction phases (preliminary and site photos), disseminating intervention results, and promoting professional work.

Moreover, together with the consolidation of the concept of authorship, many designers' private archives have been established, retaining not only technical documentation, but also many other kinds of documents (as sketches, correspondence, and press reviews).

In order to benefit of this great availability of material, that represent a resource for the knowledge and planning of projects on existing buildings, it must be adequately managed and therefore interpreted. In this context, the GIS (Geographic Information System) seems to be the most suitable tool for collecting, managing, and processing such quantity of data.

This contribution identifies opportunities and limits of a specific GIS application through the analysis of four case studies, related to 20th century architecture[1]. In doing so, it proposes an assessment of the benefits of this tool not only for the analysis and research phases, but also for the design activities.

The first two investigations, one about cinema-theatres in Emilia-Romagna and the second regarding seaside *colonie*[2] in Liguria, used the GIS to analyse complex data related to a wide territorial context.

The third one, related to the Piccapietra district in Genoa, illustrates how the use of this instrument at the city scale can provide an original perspective on an episode of urban renewal.

Finally, the last case study, about the design, construction, and transformation through time of Giuseppe Terragni's residential buildings, highlights the potential of this tool for the conscious planning of interventions and maintenance of built heritage.

GIS project

Initially developed in the geographic field, today the GIS finds applications in the area of cultural heritage. For example, it is often used to organize data from archaeological excavations or information on building materials and conditions for restoration projects.

---

1 The researches were developed within the PhD program in Preservation of the Architectural Heritage at Politecnico di Milano.

2 In Italian *colonie* is the plural of *colonia*, a word defining special institutions and constructions for the care of sick or fragile children, built in Italy between the 19th and 20th century. Since an exact translation in English is not available, it is kept in Italian in the text.

This contribution aims to propose an alternative GIS use, in this case as a georeferred graphic expression of a DBMS (Data Base Management System) with a spatial extension. This allows the classification, analysis, management, and visualization of geographical information and archival documents, both images and texts.

This application had been previously experimented by the Architecture and Design Department of the University of Genoa (formerly, Department of Architectural Science) for the management of interventions at the Albergo dei Poveri monumental complex[3] (Musso, 2017; Acacia, Casanova, 2015).

The acquired knowledge formed the basis for the development of the studies described hereafter, where the GIS is not used for the subsequent association of data to a 3D model (Brusaporci, 2017; Campanaro, 2016), but mainly as a work tool since the very first phases of the investigation.

For this reason, the GIS project was built by linking the databases created in DBMS PostgreSQL[4] to the GIS software in order to make the most of the geographical analysis. In this way, it was possible to match the geometries to an informative report, retrieve them according to different topics, and display them in maps and plans. Data, combined and arranged in tables, were then charted using the most suitable geometrical figure (point, line, or polygon) according to the type of object representation (plans on different scales, elevations, sections). Since QGIS allows the management of the spatial representation of data and their related screen consultation[5], in some cases it was necessary to link the data in PostgreSQL to another data-base software (such as LibreOffice Base) to obtain files and reports on the research results.

Thematic maps as a synthesis of complex information

In the investigations on the seaside *colonie* in Liguria[6] and cinema-theatres in Emilia-Romagna[7] the GIS is applied to analyse a large and widespread group of buildings at the regional scale. The seaside colonie in Liguria represent a heritage that is still not enough studied and known within the regional built environment, despite being a characterizing element of some sections of the Riviera due to their number and volume.

---

3 Research developed within PRIN 2010-2011, *Built Heritage Information Modelling/Management*.

4 Data gathered for the seaside *colonie* were inserted and organized in a relational database using File Maker Pro software.

5 Data can be displayed on screen, and QGIS graphic elaborations can also be printed.

6 Research title: *From therapy to holiday. Architecture of the seaside colonie for childhood in the Italian riviera. History and preservation of a modern heritage* by Francesca Segantin.

7 Research title: *Success and decline of movie theatres in Emilia-Romagna after the Second World War. Conservation of the architectures for the movies* by Elena Macchioni.

Emilia-Romagna is one of the Italian regions recording the greatest numbers of cinemagoers and venues in the postwar period; hundreds of architectures for the movies still exist on the territory, both in cities and small towns, with many buildings displaying significant architectural and structural features.

Both investigations collected a large amount of data related to the construction history and actual state of the buildings. The main sources of information are bibliographical investigation, archival research (technical documents, drawings, photographs, bill of quantities, etc.), and on site inspections (current use, conservation state, and architectural modifications).

The information collected for each building, diverse by source and type, was arranged in GIS, building an organized system of multiple georeferenced data, that can be displayed on a regional map. In fact, the GIS not only connects all the information to the exact location of the constructions, but also allows to display it according to different themes, based on the categories used to organize the data (for example: current use, architectural features, technologies, materials, etc.).

Moreover, a sheet was set up for each building of the GIS project to clearly present the contents of the database[8]. The sheet includes texts organized in various categories such as general information (name, location, period of construction, and use), architectural features (type, morphology, finishes, etc.), building history (construction and transformations over time, client and designer, etc.), and current state (state, condition, type of use, current ownership, etc.). In addition, historic and recent photographs, together with images of archival documents are inserted in each sheet[9].

The GIS, like the linked database, can be inquired about statistical data through one or more parameters, allowing the visualization of the result at different geographical scales.

Thanks to this kind of complex query, it is possible to create maps that group buildings according to various criteria. The visualization of data inserted in the database at territorial scale, enabled the identification of specific phenomena and peculiar characteristics, providing original interpretations on the subject. As for the seaside colonie, for example, the GIS was crucial to observe the distribution of those buildings on the coast, thus directing the research on deepening the reasons causing this condition.

For the cinemas-theatres, the GIS highlighted the permanence of many active premises managed by public or educational organizations in the historic centres, demonstrating how events related to the property influenced the permanence of the use of these spaces.

---

8 Both databases included active, abandoned, transformed, and demolished buildings, to create a knowledge framework as complete as possible for the period studied.

9 To display pictures within the building sheet, it was necessary to fill in the URL field for each of them.

Urban space interpretation through plans and projects overlapping

For the case study of Piccapietra district in Genoa[10], the GIS was used in a broader way than in the previously described works. The modern Piccapietra district, one of many that were built in Genoa in the second half of 20th century (Franco, Musso, 2016), was constructed after excavation of the hill underneath it and the demolition of the preexisting medieval district. Even if a modern solution for Piccapietra was in progress since the late 19th century, the district demolition was approved only in 1953, after almost one century of various projects and debates. For this reason, it was necessary to sort and analyse a high number of documents and then georeferring them to single geometries. Thanks to this approach, it was possible to understand not only modern district design and constructive process, but also its layout before and after the war.

Materials inserted into the GIS were mainly cartographic and iconographic documents, such as urban and cadastral plans, architectural projects, aerial photographs, reproductions and general views, old and new photographs. After the first GIS georeferencing phase[11] (with historical cartography, aerial photos, and buildings plans), was then possible to create a virtual reconstruction of the plan of the former district. On this baseline plan, sorting archival images[12], together with damage and reconstruction reports coming from local archives, it was possible to define the war damages extent on every single building. It was thus possible to understand how much had been destroyed, in order to better interpret the following decision to demolish the ancient Piccapietra district.

Furthermore, thanks to the overlapping of these materials in the GIS, it was possible to identify recurring urbanistic and architectural choices, contact points between new and old buildings, and unregistered modifications on existing buildings.

Finally, information about Piccapietra new buildings[13], gathered from literature and archival material consultation (such as administrative documents, projects and images, design reports, photographs, etc.) was inserted in the GIS. In this way, the GIS project became the best tool to reconstruct an updated and layered image of Piccapietra.

This GIS use allowed to piece together and understand a postwar episode of local history, lacking a specific literature, despite the fact it deeply modified the actual Genoa.

---

[10] Research in progress, provisional title: *The renewal of Genova after the Second World War between conservation and innovation. The Piccapietra case*, by Camilla Repetti.

[11] The georeferencing work consisted in non-linear transformations linked with reference point on currently existing buildings, on a technical cartographic base provided by Liguria Region.

[12] The archival images related to war damages were inserted in GIS using the position of the recovery point.

[13] For each of the new buildings: date, designer and structural engineer, owner, construction company, materials and techniques, transformations over time.

Georeferencing details for a conscious maintenance project

In the field of the research on Giuseppe Terragni's residential buildings[14] the use of the GIS tool was fundamental to have an immediate overview of their structural history through management and visualization of textual, graphic and iconographic information coming from published literature, archival materials, and surveys. Between 1927 and 1943, Giuseppe Terragni planned and carried out, either alone or in cooperation with other architects, nine buildings intended for multi-family dwellings and two villas[15]. Starting from the study of documentation, the research aims at reconstructing all the architectural modifications carried out from the design, through the building phase, until the subsequent transformations regarding space, distribution, materials, and finishes.

In order to document and integrate all the data related to planning, authorization, building and transformation phases, a database DBMS was created with a spatial extension allowing the visualization through a GIS interface. This database is meant to simplify the interpretation of the documentation related to a single building through the documents of a chronological register coming from different archives. Moreover, the database inquiry simplifies the identification of relationships between different buildings, thus allowing the detection of exchanges, influences, linguistic and typological transfers. Each building is linked to a GIS project. Original drawings constitute the base graphic layout. Then, designs details and documents referred to specific elements in plan or section, are inserted on different layers and linked to the related database sheets. Up to now, photographs of the building phase were inserted in GIS, placing them in the shooting point. The different layers, are organized in different levels, can be laid one on top the other, compared, and interrogated. In this way, the information related to different phases and different buildings are clearly and immediately available. The first analysed buildings demonstrated that reading architectural transformations in plans and creating graphic reports was easier using GIS than a CAD system. Moreover, the georeferred position of the information on maps (documents, details drawings, and pictures) allowed to obtain an overview of the amount of information on the different parts and elements of the buildings. This made possible to identify, for example, architectural elements made after detail drawings by Terragni, more problematic ones, or other that were modified during the building phase, through the analysis of material supply documents and the correspondence between customers and companies. This project was planned in such a way to facilitate future interventions being aware of the history and the knowledge of materials of these architectures.

---

14 Research in progress: *Residential buildings. Construction and transformations in Giuseppe Terragni work,* by Marta Casanova, in collaboration with Associazione Archivio Terragni.

15 Novocomum, Casa Ghiringhelli, Casa Toninello, Casa Rustici, Casa Lavezzari, Casa Rustici-Comolli, Casa Pedraglio, Villa Amedeo Bianchi, Villa Bianca, Case Popolari via Anzani, Casa Giuliani-Frigerio.

Conclusions and possible developments

The described examples demonstrate how the creation of a database, graphic visualization, and inquiry in GIS environment of the gathered data, constitute a crucial work tool for the understanding of the building history and its actual state. Moreover, through georeferencing, the GIS enable to assemble information heterogeneous by type and chronology, thus optimizing the time of the research, and eventually of the project design. The GIS allows to obtain a knowledge and management system that can be further implemented and modified over time, providing an always updated picture of the current state, therefore useful for the design phase. However, to do so, it is necessary an ongoing and substantial investment in terms of time and resources, that is only possible with the involvement of public institutions or other bodies (Myers, 2016).

The GIS project at territorial scale can be an effective tool for public administration or other subjects to collect the essential information for an informed planning regarding the distribution of resources, or the identification of objects requiring priority interventions. The GIS can expedite this operation by creating a specific query using some of the parameters considered during the survey and investigation phase (such as conservation state, recovery opportunities, significance of the building, etc.). Although the creation of a GIS project requires the operators to have a preliminary knowledge about DBMS databases and GIS software, no special skills are required for consultation. The reading immediacy though the user interface simplifies the transfer of knowledge in case analysis and design phases are assigned to different bodies or implemented in subsequent stages. Finally, the construction of WebGIS platforms starting from the built data-base, allows the online sharing of the collected information (or of part of it) and their quick visualization. Dissemination is a crucial phase, particularly for projects on architectures of the most recent past that generally lack of recognition from the society and too often suffer from interventions not taking into proper consideration their history or material consistency.

References

Acacia, S., Casanova, M. (2015), "Un sistema informativo per l'Albergo dei Poveri di Genova", *Il Progetto Sostenibile*, vol. 36-37.

Brusaporci, S. (2017), *Digital Innovations in Architectural Heritage Conservation: Emerging Research and Opportunities*, IGI Global, Hershey.

Campanaro, D.M., Landeschi, G.N., Dell'Unto, N., Leander Touati, A.M. (2016), "3D GIS for cultural heritage restoration: white box workflow", *Journal of Cultural Heritage,* vol. 18.

Franco, G., Musso, S.F. (2016), *Architetture in Liguria dopo il 1945*, De Ferrari, Genova.

Myers, D. (2016), "Heritage inventories: promoting effectiveness as a vital tool for sustainable heritage management", *Journal of Cultural Heritage Management and Sustainable Development*, vol. 6.

Musso, S.F. (2017), "Architectural restoration, ICT and BIM. The Albergo dei Poveri in Genoa as a case study" in VV.AA., *Built Heritage Information Modelling/management BHIMM*, MREADY - Ingenio, Milano.

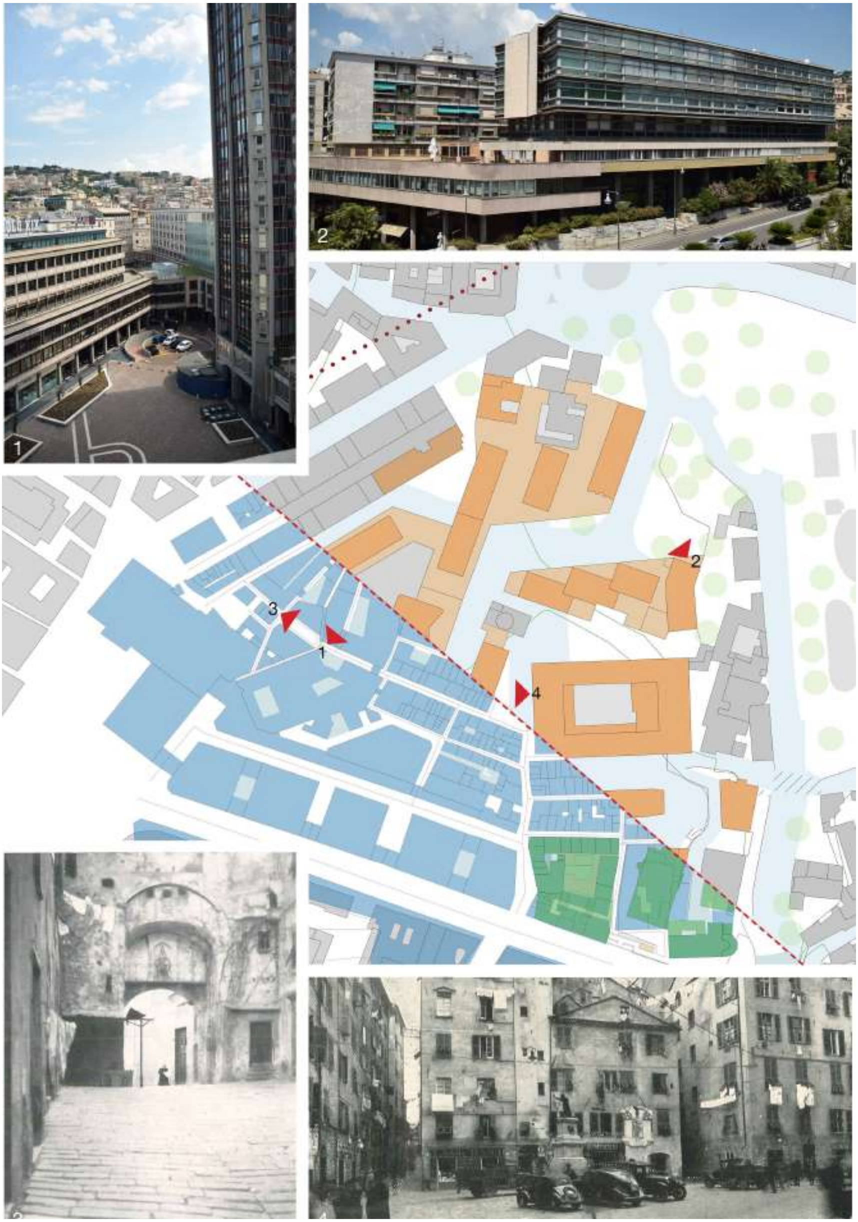


Fig. 1 - Quartiere Piccapietra (Genoa).

2.13 HERITAGE-BIM. THE INTEGRATED MANAGEMENT OF THE HISTORICAL CENTRES: THE CASE STUDY OF ARTENA

Filippo Calcerano, Elena Gigliarelli*, Raffaele Pontrandolfi **

Abstract

The article deals with the use of digital technologies to support the management and regeneration of minor buildings, in particular that of small Italian historical centres, represented by the case study of the medieval village of Artena, located south of Rome. The design of the interventions on the village was accompanied by the parallel design of a new methodology based on the integrated use of GIS and BIM systems and logics. The development of a methodological approach based on multiscalarity and the design of a holistic and integrated information model, supported by a specific Common Data Environment (CDE), led to the definition of strategies for the recovery of the village, according to the themes of the resilience and accessibility.

Keywords: BIM, GIS, Built Heritage, Regeneration

Introduction: integration of Heritage-BIM-GIS systems

The strong development of Information Technology is also involving the built heritage sector, based on an optimization of processes and transformations. The development of a digital infrastructure for the exchange of information between stakeholders is increasingly fundamental and an integrated use of BIM (Building Information Modelling) and GIS (Geographical Information Systems) can meet this need for knowledge management and processes in a multidisciplinary and multi-scale way. BIM is a process that involves different workflows within the construction industry sector, from concept phases to building management. Through the BIM it is possible to construct a 3D-semantic model/database governed by specific rules (called dimensions, which may involve technological, economic, temporal, energetic or management aspects), that is an actual simulation of the physical reality to which it refers.

---

* Filippo Calcerano is a researcher at the Institute for Technologies Applied to Cultural Heritage of the National Research Council of Italy, Roma, filippo.calcerano@cnr.it.

* Elena Gigliarelli is a researcher at the Institute for Technologies Applied to Cultural Heritage of the National Research Council of Italy, Roma, elena.gigliarelli@.cnr.it.

* Raffaele Pontrandolfi is a trainee at the Institute for Technologies Applied to Cultural Heritage of the National Research Council of Italy, Roma, raffaele.pontrandolfi@uniroma3.it.

To date most of the documentation on the historical heritage is still made up of 2D drawings, often containing only geometric information without any semantic or hierarchical correlation between the various elements of a building, or between it and the context in which it is located (Tobiáš 2016; Vacca et al., 2018). Although BIM is primarily a tool for application to new construction, recent studies are starting to demonstrate its potential in the built heritage field (Baik et al., 2014; Gigliarelli et al., 2016; Spallone et al., 2016).

The transition to a Heritage-BIM process aims at integrating not only the process of acquiring geometric data with traditional and innovative direct and indirect surveying techniques (laser scanner/photogrammetry), but also all the historical, formal, analytical (conservation, structural and energy aspects) and design documentation up to the structuring of a management and preventive maintenance system thanks to a 3D-semantic and virtual constantly updated model of the building. The model thus produced allows an optimisation of the phases of analysis, conservation and enhancement of an architectural asset solving at the same time the problem of managing the great amount of knowledge produced during these phases. Although BIM and GIS are both systems based on geometric-semantic databases (Saygi et al., 2013; Barazzetti et al., 2017), the integration between the two software environments is still under development, especially in relation to the transfer of information between the two systems (Tobiáš, 2016; Liu et al., 2017; Barazzetti et al., 2017).

The two software ecologies use different geometric representations, different data and coordinate systems and a different semantic base (Vacca et al., 2018). BIM tools are mainly for the architectural scale, specialised on 3D-semantic models of single buildings and allow a high detail to the detriment of a greater difficulty in the integration of new non-constructive attributes. GIS tools instead were developed with 2D models for modelling the existing reality on a territorial scale, with a high capacity for implementation and interrogation of spatial data attributes and less geometric potential (Saygi et al., 2013; Baik et al., 2014). The attempts at interoperability between the two software environments have so far led to different experimental approaches depending on the individual case studies and application, according to specific objectives (Liu et al., 2017; Barazzetti et al., 2017). In the field of built heritage, some researches have led to good results with the combined use of BIM tools (Revit and Archicad) and GIS (Arcgis) through a shared platform (FME, BIM server, GeoBIM, etc., Dore et al., 2012; Vacca et al., 2018). Others have focused more on the bidirectional data transfer between the open standards of BIM and GIS interoperability, the BIM data model IFC (Industry Foundation Class for BIM) and the GIS data model CityGML (City Geography Markup Language) encountering, however, gaps both from the semantic and geometrical point of view (Tobiáš, 2016; Liu et al., 2017). Another line of research has worked on the interoperability between the two systems for multi-scale analysis through the Autodesk Infraworks platform (Baik et al., 2014; Barazzetti et al., 2017).

The integrated use of BIM and GIS systems, therefore, has great potential for the analysis, planning and management of interventions on built heritage. As confirmed by the most recent researches (Tobiáš, 2016; Barazzetti et al., 2017), although there is not yet a mature platform capable of managing all architectural and territorial aspects at different scales, it is possible to develop new methodologies that combine the use of both systems or their logics, according to specific objectives and with a defined level of detail, for targeted intervention cases.

Case study

The research project of the historic village of Artena, located at the southern end of the Castelli Romani, is part of a collaboration between the ITABC and the Consortium *Castelli della Sapienza*, an organization that connects 11 Municipalities of the territory of Monti Prenestini-Lepini to promote initiatives aimed at improving the living and working environment of the associated communities. The research is aimed at the evolution and application of strategies for the redevelopment, recovery and energy improvement of historical urban fabrics and for the socio-economic and cultural promotion of the territory. Artena arose and developed on a high ridge of calcareous rock with a rather harsh morphology and very steep slopes.

It presents a historical fabric characterized by a medieval-style structure and by imposing constructions built by the Borghese family in the XVII century that have modified the entire original urban structure through an urban regeneration intervention of great engineering, architectural and social value. During the Second World War the city suffered considerable collapse and damage. In the Sixties the difficulties of communication and accessibility led to the depopulation of the village and the urban development of the new city under the slopes of the mountain, in the river Sacco valley.

Design proposal

The village of Artena while maintaining an urban structure substantially intact over time, has gradually undergone, from the second post-war period until today, a process of marginalization followed by the decline in population, a constant reduction in employment and land use, a progressive decline in the local offer of public and private services and a slow but unstoppable degradation of cultural and landscape heritage. The city, like many other Italian internal historical centres, is characterized by an important endowment of territorial resources, but has not yet developed an adequate tourist supply capacity, capable of becoming an important lever for the revival of its economy.

The historical, urban and architectural studies and the SWOT analysis carried out have highlighted as a priority, for the purpose of contrasting the reduction of the population below the critical threshold and the aging of the population, the problem of accessibility: the historical centre is distributed over a strong gradient, inaccessible to vehicles and even today the only material transport and waste collection system takes place with mules. Starting from this evaluation, design solutions were developed for the two most critical areas of the village (Fig. 1). In both areas, the excessive differences in height were tackled proposing the use of ascent and pedestrian pathways according to technologies and shapes compatible with the historical fabric and completely reversible. In order to reduce the impact also in environmental terms, local materials have been chosen, both for flooring and coverings, also native tree species were selected.

General methodology for the digital management system of Artena village

Given the diffuse and widespread nature of the interventions in the historic centre, a "multi-scale" IT process, developed on the BIM Autodesk Revit platform, was experimented, able to integrate different design levels: from planning to scheduling, from design to implementation, management and maintenance. A precise system hierarchy, assisted by internal rules of operation, structures the holistic 3D-semantic database and constitutes a model of cognitive synthesis. We started by generating a general information model called "master" realised through a georeferenced system of shared coordinates and reference levels and grids developed in a special template file (.rte) in which the local models (linked to each other) corresponding to the three intervention scales were displayed: macro-urban, micro-urban and architectural scales, used according to the project and intervention needs.

The topographic context was developed by defining distinct models corresponding to the different levels of development (LOD) according to the intervention scales using the "architectural disarticulation" and "digital reconstruction" methodology, defined by the Italian UNI 8290 standard. The libraries created are not simple 3D visualization products but segmented models capable to describe the architectural vocabulary, information on their physical characteristics and the geometries connected to it are represented with different levels of accuracy and detail (LOD). The level 0 of the model hierarchy, which contextualizes the spatial planning reference information defined by the General Urban Development Plan (GUDP) and its variants and level of development, is defined as LOD A, as required by the Italian UNI 11337 Standard on the Digital Management of Construction Information Processes. This general container of georeferenced information allows to view, separately or simultaneously, multiple models of the different areas of intervention even at different scales.

Level 1 of this digital hierarchy, whose urban reference framework is that of detailed urban planning, identifies a scale defined as "macro-urban" with LOD B, where the volumes of the buildings and the roofing geometries are modelled. In this level of investigation all metadata, coming not from geometric but from documentary sources - such as data sheets with information on the consistency of buildings, photos, images, cadastral extracts - are linked to the digital model, developed through the "Conceptual Massing" tool of Autodesk Revit. All information relating to the individual building units, such as the state of conservation, the degree of maintenance, accessibility and constituent materials, collected from surveys and archival research (historical documentation, GUDP, GIS analysis), are managed through the creation of sets of shared parameters, connected to each mass, and obtained for subsequent targeted queries through the use of special view filters and thematic schedules. The management and implementation of this data in a single digital database, allows clash detection, through the simultaneous use of 2D and 3D thematic views. Level 2 identifies the "micro-urban" scale, in which the urban settings of the historical fabric are defined and where all the architectural and typological elements appear: the walls and the openings, the structural elements, which are distinguished by a label and a standard mark to allow a preliminary quantitative analysis through the extrapolation of schedules. At this level of definition (LOD C) it is possible to insert and display the architectural and urban planning and requalification elements. The overall 3D parametric model of the historical buildings and urban spaces has been created with the following phases: the analysis of the geometries and the retrieval of information from the document sources and existing surveys; a survey campaign carried out through the direct verification of information and the photogrammetric survey for the definition of the elevations; the construction and implementation of libraries of the most common typological and structural elements; the construction of parametric façade models and finally the integration of BIM with a GIS system for spatial referencing. The last level of detail (level 3) is defined as the "architectural scale", whose normative reference is the LOD D (defined parametric elements). At this scale it is possible to accurately define the project interventions also with in-depth analysis of the parametric object libraries with a special coding protocol. The starting point is always the survey with innovative and traditional techniques, from which we move on to refine the geometry and define the specifications and details (materials, finishes, etc.) of each library object up to the organization of a graphic-numeric system for the integrated management of data in order to achieve an archive and a targeted planning of the interventions.

The creation of specific digital technical sheets of each product and specific object libraries representing the most frequent architectural elements, constantly updated and implementable and containing all the indications of the Urban Recovery Plan, becomes an effective tool for planning and intervention strategies from the municipal administration.

This also allows knowledge sharing and the activation of a collaborative process with all the figures involved in the architectural and urban regeneration. Specifically, the urban redevelopment project proposals are oriented towards the improvement of accessibility systems, through the overcoming of strong gradients in height, a source of discomfort for the population of Artena, a city with a complex orographic profile.

Solutions for hectometric systems have been developed with a series of connected lifts that allow for pedestrian connection.

The use of BIM, loaded with information on the various elements, allows the designer to evaluate the impact of the intervention on a general level and facilitates the verification of the various components, the identification of critical issues, quantitative and qualitative control and also a careful economic evaluation. Moreover, the virtual simulation of the construction phases enables the identification of critical issues and problems by controlling the sequence of the process.

Results and discussions

The research provided insights on the digitalisation of the design process and on the sharing and management of heterogeneous data for the purposes of greater efficiency in the coordination of technical skills and the division of roles in the information management process through a multi-scale approach on a BIM platform.

Data from GIS georeferenced systems (Qgis, ArchGIS), documentary analyses and traditional and innovative surveys have allowed the development of a constantly updated set of federated models, organised according to the different intervention scales.

This required the structuring of a digital hierarchy and a data exchange protocol for the whole process: the definition of a specific Information Management Plan (IMP) designed to outline the objectives to be pursued, the specifications for the exchange of data and the codes, the methods of control and verification, and finally the roles and responsibilities of each actor involved in the entire planning, scheduling and management process for each intervention. The integrated management of the information flow from the territorial/urban to the architectural and detailed scale, through the joint use of a unified platform with BIM-GIS logic, is in line with the provisions of the new Italian DM 560/2017, which envisages the obligation of digitisation in the construction field starting from 2019 and that by 2025 will be mandatory for all contracting authorities and local administrations.

The methodology was also fundamental for the programming of smart, intervention strategies consistent with the analyses and the data collected, for an improvement in the efficiency of local administrations.

Future works

The use of an easily manageable interoperable platform, which allows the joint use of BIM and GIS systems and models, is increasingly necessary to activate an efficient process and a better and more flexible interscalar interaction with the models according to the expected needs. To overcome the rigidity of the current hierarchy levels envisaged, we will try to integrate the BIM digital model on the Autodesk Infraworks platform, in order to evaluate strengths and weaknesses for the improvement of the workflow. This tool and methodological approach with further in-depth developments will allow the creation of a knowledge base that can be constantly implemented and interrogated, for the optimization of the analysis, planning, design and management of urban centres and for a better work organisation, based on the digitization of the process, within the administrative technical offices.

References

Baik, A., Alitany, A., Boehm, J., Robson, S. (2014), "Jeddah HBIM - Object Library". ISPRS Ann Photogramm Remote Sens Spat Inf Sci 5:41-47.

Barazzetti, L., Banfi, F. (2017), "BIM and GIS: when parametric modeling meets geospatial data". ISPRS Ann Photogramm Remote Sens Spat Inf Sci IV-5/W1:1-8.

Dore, C., Murphy, M. (2012), "Integration of Historic Building Information Modeling (HBIM) and 3D GIS for recording and managing cultural heritage sites", *IEEE*, pp 369-376.

Gigliarelli, E, Calcerano, F., Cessari, L. (2016), "Implementation Analysis and Design for Energy Efficient Intervention on Heritage Buildings", Ioannides M Al Eds Digit Herit Prog Cult Herit Doc Preserv Prot EuroMed 2016 Lect Notes Comput Sci Springer Cham 10058.

Liu, X., Wang, X., et alii (2017), "A State-of-the-Art Review on the Integration of Building Information Modeling (BIM) and Geographic Information System (GIS)", ISPRS Int J Geo-Inf 6:53.

Saygi, G., Remondino, F. (2013), "Management of Architectural Heritage Information in BIM and GIS: State-of-the-art and Future Perspectives", Int J Herit Digit Era.

Spallone, R., Piano, A., Piano, S., (2016), "BIM and cultural heritage: multi-scalar and multi-dimensional analysis and representation of an historical settlement", *Disegnarecon* 9:13-1-13.13.

Tobiáš, P. (2016), "BIM, GIS and semantic models of cultural heritage buildings", Geoinformatics FCE CTU 15:27-42.

Vacca, G., Quaquero, E., Pili, D., Brandolini, M. (2018), "GIS-HBIM integration for the management of historical buildings", ISPRS - Int Arch Photogramm Remote Sens Spat Inf Sci XLII–2:1129-1135. 5-262.

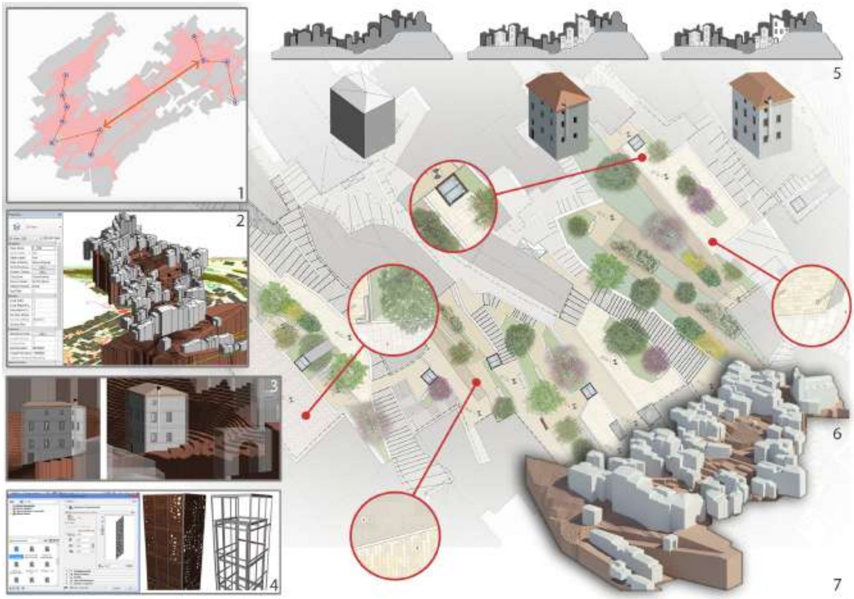


Fig. 1 - Project and methodological summary: 1. Concept, 2. Macro-urban scale work screen, 3. Micro-urban scale work screen, 4. Architectural scale work screen, focus on the hectometric system. 5. Parallel diagram of the methodological approach scales (from left to right macro-urban, micro-urban and architectural-tectonic) with the related increasing project LODs. 6. 3D image of the Artena border. 7. Project excerpt of the interventions with focus on specific details.

2.14 Light Resource Building Approaches for Eco Innovation of Building Processes

Martino Milardi[*]

Abstract

The subject matter is collocated in the scenario where the emergence of approaches with a strong green or circular connotation is becoming more evident, i.e. new ways that cross production chains and implementation practices, often becoming significant drivers. The profound revision of the statutes of the design processes due to the fallout of the economic situation and to the need for substantial innovation has generated a fertile field of opportunity where the project can direct new efforts of its practices. Among the various strategic spheres that arise from it, the architectural project finds a field of action in eco-innovation and in the modalities that with this specific theme define the assumptions of the "Resource-Efficient Building" (Light Resource Building).

Keywords: Design, Efficient Resource, Materials, Construction, Eco-Innovation

The "resource-efficient construction" approach: an alternative vision of building production

The need to "Dwell" and the consequent construction as well as being the natural founding characteristics of human life, are recognized as genetic bases of European culture.

However, the construction sector, and construction in particular, are the subject of more study in more fields of knowledge as considered among the determining causes of both economic situations and "new" environmental impacts such as climate change.

The "efficient resource" approach, promoted at European level and shared internationally, expresses the need to use less natural resources to achieve the same or better product/output, thus internalizing the concept that the performance of transformative processes could increase efficiency levels with the result of finally getting "the more with less" (AMEC, 2013).

For the sector, it means not only employing resources more efficiently to realize, or restructure artefacts but also to reduce the amount of resources necessary for their operation.

---

[*] Martino Milardi is Associate Professor at the Department of Mediterranea University of Reggio Calabria, Italy, mmilardi@unirc.it.

This performance would not only tend to improve the environmental performance of the processes, but at the same time would yield greater economic returns.

It is too known that the construction sector is the largest consumer of raw materials in the EU; construction and demolition activities make up about 34% of the waste produced each year (EEA, 2016).

At the same time, for some years European funds offer incentives that allow companies to renew their processes in order to reduce their environmental burden; such aid is framed in the logic that the most efficient use of resources and recycling of waste/waste would significantly reduce the Total Material Requirements (TMR) of European companies.

The same logic combines the concept of "environmental incentive" (deriving from the desire to promulgate green culture in production models), to the economic one, where reducing material inputs could actually reduce the costs.

Therefore, a more systemic and global approach to construction and restructuring actions seems necessary, such as to understand how energy and materials can be used efficiently, considering overlaps and compromises between them. This broadening of perspective on efficient resources could contribute to a better realization of environmental goals of established communities and models of development, also because in its foundations this perspective internalizes the dimensions, social, environmental and economic (Bringezu, 2009).

Ultimately, resource-efficient construction is not just "transforming" more efficiently (i.e.: reducing waste streams), but also finding new ways to achieve the same (or even superior) functionality, with a minor use of resource-intensive materials, new technologies and new approaches to design.

The construction material requirements for the "light-resource" building

It is now established that awareness of the excessive and uncontrolled consumption of resources is contributing to the formation of one of the greatest environmental challenges of the 21st century.

While this consumption does not manifest itself as a clear and visible problem, such as pollution or toxicity, it actually contributes to greater environmental pressure and problems of "effect mobility", for example by shifting the negative impacts of production to abroad, so that these are not seen by consumers in the countries of consumption (OECD, 2013).

The planet has reached its points of no return for a certain "number" of environmental systems, beyond which the fear of collapse becomes relevant (Meadows et al., 2004, Rockström et al., 2009, EEA, 2010).

Recognized as the largest "resource consumer", the construction sector is critical to the trend of this trend, but there is great potential to reduce material consumption through "efficient resource construction".

Other data concern the share of minerals in Domestic Material Consumption (DMC) of UE (27 State) is about 52%[1].

Of this percentage, only a small part cannot be used in the construction sector, while the majority is, making the consumption of material in the construction sector a factor of "intense and maximum demand". A useful example of intense material consists of stone aggregates, since, while they do not seem to contribute "visibly" to environmental emergencies; they actually constitute evident environmental pressures. The aggregates are granular materials, such as sand, gravel and crushed stone. They are, for example, the main ingredient of ready-mix concrete and include the vast majority of construction minerals (BGS, 2010). In 2009, the total demand for European aggregates was around 3 billion tonnes, produced mainly by small and medium-sized enterprises on 22.000 sites across Europe (UEPG, 2010). The construction of a new average building uses up to 400 tons of aggregates, as well as the construction of 1 km of motorway uses up to 30.000 tons (Bleischwitz, Bahn Walkowiak, 2007). Throughout the life cycle, environmental problems[2] are always "present", especially in the extraction phase (change in land use for mines and quarries, variation in groundwater levels, etc.). However, at the same time the environmental pressures also play an important role. Firstly, the extraction of aggregates really contributes to the depletion of resources. To mitigate this connection, a useful measure could be to hinder the absolute decoupling of PIL from the DMC. In their use phase, aggregates are used to produce concrete, releasing large amounts of CO_2, thus contributing to the "sealing" of the fertile soil layer for the purpose of new portions of built environment. At the end of their use, aggregates are disposed of or recycled and, to date, the percentage of construction and demolition waste (C&D) is high, given 33% of the waste produced each year in the European Union (EEA, 2010). That witness how much requalification and demolition of buildings generate large quantities of materials that can be recycled (Geibler et al., 2010).

- the creation of more efficient methods to recycle aggregates, finalizing the supply chain to their reuse both as an "input" constituting a new value of the real estate;
- to contribute to new constructive modalities that reduce the need for aggregates through their material substitution;
- pursuing "light-resource" building.

---

1 This percentage is very different between European countries. From over 70% in Portugal and Ireland to around 30% in the Netherlands and Greece. Between 2000 and 2007, this percentage rose in the EU-27 (from about 49 to 52% of the DMC). Trends are very different between countries. Comparing the years 2000 and 2007, the total amount of mineral consumption decreased in Italy, Germany, the Netherlands and the UK. While it increased in Spain (31% more in 2007 than in 2000), the Ireland (consume 40% more) Greece (consuming 42% more) and Bulgaria, Lithuania, Romania, Estonia and Latvia (with an increase of over 50%).

2 In reference to the alterations and qualitative impairments of Environmental Compartments: Air, Water and Soil; or anyway, the problems concerning the Bio and the Geosphere.

Industrial policies play a key role in reducing impacts on the use of resources and on the environment, through more efficient production processes, a different project of energy flows, and the dematerialization of production cycles, preventive strategies, cleaner production technologies and procedures.

"Clean production", as well as a review of product life cycles to minimize waste production, play a key role in reducing impacts on the use of resources and on the environment (OECD, 2010).

The concept of cleaner production was introduced by the Office of Industry and Environment of the United Nations Environmental Program (UNEP-IE) in 1989 and recognized by the Ministerial Conference organized by UNIDO on ecologically sustainable industrial development (Copenhagen, 1991).

Clean production consists of the continuous application of an integrated preventive environmental management strategy, applied to processes, products and services, to increase eco-efficiency and minimize risks to health and the environment.

It can be applied to production processes (saving raw materials and energy, eliminating toxic and dangerous raw materials and reducing the quantity and toxicity of all emissions and waste), to products (reducing the negative impacts during the entire life cycle, from extraction of raw materials at the disposal stage) and to services (incorporating environmental concerns into the design and provision of services).

The implementation of this concept presupposes a cultural change. Requires defining a new approach to the industry relationship; requires responsible environmental management, the creation of a suitable national political environment and the assessment of technological options. Furthermore, eco-efficiency represents a life-cycle perspective that follows products from the extraction of raw materials to final disposal stages; it is therefore an extension of the Total Quality Management process.

In other words, the vision of eco efficiency is that of "producing more from less". Reducing waste and pollution and using less energy and raw materials is obviously positive for the environment, but it is also positive for the business world, as it cuts the costs of companies and avoids potential environmental responsibilities; it is therefore a prerequisite for the long-term sustainability of the production process.

Ernst Ulrick Von Weizsacker, refers to the need to operate an "efficiency revolution", that is to make possible the development, considered central for the improvement of living conditions, compatible with the environment by increasing the efficiency of production systems, settlements, of mobility (Weizsacker, 2009).

The new goal of the building design will be to respond to the problems of our planet and to a development that, to be sustainable, can only reduce the quantities involved through the optimization of use, the increase in efficiency, the limitation of consumption and tend to reuse and recycle.

The Building-Resource-Efficient

The Building-Resource-Efficient, considers building as a single functional unit, rather than consisting of separate components and expresses the need to use fewer natural resources to achieve the same - or better - “product/output” budget. Trying to optimize the functionality of the entire system, we intend to internalize the concept that the efficiency of transformative processes facilitates the increase of efficiency levels, with the result of “obtaining the most with less”. This, however, requires the designer to have a deeper understanding of the object to build, the context conditions, the selection process of the materials, etc.

The focus is increasingly on “invisible technologies”, with greater attention to design integrated, to the organization of the processes, to the control of the life cycle of the materials and where, the phases of management and decommissioning acquire a fundamental role for the sustainable dimension of the architectural project (Antonini et al., 2010).

It seems obvious, but it is very clear how much innovation (better if eco-innovation) is ever more necessary to achieve a truly sustainable development, in its concretization of the balancing of environmental and socio-economic objectives.

In the future, “compromises” and synergies will have to consider in a more comprehensive way, which means that instead of developing a new material to replace another material, innovation will have to “think” about how one component could replace multiple functionalities by meeting the needs of users also in different geographical areas.

Innovative technologies therefore, but a contemporary restructuring of governance processes will be necessary to review the sector and contribute to the creation of “sustainable companies”.

To improve resource efficiency in the construction sector, a strategy is to replace resource-intensive materials with eco-materials. In this sense, the “*Resource-Light Construction*” seems to be a more complete approach because it considers the building as a single functional unit, rather than consisting of separate components, so it tries to optimize the functionality of the whole system. Moreover, being the functionality of the individual components a part of this approach, to realize and improve this functionality with less material input is the pinnacle of process innovation based on material flows (Milardi, 2015).

The *Resource-Light Construction* can be possible with eco-materials, as these are less resource intensive and less polluting than usual ones. This feature also includes revenues generated in the production process and the replacement of resource-intensive raw materials. However, we must recognize how the line of demarcation between what configures the “eco” or “not-eco” character of a material is not absolute, if not even blurred, in fact, a material can also satisfy ecological values by covering requirements from the characters different.

Among the challenges of the 21st century one of the biggest is probably the rational use of resources and especially the limited ones and this requires a necessary and pressing change to the building sector (EU Commission, 2011).

From the aerospace and automotive sectors, we know that a higher "weight" automatically means more energy "commitments".

Many studies have shown that even in construction, technologies and materials needed that make a building lighter, so that it has "consumed" less resources and energy.

However, lightweight construction has to be considered beyond the mere indication of using light materials or minimizing the use of material.

Resource-Light Construction refers more directly to the appropriate use of construction materials and techniques, providing the most effective response to the specific needs of a constructed object. In this case, also, the analysis method of material flow and the material intensity calculation are offered as useful tools.

Conclusions

Starting by the assumptions just described, the support of new organizational structures, process technologies, ICT systems, seems crucial to implement a massive (if not radical) system innovation, now unavoidable in the construction sector, thus contributing to growth based on the Resource-efficient construction and a truly sustainable economic development.

This can be supported by ICT logics, which, by developing new hardware and software, offer the possibility of "dematerializing" some production phases through simulation and virtualization of supply chains, processes, products, favouring a lean, light, adaptable and flexible industrial production.

However, it should be noted that, even if with different "speeds" compared to other sectors, even the building sector is following this change.

In fact, different "types" of eco-innovation are finding application in the European field, even if the sector experts believe that this must be much strengthened starting from the process level, at the same time hoping for a systemic change of the different elements of the sectors productive (EACI, 2013).

Furthermore, it is evident how many lines of research can be developed and how much these could offer the project contents, methodological apparatuses, operational tools and a real capacity for transdisciplinary management of the processes.

This succinct scenario seems to offer clear opportunities, where the Project can not only reposition itself to the desired centrality in the processes, but also acquire new dimensions of scale and scale that could form an effective managerial role in those production chains that have as their horizon the New Qualities requests to the architectural action of the future.

References

AMEC for the European Commission (2013), *The opportunities to business of improving resource efficiency. AMEC Environment & Infrastructure*, UK Ltd, Northwich.

Antonini, E., Giurdanella, V., Zanelli, A. (2010), "Reversible Design Strategies to Allow Building Deconstruction on a Second Life for Salvaged Materials", in Zachar, J. et alii (eds), *Main proceedings of the 2th International Conference on Sustainable Construction Materials and Technologies*, 28-30 June 2010, Università Politecnica delle Marche, Ancona.

BGS (2010), *Commodity profile: Rare earth elements*, Keyworth, BGS, Nottingham.

Bleischwitz, R., Bahn-Walkowiak, B. (2007), "Aggregates and construction markets in Europe: towards a sectoral action plan on sustainable resource management", *Minerals & Energy-Raw Materials Report*, 22 (3-4), pp. 159-176.

Bringezu, S. (2009), "Visions of a sustainable resource use", in Bringezu, S., Bleischwitz, R. (eds), *Sustainable Resource Management: Global Trends, Visions and Policies*, Greenleaf Publishing Ltd, Oxford.

EACI (2013), *Eco-innovation. Greener business trough smart solutions*, Executive Agency for Competitiveness and Innovation of the European Commission, Publication Office of the EU, Luxembourg.

EC European Commission (2011), *Roadmap to a Resource Efficient Europe*, COM (2011) 571, 20.09.2011, European Commission, Brussels.

EEA (2010), *Annual report 2010 and Environmental statement 2011*.

EEA (2016), *Air quality in Europe - 2016 report*.

Meadows, D. et alii (2004), *Limits to Growth: The 30-Year Update*, Earth Scan, London.

Milardi, M. (2015), *L'edificio risorsa. Caratteri e indicatori di eco-efficienza in edilizia*, Edizioni Nuova Cultura, Roma.

OECD (2010), *Eco-innovation in industry, Enabling green growth*, OECD Publishing, Paris.

OECD (2013), *Material Resources, Productivity and the Environment*, OECD Publishing, Paris.

Rockström, J. et alii (2009), "Planetary boundaries: exploring the safe operating space for humanity", *Ecology and Society,* 14, available at: http://www.ecologyandsociety.org/vol14/iss2/art32/.

Von Geibler, J. et alii (2010), "Sustainability assessment of entire forest value chains: Integrating stakeholder perspectives and indicators in decision support tools", *Ecological Modelling*, 221, 18.

Von Weizsäcker, E.U. (2009), *Factor five: transforming the global economy through 80% improvements in resource productivity*, Earthscan, London.

2.15 NEW TECHNOLOGIES AND DESIGN: INNOVATIVE CO-DESIGN TOOLS

Grazia Giulia Cocina, Gabriella Peretti*, Riccardo Pollo*, Francesca Thiebat**

Abstract

Co-design has always existed, although in various forms. However, tools and methods have recently changed, including an ever-increasing number of new technologies used to encourage and simplify participation by all the users involved in the various design stages. Tangible User Interfaces (TUI) is one such technology that has not yet been sufficiently studied. These interfaces make digital data not only visible but tangible so that they can be controlled using physical objects that are easy to manipulate. This contribution will provide a more in-depth analysis of these tools, highlight their potential, and theorise their use in the design of complex projects such as hospitals.

Keywords: Co-design, Hospitals, Tangible User Interfaces, Participatory tools.

Framework

Several factors - including multiple users, decision-makers and relationships - make architectural design and the building process extremely complex. For hospitals in particular, these factors include the technical, managerial, and functional aspects of the activities in question.

The ethical, social, and economic importance of these activities means that consideration has to be given to the special needs of the patients, health workers, technicians, or simple citizens who use these services when they work.

There is in fact ample proof that the quality of the environment can not only influence the therapeutic outcome (Ulrich et al. 2004), but also affect the costs of the services and management.

---

* Grazia Giulia Cocina is a Postdoctoral Researcher at Department of Architecture and Design, Politecnico di Torino, Italy, grazia.cocina@polito.it.

* Gabriella Peretti is Full Professor at Department of Architecture and Design, Politecnico di Torino, Italy, gabriella.peretti@polito.it.

* Riccardo Pollo is an Associate Professor at Department of Architecture and Design, Politecnico di Torino, Italy, riccardo.pollo@polito.it.

* Francesca Thiebat is an Assistant Professor at Department of Architecture and Design, Politecnico di Torino, Italy, francesca.thiebat@polito.it.

As a result, an extremely thorough design process must be adopted to establish the present and future needs of those who use these spaces so that users can use and perceive them as suitable environments.

Appropriate tools are the ones that provide an in-depth analysis of users as part of the demand-performance metaproject.

Depending on how they are employed, they should present specific ways to involve the users, medical workers, technicians, and patients in order to identify solutions that will satisfy the predefined objectives.

In fact, all too often, once construction of the buildings is completed, they do not fulfil the function envisaged during the design stage. Proof comes in the following form: numerous post construction interventions not only spark considerable direct costs, but also affect the efficiency of the health centre.

To avoid this risk, designers must accept the challenge of involving the final users in order to meet their needs. This dual objective can be achieved by adopting the methods developed to optimise the design of services and products and using them in the field of architecture.

These methods can be divided into two big categories: User Centred Design and Co-Design. Despite the fact that the prime focus of both methods are users and their needs, they differ in the way they interact with the users.

User Centred Design considers users as being predominantly passive, i.e., designers study their needs either through observation or interviews. Instead Co-Design focuses on how to actively involve users in the design process. The main difference between these two approaches is therefore to shift from design "for users" to design "with users" (Sanders, Stappers, 2008).

There are several ways for users to be involved in the design process, depending on whether the designers act as interpreters or play a supporting role. As an interpreter the designer involves users as much as possible, but he is still the person who will later implement all their inputs. Instead if he plays a supporting role, he will tend to put himself on a par with the users involved in the overall organisational process.

When a hospital is designed the interaction between the design of the spaces and the activities performed there must necessarily be governed by qualified designers so that users – above all health workers with their knowledge and specific expertise – can express themselves to the full and be part of the design process.

In other words, the role of the design team is crucial, as is the involvement of specialists (organisational health, architecture, technologies, and environmental and clinical psychology). However, it is always the designer who plays a leading role and takes the responsibility for the choices that are made. They use their disciplinary expertise to steer user involvement.

This contribution will use case studies and examples illustrated in literature to identify innovative co-design tools that can be applied to the design of hospitals.

Co-design: tradition and innovation

Not many documented architectural projects have fully exploited codified user involvement methodologies, especially in Italy. This approach tends to be more prevalent when designing patient services or care pathways from a medical point of view. For example, Experience-based Co-design (EBCD) developed and disseminated in Great Britain in 2005 and strongly supported by the local health system. The EBCD is an approach used to improve the quality of health services through user involvement and experiences. In a co-design process staff and users work together in partnership; they discuss their experiences and then decide the priorities that need to be changed and how to implement them (Donetto et al., 2014).

The EBCD has become popular beyond the borders of the United Kingdom, so much so that from 2005 to 2013 numerous user involvement projects implemented in six different countries have produced excellent results.

Despite the fact that highlighting users' experiences is undoubtedly one advantage of this approach, it was not invented specifically to be used in architectural design.

Nevertheless, the benefits of co-design in the field of hospital design have been acknowledged in international literature, as underscored by Steen et al. (2011). They state that the key to a successful patient-staff relationship is to recognise that patients are the "experts of their experiences" and must therefore be taken into consideration during the design phase.

The Pharmacy of Whittington Hospital (London) is an interesting example of a recent co-design process. The hospital employs 4,000 staff who care for more than 500,000 people across north London. Although not a big project, the pharmacy is a strategic hub in the hospital. The project involved thirty-eight medical staff and used affinity mapping techniques[1] and *experience prototyping*[2]. The Urban Hospice designed by Nord Architects (Copenhagen) is another example of hospital co-design. The participation implemented by the studio envisaged close collaboration between the architects, patients, and users; this approach impacts enormously on the final design which is always first class. The architects organised workshops where the actors involved established their needs and then created scale models.

Although these projects are important examples of co-design, they use traditional methods which do not lead to a real, beneficial involvement of operators and users. In fact, traditional methods such as mock ups (ranging from a schematic scale to full scale) are based on personal interviews and the not always symmetrical sharing of documents and physical models.

---

1 Affinity mapping techniques involve a creative process to gather and organise a large amount of data, ideas and proposals and then highlight their relationship and stimulate a discussion.

2 Simulation of the service /space/activity capable of envisaging and assessing certain performances using physical interactive experiences.

These characteristics are the reason why little use is made of co-design when it comes to designing hospitals.

In recent decades efforts have been made to solve these difficulties. Co-design tools have been radically revamped thanks to new technologies which have drastically changed that way in which information is transferred and shared; they have also added interaction and simultaneity to the active participation of users in the design process.

There has been significant progress in the design of some tools that use immersive environments, including Augmented Reality (AR) and Augmented Virtuality (AV). Augmented Reality makes it possible to visualise a scenario in which the real world is virtually embellished with additional information generated by specific software programmes. Users are completely immersed so that they cannot tell what is real and what is not. Augmented Virtuality instead creates a virtual space in which real elements are integrated into the environment and users can interact with them in real time.

Tangible User Interfaces (TUI) are another kind of tool (still experimental) that could play an important role in co-design since they would allow greater sensorial and interactive user involvement. They use innovative interfaces that make digital data not only visible but tangible so that it can be controlled through physical objects and allow multiple users, even if they are not experts, to collaborate and participate fully in the simulated design process.

Tangible User Interfaces: possible tools to enhance co-design in hospitals?

In 1993 a special edition of the magazine Communications of the ACM entitled Back to the real world presented a provocative hypothesis: computer graphics and virtual reality would distance people from their environment and as a result the real world would increase its digital functions rather than oblige users to participate in a virtual world (Shaer, Hornecker, 2010).

This inspired the Tangible User Interface concept, an alternative to the usual computer interfaces known as Graphical User Interfaces (GUI). In fact, the latter provides data in the form of pixels on a display; this means that the user interacts only with a mouse or keyboard, making the relationship null or non-existent since it is mediated only by vision and not real interaction.

Instead TUI use physical devices to interact with the digital contents; they manage to exploit our haptic sense and activate an interaction between data elaboration and manipulation that can be instantly and directly re-elaborated.

Professor Hiroshi Ishii, founder of the MIT Tangible Media Group defines Tangible User Interfaces as follows: «user interfaces that augment physical reality by combining digital data and everyday objects»[3].

---

[3] https://tangible.media.mit.edu/.

TUI can be used in many fields and in many ways; they can facilitate the cognitive processes of users with specific needs or be used in architectural design projects, again to facilitate the mental efforts that are required, especially the efforts needed to succeed in tangibly representing a problem.

Tangible representation can be particularly effective in urban planning and architecture because it can facilitate the designers' cognitive perception of space and provide a more creative immersion in the problem, thereby enhancing sharing and collaboration between users.

TUI can be either passive or active, first generation or second generation. The so-called "tangible workbenches" are one of the most important first generation TUI. They are interactive surfaces developed to support co-design in which tangible objects are manipulated and their movements perceived by the workbench. This kind of TUI also uses dynamic representations thanks to video projections accompanying the manipulation of the tangible objects.

The Urban Planning Workbench (Urp) (Underkoffler, Ishii, 1999) developed by the Tangible Media Group is one example of a Tangible workbench. The Group uses physical models of buildings to simulate shadows, reflected sunlight, wind flows, and other parameters that can be controlled using several interactive objects.

The Urp is a first attempt to involve users in the design process. However, it does have some rather important limitations: users have to necessarily use a predefined set of objects (in this case architectural models) and can only modify their spatial relationship but not their form.

Based on these considerations the Tangible Media Group designed a second generation of organically-shaped TUI. This generation uses other tangible materials, such as clay and sand, that are easier to shape and manipulate. Illuminating Clay and Sand-Scape (Ishii, 2008) are two excellent examples. These two materials are used to shape and facilitate comprehension of complex topographies, otherwise difficult to create using conventional 3D modelling tools. The characteristic of the TUI known as PICO (Pattern, Ishii, 2007) make it the most appropriate for use in architectural design. This interface has an interactive table surface where small objects can be positioned and moved; the objects can be used to tackle the problems associated with complex layouts. PICO combines the advantages of relatively simple mechanical systems with the power of computerised calculus. There are two ways to move the objects: either using electromagnets controlled by the software, or by the users around the table who can physically intervene in the computational optimisation process. A comparative study of several co-design tools has shown how, compared to other proposals, users have solved the spatial problems of complex layouts more efficiently when they use this tool (Shaer, Hornecker, 2010).

Other TUI use tangible interaction in other fields such as logistics. Tinkersheets is a simulated environment that exploits simulation parameters to manage a warehouse. Users establish the parameters by positioning small magnets.

This not only allows office work to be planned and monitored by visualising the activities, but also permits alternative scenarios to be developed.

The key feature of TUI is that they go beyond the limits created by the boundary between physical and digital due to the strong link between tangible objects and intangible representations.

Using familiar objects facilitates the cognitive development of new ideas through psycho-sensorial perception and body movement (Turkle, 2007). In fact, gestures are not just a means to communicate but play an important role in the cognitive development of ideas and concretisation of what is verbally expressed (Goldin-Meadow, 2003).

Early experiments used TUI as support tools to experiment with participation in the design process; they exploited social interaction and dialogue between groups of users, first and foremost designers and future users. This collaboration is enhanced by some of the unique features of TUI such as familiarity, use, and intuitive interaction with everyday objects; these features boost the active involvement of users thanks to the possibility of multiple system access points; this allows simultaneous interaction and something more than just mouse and keyboard mobility. This is the reason why the platforms are very often like round tables where people can meet.

Using these mechanisms TUI allow users to exploit their thoughts and kinaesthetic memory and turn them into non-binding gestures. Actions such as pointing to objects, changing their arrangement, and transforming them can serve as epistemic actions that reduce the mental work load of a certain task by making use of non-mental resources and simplifying them vis-à-vis traditional user interfaces.

All the characteristics of TUI, and the examples presented here, lead us to believe that these tools could well be used to enhance user participation in the design of a complex building such as a hospital. More specifically, the flexibility of TUI, ease of use, and adaptability to different situations, could be exploited during the various stages of a hospital design, in particular:

- during the first concept stages to stimulate ideas from all users;
- during elaboration of the design to simplify communication between the professionals involved;
- during the modification and verification stages to receive feedback from future users;
- during the final design stages to illustrate and successfully explain the design choices;
- while the building is being used in order to help manage the workload.

Alla luce di quanto detto sino a ora, possiamo sostenere che le TUI, pur In light of all the above we feel confident that even if TUI are technologically complex they are important tools with which to experiment, study, and comprehensively apply in the field of co-design so that the final designs satisfy the needs of future users since they are based on a joint, collaborative effort.

References

Donetto, S., Tsianakas, V., Robert, G. (2014), *Using Experience-based Co-design to improve the quality of healthcare: mapping where we are now and establishing future directions*, King's College London, London.

Goldin-Meadow, S., (2003), *Hearing Gesture: How Our Hands Help Us Think*, Harvard University Press.

Ishii, H., (2008), "The tangible user interface and its evolution," *Communications of the ACM*, 51, 6, pp. 32-36.

Patten, J., Ishii, H., (2007) "Mechanical constraints as computational constraints in tabletop tangible interfaces*" Proceedings of CHI'07*, ACM, NY, pp. 809-818.

Sanders, E.B.N., Stappers, P.J., (2008), "Co-creation and the new landscapes of design", *CoDesign,* 4, 1, pp. 5-18.

Shaer, O., Hornecker, E., (2010) "Tangible User Interfaces: Past, Present, and future Directions", *Foundations and Trends in Human-Computer Interaction*, 3, nn. 1-2, pp. 1-137.

Steen, M., Manschot, M., De Koning, N. (2011), "Benefits of Co-design in Service Design Projects", *International Journal of Design*, 5,2, pp. 53-60.

Turkle, S., (2007), *Evocative Objects: Things We Think With*, MIT Press, Cambridge.

Ulrich R., Zimring C., Xiaobo Q., Anjali J., Choudhary R. (2004), *The role of the physical environment in the hospital of the 21th century: a once-in-a-lifetime opportunity*, Report to the Center for Health Design for the Designing the 21st Century Hospital Project.

Underkoffler, J., Ishii, H. (1999), "Urp: A Luminous-Tangible Workbench for Urban planning and Design", *Proceedings of CHI' 99*, ACM, NY, pp. 386-5393.

2.16 IMPROVING BUILDINGS QUALITY THROUGH THE REDUCTION OF THE ENERGY PERFORMANCE GAP

*Emanuele Piaia**

Abstract

The paper introduces a new quality assessment methodology, based on the concepts of "self-instruction" and "self-inspection" for low energy buildings built with prefabricated technologies. The application of this methodology becomes crucial because there is an increasing number of buildings that consume more energy than what expected during the design phase, despite: new energy efficiency standards, innovative digitalised design processes, use of highly performing building components. Reducing the gap between predicted and measured performance is therefore also necessary in consideration of the new European Union roadmap, which encourages the construction and refurbishment of energy-efficient buildings.

Keywords: Energy efficiency, Building inspection, Quality control, Building Information Model, Augmented Reality

Introduction

The European Commission's 2030 framework for climate and energy policy emphasizes that the largest share of the energy saving potential in the European Union is in the building sector which is identified as one of the key sectors to achieve the 20/20/20 targets. In fact, buildings are responsible for approximately 40% of energy consumption and 36% of CO2 emissions in the European Union (Buildings Performance Institute Europe, 2011).

Considering these ambitious goals, the European policy framework aims to create the conditions for improving energy efficiency of new construction and existing buildings. For this purpose guidelines are expressed in the Energy Performance of Buildings Directive (Directive 2002/91/EC) and its recast (Directive 2010/31/EC) that states the implementation of nearly zero-energy buildings as building target from 2018 onwards.These recent European directives have actually changed the construction sector. Analysing the building product market, the increased commercialisation of high-performance building components from an energetic point of view can be noticed.

* Emanuele Piaia is a Researcher at the Department of Architecture, University of Ferrara, Italy, piamnl@unife.it.

On the other hand, reflecting on design aspects, the aspiration to achieve high energy standards through the use of advanced digital design methods and the assembly of performant building components (especially prefab components) is evident.

Modern buildings are, in fact, largely made of prefabricated products (estimated in 70% of the whole European Union buildings) where architectural and MEP-HVAC components are currently designed and manufactured according to high quality standards whose design and technical performance have been tested prior to transport on construction site. The increase of the industrialization process' development, compared to on site construction, has brought several benefits: faster building construction, lower cost and more efficient assembly of components.

Despite the application of innovative digitalised design processes, the availability of high performance building components on the market and the increase of new energy efficiency regulations, buildings generally consume two to five times more energy than expected in the design phase (Menezes, Cripps, Bouchlaghem, Buswell, 2012) as demonstrated by the Chartered Institution of Building Services Engineers.

The discrepancy between the expected energy performance of the building at the design level and the real measured performance of the building constructed is defined as "performance gap". Reducing the gap between predicted and measured performance is crucial for the new European roadmap and to accomplish nearly zero energy buildings.

In this field, the European research project INSITER (Intuitive Self-Inspection Techniques using Augmented Reality for construction, refurbishment and maintenance of energy-efficient buildings made of prefabricated components, funded from the Horizon 2020 programme) developed a new quality assessment methodology for new and refurbished buildings, aimed to fill up the performance mismatch between design and construction stages.

Three main objectives characterized INSITER:

- to eliminate the gaps in terms of quality and energy-performance between the design and the realisation of energy efficient buildings made of prefabricated components, by connecting the BIM (Building Information Model) virtual model with the physical building in real time;
- to develop innovative systems as a set of intuitive, robust and cost-effective hardware and software for self-instruction and self-inspection adopted by workers and other stakeholders involved in the construction processes;
- to develop an innovative methodology, which consists of protocols and guidelines for self-inspection and self-instruction.

The following part of the paper introduces the main causes of the performance gap and the innovative inspection procedure proposed by INSITER.

Causes of performance gaps

Previous studies on the energy performance gap suggest several causes for the discrepancy between prediction and measurements.

At the "design stage": miscommunication about building performance targets between client and design team or within the design team itself; lack of appropriate design construction details and technical specification; incorrect application of methods or tools to predict the energy performance.

At the "construction stage": misunderstandings by construction workers about how design specifications and construction procedure should be implemented on site; lack of on construction-site practical considerations by designer. At the "operational stage": where the gap is influenced by inadequate use and behaviour of the building occupants, altering the performance defined in the design phase. The INSITER methodology is applicable exclusively at building construction stages in order to reduce the errors on site.

On the basis of this assumption, the research activity considers the design stage as perfect and does not contemplate the operational stage. Analysing buildings technology system, the main elements that can be recognized at construction stage as critical to achieve the as designed energy performance criteria are the building envelope and MEP/HVAC systems.

The building envelope can be divided into five items:

- foundation and ground floor (including foundation connection and façade connection);
- solid prefab façades (including window openings);
- curtain walls;
- roofing systems;
- connections between existing building and new elements.

On the other side, four main MEP/HVAC systems can be identified:

- heating & cooling;
- mechanical ventilation;
- solar hot water;
- LED lighting.

Studies on the introduced critical components have concretely demonstrated their significant impact on the building energy efficiency, especially now when the availability of better energy efficient components is increasing. For this reason, it is important the monitoring activity at construction site (from storage to commissioning) in order to ensure that these performance benefits are not lost due to incorrect assembly during the construction process which could affect the final building performance. Studying industrialized buildings made with prefab components, several errors can be committed during the construction and manufacturing stages, such as: off site building and MEP-HVAC components manufacturing in conflict with the design; incorrect or poor technical manufacturing of building envelope and MEP-HVAC components; on site manufacturing in conflict with the design; assembly of prefabricated components damaged due to transport, movement and incorrect storage on site; poor components locations or improper installation; misinterpretation or incorrect use of the technical documentation elaborated by the design team; geometric problems (size and shape) of building components; installation of unsuitable material; windows and doors incorrectly sealed on site. Last but not least, irregular site inspection by the project manager. Indeed, regular inspection on building construction site by the project manager is fundamental to control the quality of the work progress (Roders, Piaia, Sebastian, 2016).

Innovative methodology for building inspection

Currently, there is a lack of systematic evaluation and monitoring of the construction process. Conventional monitoring methods depend on extensive manual interaction, which is inaccurate, time-consuming and labour-intensive. Thus, the traditional practice heavily relies on inspectors' personal judgment, observational skills and their personal experience. These aspects imply a high probability of incomplete and inaccurate inspection reports. Furthermore, the inspection manual approach in contrast to a systematic approach is recognised as one of the main problems that cause project delays and cost overruns (Omar, Nehdi, 2016). Therefore, it is necessary to propose systematic quality assessment procedure in order to eliminate construction errors, to fill up the performance gap, to reduce on site rework and to maintain expected construction time and costs. In this field the INSITER project proposes:

- a method for self-inspection, directed to construction workers, containing an explanation of what kind of activities they should carry out for quality control and at which moment during the construction process;
- hardware tools that can be used for self-inspection, such as laser scanners, thermo-cameras, etc.;
- software that allows the previously mentioned self-inspection tools to communicate each other by means of a smart application programming interface and data integration with a cloud-based BIM;
- a BIM for life cycle performance and asset management of energy-efficient buildings able to connect the virtual model and the building on construction site in real time.

One of the main innovations proposed by INSITER within the building sector is represented by the concept of "self-instruction" and "self-inspection".

Self-instruction is a pro-active approach to provide workers with interactive digital guidance during the construction process, in order to prevent wrong actions. Self-instruction is provided on mobile devices, with continuous updates based on both pre-planned process as well as real time feedback from self-inspection.

Self-inspection instead, encourages construction workers to check their own working processes and the results respectively, both individually as well as peer-to-peer with other workers. The concept of self-inspection that is performed simultaneously with on site processes indeed, strongly contrasts the traditional post-inspection approach. In order to solve actual problems during construction, refurbishment, maintenance and commissioning phase, INSITER develops a new methodology with a dedicated toolset. The INSITER methodology is based on eight steps and provides for the integration with BIM models and AR (Augmented Reality) techniques.

Step 1 Mapping of actual technical conditions of the site or the building and economic assessment, requirements acquisition and comparison with the as-is situation. This step is performed by building occupants, owners, and technical advisors/inspection specialists. Such mapping is done using INSITER self-inspection software.

Step 2 Self-inspection in the procurement, production and delivery of prefabricated components. The step includes quality management; definition of procurement methods for contractors and suppliers; inspection of products in the factory.

Step 3 Building modeling in BIM. The building (new or existing) will be modelled in BIM, including detailed modelling of the current building and MEP/HVAC components that are critical for final energy performance.

Step 4 Generating and deploying BIM based AR for self-instruction and self-inspection. Scope of this step is to develop AR by embedding BIM and VR (Virtual Reality); to extract BIM/VR process information in self-instruction for manufacturers accessible on mobile devices; interfacing investigation tools with inspection software.

Step 5 Virtual validation of quality and performance through BIM checking and clash detection; as well as process optimization by means of virtual reality simulation. When errors are found, INSITER self-inspection protocols will apply for: review the clash details and then determine the severity of this clash; trace back the defaulting components to their manufacturers/suppliers and ask these actors to perform review thus propose recovery solutions.

Step 6 Self-inspection and self-instruction during preparation of construction site and logistics. Check of the construction site and update of site's BIM based on actual conditions; optimization of time and cost schedules by analyzing risks of delay and budget-overrun; update of self-instruction guidelines for construction workers.

Step 7 Self-inspection and self-instruction during construction, refurbishment, maintenance process. Check of the correctness and conditions of the delivered prefab components; implementation of self-instructions on construction workers mobile devices; comprehensive evaluation at certain intervals, performed by the site supervisor, involving workers from contractors and subcontractors.

Step 8 Self-inspection and self-instruction during pre-commissioning, commissioning and project delivery.

- *Step 8.1* Self-inspection during pre-commissioning by contractor and building owners: checking whether all systems work properly according to design specifications; check of the preliminary performance of building; registration of deviations and necessary measures; update of BIM in relation to the as-built model.
- *Step 8.2* Self-inspection during commissioning by contractor, building owners and occupants: set up and adjust the building and MEP/HVAC systems according to desired conditions; update performance information within BIM; connect the BIM with facility management or building automation systems, or, again, energy monitoring systems; BIM for self-instruction for building occupants.
- *Step 8.3* Self-inspection during project delivery: final inspection by the inspection specialist, contractor, building owners and the occupants; delivery of the building, including the as-built and the as-operated BIM; development of performance-based maintenance plans referred to the as-operated BIM, which can lead to (re)confirmation of warranty; update of the actual building performance, during operational phase, by building occupants through their mobile devices; delivery of self-instructions to building occupants, accessible/operable on their mobile devices.

Conclusions

New European Union policies require increasingly energy efficient buildings. As introduced, within the building sector there is an increasing concern about the mismatch between buildings' predicted energy performance at the design stage and the measured performance at commissioning stage.

It is necessary to mitigate defects and errors inside the construction process because they could affect building performance, construction time and cost.

Late detection of such construction errors/defects could be problematic in order to mitigate them on time.

The presented INSITER project proposes a new comprehensive methodology in order to reduce the amount of construction errors.

The methodology adopted can be summarized in three main stages.

The first stage is focused on digitalizing of the building in BIM, including its components and construction processes, where information is structured to be eligible for deployment during the construction stage.

As time related information about construction/assembly sequences is included in the 3D model, a four-dimensional (4D) BIM is developed. The BIM approach in the INSITER project will be based on the IFC (Industry Foundation Class) open standard to ensure appropriate interoperability.

Static IFC BIM models are enhanced with process simulations to include dynamic 4D information, handed from design team to on site workers. Then, the 4D simulations become available for self-instruction for construction workers (Riexinger et al., 2018).

The second stage deals with laser, thermal and acoustic/ultrasound scans of an existing building in a refurbishment project, or of a full scale mock up with crucial building components in a new construction project. The scan results are integrated in/superimposed to BIM for showing critical points where defects exist or potentially occur.

Virtual clash detections are performed off site using relevant BIM tools. Two approaches to clash detection are used: the first one concerns the detection and elimination of clashes due to design errors; and the second one analyses possible clashes when the design solutions are compared against the actual conditions, shown by the scan results that are integrated in BIM.

In the third stage, AR using the 4D BIM is prepared. Self-instruction models and identified or potential construction errors highlighted are visualized and examined in the AR environment (Sebastian et al., 2018).

Within the scope of the INSITER project, a comprehensive methodology has been developed for construction workers, project manager, building inspector, in order reduce the amount of errors.

Now, the methodology will be tested in real demonstration cases in different type of projects (new construction and refurbishment, including commissioning and maintenance).

References

Buildings Performance Institute Europe (2011), *Europès buildings under the microscope. A country-by-country review of the energy performance of buildings*, BPIE, Brussels (2011), Report.

Menezes, C.A., Cripps, A., Bouchlaghem, D., Buswell, R. (2012), "Predicted vs. actual energy performance of non-domestic buildings: Using post-occupancy evaluation data to reduce the performance gap", *Applied Energy*, 97, pp. 355-364.

Omar T., Nehdi, M.L. (2016), "Data acquisition technologies for construction progress tracking", *Automation in Construction*, 70, pp. 143-155.

Riexinger, G., Kluth, A., Olbrich, M., Braun, J.D., Bauerenhansl, T. (2018), "Mixed Reality for on-site self-instruction and self-inspection with Building Information Models", *Procedia CIRP 2018*, 72, pp. 1124-1129.

Roders, M., Piaia, E., Sebastian, R. (2016), "INSITER self-inspection method and instruments to ensure optimal performance of prefab retrofitting solutions", Sustainable built environment: Transition zero, *Conference publication of the SBR16*, Utrecht, April 7-8, 2016, HU University of Applied Sciences, Utrecht, pp. 33-42.

Sebastian, R., Olivadese, R., Piaia, E., Di Giulio, R., Bonsma, P., Braun, J.D., Riexinger, G. (2018), "Connecting the knowhow of design, production and construction professionals through mixed reality to overcome building's performance gaps", *MDPI Proceedings 2018*, 2, pp. 1153-1157.

Fig. 1 - The H2020-INSITER research project develops a new methodology for evaluating the construction quality of buildings in order to reduce the existing performance gap between the design phase and the built building. The methodology aims to connect all the knowledge of designers, producers and builders through augmented and virtual reality in order to reduce construction errors on site.

2.17 INDUSTRIAL PRODUCTION, NEW TOOLS AND TECHNOLOGIES FOR DESIGN OF CUSTOM PREFAB HOUSING

Spartaco Paris, Roberto Bianchi*, Beatrice Jlenia Pesce**

Abstract

The paper investigates the relationship between the production of systems and components for prefabricated houses and the innovation of design tools. The goal is to understand the current limits and potentials of the available instruments of parametric modelling; it follows an operational path articulated in two parallel activities: an analysis carried out on recent case studies of industrialized houses and through an experimentation activity carried out on the field. The text focuses on BIM, which allows creating virtual models that simulate the construction, the use and the management over time.

Keywords: Mass customization, adaptability, reversibility, BIM, digitalization

Introduction

The paper investigates the relationship between the production of systems and components for prefabricated houses and the innovation of design tools.

This theme is part of a research developed within the Ph.D. in Planning, Design and Technology[1] and within the University research carried out at the University of Rome[2]. This ongoing study aims to understand the current limits and potentials of the instruments, available today, for parametric modelling; it follows an operational path articulated in two parallel activities: an analysis carried out on recent case studies of industrialized houses and through an experimental field research.

* Spartaco Paris is an Associate Professor at the Department, Sapienza University of Rome, Italy, spartaco.paris@uniroma1.it.

* Roberto Bianchi is a Lecturer at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, roberto.bianchi@uniroma1.it.

* Beatrice Jlenia Pesce is a PhD Candidate at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, jlenia.pesce@uniroma1.it.

1 "Industrial mass customization for temporary and reversible housing", Beatrice Jlenia Pesce, Tutor: Prof. Spartaco Paris, XXXI cycle, PhD in PDTA, Sapienza University of Rome.

2 "Advanced technologies and design criteria for systems and components in residential buildings retrofitting for building envelope" coordinated by Spartaco Paris.

One of the research fields of the Modern Movement has been to increase the adaptability of domestic space, stimulating many of the reflections and experiments in residential architecture by the main modern and contemporary architects (Schwartz-Clauss, 2002).

Today more than ever, the progressive overlapping of the working sphere with the private one, as well as the need to foster an increasingly flexible lifestyle, free and nomadic, has led to search, with ever greater commitment, housing solutions that can be freed from predefined layouts (Ábalos, 2012).

The adaptability of the domestic space has already reached in the past the most interesting results when it was pursued through industrialized construction systems. The current prefabricated systems, although starting from the standardization of the components, allow greater flexibility in the design phase and a consequent adaptability during the entire architecture life cycle.

Designing depending on the adaptability of a system, means dealing with the "time factor" of the project, time from which changes in uses and functions are achieved, but also spatial configurations. According to R. Krananenburg[3]:

> «A house designed for mobile, flexible living could be one which during its inhabitation might be moved from one place to another or be changed in its shape or structure – walls might fold, floors shift, staircases extend; lighting, colours and surface textures metamorphose. Parts of the house could leave the site or a part could be added or the whole building could leave the site and return, or the entire building could roll, float or fly to a different location» (Kronenburg, 2002).

The building systems that might support this sight of inhabit are usually customizable and use specific management and design tools. Nowadays the customer requires an increasing personalization of the "product" he needs.

In the 21st century, architecture would be a customizable "product": modular construction is no longer conditioned by mass production, repetition or uniformity. Today, in all industrial productions, mass customization[4] has almost completely replaced mass production. The latter depended on production rate to reach economic convenience; on the other hand, mass customization, thanks to a different production and management model, subverts this production rule, following a cultural model that puts the customer at the centre, as an active subject in designing and manufacturing. Companies like Dell or Nike succeeded also thanks to the ability to offer their customers high quality products with a high customization level, while maintaining a low cost. This has been possible by subdividing the product into smaller parts on which the consumer can make a choice. Through a careful management of suppliers, obtained through informatics control platforms, these companies can assemble the product, depending on the buyer desires, and send it in a reasonable time (Kieran, 2004).

---

[3] "Modern Architecture and the Flexible dwelling", in *Living in Motion*, p. 21.

[4] Definable as "the production of high-quality components, adaptable to the individual choices of designers and consumers" (Hashemi et al., 2016).

Today, mass customization suggests a new way of design architecture and offers the tools to manage its complexity, due to the increasing level of mechanization. Each component is designed and verified by an interdisciplinary team that guarantees its reliability. The simulators and the virtual models also make it possible to control and to verify, in real time, the form, the performances and costs, thus allowing choices that are more conscious. The informatics tools make it possible to organize the complexity in both design and construction phases, managing time information, costs, assembly sequences, the geometry and the position of each component. Among these informatics tools there are the BIM[5]. This type of digital platforms allows creating virtual models that simulate the construction, the use and the management over time of the architecture. The simulation makes possible to divide the building in littlest and easily manageable parts that can also be designed or manufactured in another place, and shipped directly to the site for the final assembly. In these digital models the joints and angles are designed and studied as well as information regarding the constraints and performance of each component. The virtual model becomes a verification tool that makes the use of physical mock ups superfluous and allows solving the possible interferences between the architecture parts before the construction phase. With these processes, "doing' architecture can be raised through greater control of the project, raising quality standards and improving performance. Using BIM software, designers therefore have the opportunity to control, in addition to the single multidisciplinary contributions involved in the project, the entire design / production process, the constraints and the role of all "parts" which compose the construction. He can manage the design and assembly of each components "piece by piece", providing for their sequence of assembly and connection. One of the other potentials inherent in the use of a BIM software for architecture is the possibility, as it happens for other industries, to establish a direct connection with the world of research and experimental production, since it is possible to verify the functioning and performance of innovative components within the same virtual model.

A case study: *pop-up system*

In this context, a field research was carried out on a series of light and customizable building systems that can also be used for temporary housing.

The systems have been selected for their flexibility and adaptability. It was possible to study the *pop-up building system*, through virtual models managed with a BIM software, a period of study within the Italian design partner of the French pop-up house and, during the system upgrade, into the French factory.

---

5 Building Information Modeling, «acronym coined at the beginning of 2002 to describe together virtual design, building and Facility Management» (Osello, 2012).

The pop-up construction system belongs to the family of wooden frame systems. It was patented in 2015 by the Marseilles pop-up house as a highly insulated system, whose walls are made of expanded polystyrene panels (Eps), a low-density thermal insulation material. The polystyrene panels have uniformly flat surfaces on each side and are assembled together by means of microlamellar wood studs (Lvl), 30 mm thick, interposed adjacent to the Eps panels. The studs and panels have the same depth. They are connected to each other by means of screws 665 mm long, arranged along the whole height, which, crossing the entire thickness of the panel, avoid the deformation of the stud both transversely to its plane and at the moment. This arrangement of the connections allows the panel to collaborate statically against the lateral forces of the wind. The innovation compared to other similar construction systems, as specified in the patent application, lies in the extreme simplicity of the system, in the choice to use very light and handy construction elements, and in the collaboration of the insulating panels to the statics of the building. The same static and constructive solution employed for vertical bearing structures is also proposed for horizontal structures. The dry assembly of the building system, without the use of glues, facilitates the disassembly of each component, in view of reuse or recycling. The hyper-isolated structure makes passive houses and requires a careful bioclimatic design. Consistently to the site, the designers perform simulations of the solar path, adding, where necessary, overhangs brise soleil; the windows are usually placed aligned to the inner surface of the wall in order to exploit its thickness for shading. The building system is designed to adapt to all the French microclimates, but it can also be imported into the Italian climate context where the first pop-up buildings begin to be built.

250 buildings have already been built (in just over 3 years of commercialization), with good future sales previsions. The system, due to its micro-modularity, allows a good flexibility in design phase, guaranteeing a high degree of planimetric and volumetric customization. Now the constructive limits are in the maximum high development of two floors, in the maximum free light between two bearing walls of about eight meters and in maximum overhang.

These limitations, however, are irrelevant if we think that the market to which the company head towards is the one of isolated houses. What has established the success of this company, in addition to the quality of the architecture, is a careful management of the process. The company, which has a background in the IT sector, has focused both on the digitalization of design and configuration phase, developing a BIM application from the Sketch-up software, and on automating the construction process. The software is optimized for the management of that building system and allows controlling the costs and constructive implications of the design choices in real time. Starting from this application, the online configurator was developed, available to design partners, which makes the design and modelling phase immediate, considerably shortens communication times with the company and with the customer.

Once the project has been completed, the company calculates the structure and the energy performance and provides the certifications required by the French legislation[6]. In this phase, it is very important to acquire the climatic data on the prevailing winds because, since this is a light construction system, they imply an increase in the structure at the points of greatest stress.

The company follows the double channel of mass custom and semi-custom production: it is so possible to design a completely new house or to modify a pre-arranged housing model, starting from a dialogue between the user and the designer aimed at identifying customer needs.

The construction elements follow the modular logic of the system and come to the construction site ready for assembly, with a detailed design, a precise storage and installation plan[7]. A team that has been formed by the company then assembles the house. A single worker can easily transport and place each component. The speed in execution makes this system usable in emergency conditions. The production times for a single house are about 6 weeks, but the assembly time is about 10 days. The costs are competitive, even on the Italian market; however, it is necessary to activate a minimum production volume, equal to a surface of 70 square meters, so that the company obtains economic advantage. At the moment, therefore, small houses are not sold.

One of the strengths of the building system is the quality of the materials chosen on their low pollutant emissions into the air[8]. The company is constantly working to optimize connections and joints, to reduce the number of components and to minimize on site assembly operations. The design research within the company focuses on reducing maximum number of components produced by external subcontractors in order to manage the production phase as autonomously as possible, optimizing the times. Other customizable industrial production, tends to produce increasingly complex components and to reduce the number to shorten assembly operations. The pop-up case pursues this goal in the opposite way: simplifying the components, which are always monomaterial, thus favouring their reuse. During the experimentation phase, we developed, in collaboration with pop-up house Italian partner, the project of a 30 m^2. housing module that, when aggregating with another module, allows to reach a covered surface area of 70 m^2. In fact, the Italian market also requires very small modules that can be used as pavilions, dependences, or small offices. The idea was to design a more adaptable home, which could change over time, growing or decreasing, without causing excessive resource waste.

---

6 The French certification rules do not match with the Italian ones, so it is necessary that the Italian partner verify the structural design calculations.

7 Each building is equipped with an assembly and disassembly booklet.

8 The Eps is neutral to smell, does not degrade the air quality of the spaces that delimits and prevents the formation of molds, it is also sealed behind the panels of Osb. The panels mounted in pop-up houses are free of formaldehyde and have E1 emission class, as well as the phenolic glue used in the micro-lamellar uprights.

The modules can be added to the existing one(s), using a spatial filter that becomes distribution and which is built by translating the overhanging roof above one of the entrances. Precisely to allow the free arrangement of the module depending on orientation or aggregation mode, each of the four sides has a window or a door that allows the modules to be connected in each direction.

Although the pop-up house has produced an innovative constructive system, focusing on the digitalization of the process and on the automation of production, there seems to be no complete reflection on how this innovation can influence new forms of living.

The small experimentation, starting from the technological and constructive assumptions developed within the pop-up system, proposes a solution that opens up to future scenarios in the field of residential constructions.

Conclusions

To date, we have seen a difficulty in updating the production chain, mainly used to conceiving the design and construction activities in a traditional way, and, at the same time, the need to increase the level of training - even within the company - of all the actors involved from the conception phase, to production up to construction.

Actually, a significant development element with a great potential is the possibility of providing a building system not only with an as-design model, but also with an as-built model, for managing operation and maintenance activities.

References

Ábalos, I. (2012), *Il buon abitare. Pensare le case della modernità*, C. Marinotti Edizioni, Milano.

Hashemi, A., Kim, U. K., Bell, P. (2016), "Prefabrication" in Noguchi, M. (ed), *ZEMCH: Toward the Delivery of Zero Energy Mass Custom Homes*, Springer, Basel, pp. 65-94.

Kieran, S., Timberlake, J. (2004), *Refabricating Architecture – How manufacturing methodologies are poised to transform building construction*, McGraw-Hill, New York.

Kronenburg, R. (2002), "Modern Architecture and the Flexible Dwelling", in Schwartz-Clauss, M. (ed), *Living in motion. Design and architecture for flexible dwelling*, Vitra Design Stiftung gGmbH, Weil am Rhein, pp. 11-17.

Osello, A. (2012), *Il futuro del disegno con il BIM per Ingegneri e Architetti*, Flaccovio, Palermo.

Paris, S. (2017), "Il rinnovamento della cultura tecnologica nel progetto, tra nuova tettonica e tecnologie digitali. Scenari internazionali dell'insegnamento e della ricerca", *Techne*, n. 13, Firenze University Press, pp. 194-203.

Schwartz-Clauss, M. (2002), "Dwelling on Living in motion – an Introduction", in Schwartz-Clauss, M. (Ed), *Living in motion. Design and architecture for flexible dwelling*, Vitra Design Stiftung gGmbH, Weil am Rhein, pp. 11-17.

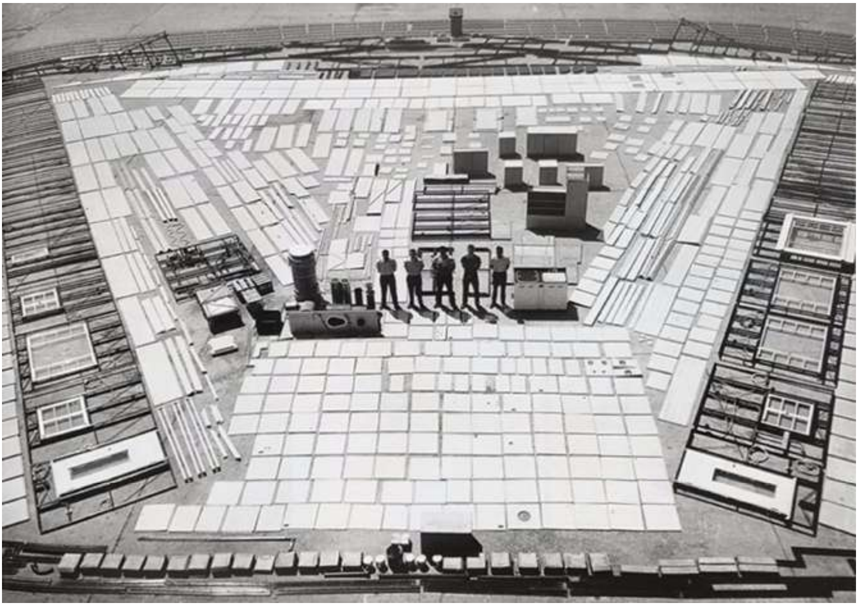


Fig. 1 - Lustron house. Columbus, Ohio, 1948-1950. Carl Strandlund.

2.18 HYBRIDIZATION BETWEEN BIM AND VPL. SOFTWARE DEVELOPMENT FOR EMBODIED ENERGY CALCULATION OF BUILDINGS

Roberto Giordano, Massimiliano Lo Turco*, Yoseph Bausola Pagliero**

Abstract
The technological project is recently moving towards new paradigms to be considered as complementary to traditional ones. This is a crucial change intended to respond both to the deep crisis in the construction sector and to the innovations of the digital age. The information to be processed are comprehensive and articulated and, consequently, it is necessary to acting with new methods and tools that can digitally simulate the building's performance and its impact in the lifecycle.
The paper deals with the results of research aimed at characterizing the impact of construction products, through the development of a generative algorithm enabling to dynamically relate the Embodied Energy in the design process.

Keywords: Systemic thinking and parametricism, Embodied Energy, Visual Programming Language, Building Information Modelling

Introduction

In the past, the construction sector has often shown little sensitivity to economic, technological and social changes. The way the building was conceived, developed and built was based on a set of established requirements. The building had to perform specific functions, using materials and components with defined and standardized characteristics and it was designed to remain the same over time. The transition from the traditional building to the Smart Building caused a change. ICT (Information Communication and Technology) was progressively introduced in the building design as well in the construction activities. It was added the need of an analytical dimension, decomposable to "monolithic" character of traditional building, where the project is the result of an overlapping and a mutual coordination among the several subsystems.

* Roberto Giordano is an Associate Professor at the Department Architecture Design, Politecnico di Torino, Italy, roberto.giordano@polito.it.

* Massimiliano Lo Turco is an Associate Professor at the Department Architecture Design, Politecnico di Torino, Italy, massimiliano.loturco@polito.it.

* Yoseph Bausola Pagliero is a Visual Programme Consultant, yoseph.bausola@vplbim.com.

In such frame the use of BIM (Building Information Modelling) methodologies seems to be the best answer to these instances (Garzino, 2011).

The interdisciplinary research carried out by the Department of Architecture and Design (DAD) was aimed at exploring the capabilities offered by VPL (Visual Programming Language) digital environments based on nodal graph systems, to define specific technical approaches: a conscious algorithmic approach simplifies the parameterization of complex forms; moreover, this approach allows to relate in real time and parametrically those variables designed to verify the energy impact of construction products in the design stage, operating an efficient integration of the different systems (spatial, structural, performance, etc.) that constitute the architectural object.

Interoperable methodologies for the building design and the process

The synergies between digital parametric modelling, repeated morphogenetic algorithms and the definition of variables that allow the measurement of environmental impact through shared and interoperable virtual environments can be considered the most innovative aspect of the research.

Before entering into the description of the proposed calculation method, it is crucial to dwell on the meaning of the term parameter, which is very much in use today and can be characterized according to the context of application.

There are software applications in which the parameter is central to a system of associated dimensional relations and is given flexibility by procedures that facilitates not only the formal conception but also the changes occurring in the subsequent construction stages - fertile ground for experimenting with programming code (Converso, 2010). This is the case of nodal systems, obtained through the recognition and abstraction of simple geometries to which approximate complex forms. Then, the analysis of the same forms has been processed, also through the use of various applications considered essential for the representation of 3D models (Terzidis, 2006) and in the management of complex structures (Rhinoceros, Grasshopper® and its plug-in). In other scenarios, usually poorly interoperable with the previous ones, the term parameter refers to the control of a certain number of variables (geometrical/relational and other ones) that enable a particular process to be managed. In the well-known context of the design software packages, the process of the constructing relationships and generating objects via modelling procedures is often carried out using programming environment provided within the individual applications, that are known as scripting. This refers to a programming language available within a software application that enables it to be tailored from the inside, by customizing the tools. Today, these tools have made functions available to designers that were previously inaccessible functions, thus enhancing not only the modelling procedures but as a result also making it easier to use.

IREEA Plug-in. A dynamic eco-design tool

In the above-mentioned scenario, software such as Grasshopper® can not to be considered as simple tools that help the designer. They are design programming models based on graphic interfaces that allow designers to customize codes capable of processing the shape and functions of a building.

Among the codes several information (input) can be included. They specify - or aid to specify - the building's performance as well as the components and materials' performances. In order to minimize the impact on the ecosystems, the building needed to be assessed in terms of environmental sustainability, through an increasingly number of requirements. Such requirements are not exclusively limited to the optimisation of energy and environmental resources during the use stage of a building. Recently, indeed, some environmental indicators have been fully included in the methods to analysing and assessing the performance of a building over its life cycle. Nowadays architects have to take into account such indicators in their project activities.

In order to enable the Life Cycle Assessment - LCA[1] as a method and a tool for assessing the environmental sustainability of architectural and technological options, the DAD building technology's research group developed a spreadsheet in .xls format named IREEA (Initial and Recurring Embodied Energy).

IREEA is made up of a database and a spreadsheet which allow - through a combined procedure - to calculate the primary energy content from renewable and non-renewable sources for a high number of building systems and some building services. The calculation is made in relation to the building life cycle that can be set up by the user. This make possible a comparison between the results and parameters of some international standards and norms (Swiss society of engineers and architects, 2012).

Embodied Energy (EE), also known as Grey Energy, defines the total amount of Primary Energy (MJ) - usually making a distinction between renewable and non-renewable energy sources - used to produce, use, maintain and dispose of a product in its life cycle. EE is therefore an energy indicator enables to quantify the performance of building systems, which can be related to other parameters, in particular the Operational Energy (OE), which defines the Primary Energy need for cooling and heating as well as for the domestic hot water and lighting.

The EE methodology was developed in accordance to ISO 14040:2006 and EN ISO 15978:2011 standards, as well as with the Swiss Minergie® certification. The swiss certification requires the fulfilment of threshold values in order to obtain the building license both in the case of new construction and in the case of renovation.

---

1 Life Cycle Assessment can be assumed as «a process of objective quantification of energy needs of materials used; a quantification of releases into the environment; a process to assessing the impacts on the ecosystem and the pollutant emissions» (Giordano, 2010).

EE accounts for a significant percentage of the building energy balance. For certain typologies and uses of buildings, it can account for more than 50% of the total primary energy need. Like the OE, it is recommended to calculate the EE from the preliminary design process; this in order to make the results of the building life cycle analysis capable of influencing the characteristics of the building, at least with regards to materials and building systems. It should also be considered that most of the tools - mostly software - developed to date are not developed in order to "build" an interface enabling to correlate the EE analysis with the design process[2]. The EE values of the IREEA database were then used as input data, necessary for developing a generative algorithm; this was done by importing the data through a plug-in of the VPL software, making possible to dynamically relate the database - necessary for the calculation of the EE of a building - with Grasshopper®'s algorithm. The database information is used in three main clusters, or, "containers" able to gather algorithms.

The first cluster is useful to characterize the performance of the material used in the i^{th} layer that composes a j^{th} building system.

The second cluster was aimed at relating the values determined for the materials in order to quantify the EE of the j-th building system.

The third cluster is the outcome of the information importing process. The information that were processed in the second cluster into the building's algorithm. This could be called the IREEA algorithm or IREEA plug-in.

In order to verify the accuracy of algorithms, the plug-in was applied at architectural and technological design scale.

The building shown in figure 1, The Hide, is a project of a 22-storey tower, 92 metres height, sited in the city of Turin. It is a project aimed at renovating and raising the former INPS (National Institute of Social Security) office headquarters. The new tower is located at the intersection between two roads: Corso Filippo Turati and Via Amerigo Vespucci. On the first floors, some tertiary functions will be maintained, while on the following floors, a hotel will be built. Finally, the last three floors (from the 19^{th} to the 21^{st}) are intended for gym, restaurant and lounge bar with panoramic terrace. It is evident that The Hide is featured by a certain technological complexity and innovation, particularly with regard to structural and technical elements. It provides for: steel-trusses, a double skin along the facade facing the south-southwest quadrant; curtain walls in the other facades. The heterogeneity of building materials and components allowed the research team to carry out an EE analysis and assessment over a considerable amount of data, necessary to validate the algorithm. Finally, one cannot overlook that The Hide was developed in a parametric way using Grasshopper®[3].

---

2 One of the most well known building Life Cycle Assessment tools matched to a design software is Tally™. It allows to determine some environmental impact categories for the Revit system.

3 The project data were processed through ArchiCAD® included in the Grasshopper® model.

As mentioned before, through the third cluster, IREEA was imported in its parametric version within the algorithm that characterizes The Hide. The EE of the building was thus determined on the basis of an estimated life cycle of 50 years[4]. In order to verify the algorithms accuracy, the results of the third cluster were compared with those obtained using the spreadsheet in .xls IREEA format. The results for the technical elements (normalised to 1 m^2 of building system) show a deviation of about 1%; the results for the building show a deviation of 3%. The deviation in the determination of the building's EE is due to the calculation procedure of building surfaces; in one case was counted manually by the user, in the other one was processed by a Grasshopper® algorithm.

Results and conclusions

The parametric development of a building designed in a VPL environment has made it possible to develop a procedure of interoperability between the two platforms (VPL and BIM), able to record the data entered in different work environments, to verify the quality of processing on a building used as a case study and to update in a responsive way to changes made by the user.

The crossing between the two systems and the interconnection with the spreadsheets dedicated to the calculation of the EE (checkable in real time) is the most innovative element of the research.

There are, nevertheless, some critical issues that may be the object of further investigations, also as a result of future releases of the tool Grasshopper-ArchiCAD Live Connection. The BIM model consists of 87% of building components generated in the BIM platform following the described workflow.

The remaining percentage refers to the remaining building components that, although of minor importance for energy calculation purposes, have been modelled directly in the BIM environment and therefore do not allow real-time verification of the relationships between geometric and performative attributes.

A second order of problems derives from the partial semantic recognition of some construction elements, in the transition between the algorithmic program-objects. Also, in this case, it is worth remembering that the connection tool in a stable configuration has been released for a couple of years and each subsequent version integrates and optimizes the workflow identified for the previous versions. In a context still under development, however, the overall reliability of the proposed method and of the plug-in developed deserves to be pointed out. It was found a negligible percentage deviation (less than 5%) between the EE values (calculated through the analysis resulting from the relationship between BIM, VPL and IREEA) compared to the same values obtained ex post through a more traditional calculation approach.

---

[4] Coherently to Minergie™ standard.

This demonstrates the great flexibility of an A-BIM (Algorithmic BIM) approach, useful not only for the discretization of complex forms, but also for the integrated control of an ever-increasing number of variables belonging to the different disciplines that participate with different roles and competences in the different phases of the decision-making, construction and maintenance processes (Lo Turco, 2015).

Acknowledgements
The authors thank architects Mario Napolitano and Francesco Fiorentino for the precious work carried out during what was originally a thesis of Master's Degree in Architecture for the Sustainable Design turned over time into a real multidisciplinary research activity, characterized by several innovation elements. Since: *Whoever lifts the anchor is always the youngest!*

References

Converso, S. (2010), *Il progetto digitale per la costruzione. Cronache di un mutamento professionale*, Maggioli, Santarcangelo di Romagna.

Garzino, G. (ed) (2011), *Disegno e in formazione, Disegno Politecnico,* Maggioli, Santarcangelo di Romagna.

Giordano, R. (2010), *I prodotti per l'edilizia sostenibile*, Sistemi Editoriali, Esselibri, Napoli.

Lo Turco, M. (2015), *Il BIM e la rappresentazione infografica nel processo edilizio: dieci anni di ricerche e applicazioni*, Aracne Editrice, Ariccia.

Swiss society of engineers and architects (2012). "Energia grigia negli edifici (Buildings grey energy)", *Quaderno tecnico SIA 2032*, (accessed 12.09.2018).

UNI EN ISO 14040 (2006), *Environmental management - Life cycle assessment - Principles and framework*.

Terzidis, K. (2006), *Algorithmic architecture*, Elsevier, Amsterdam.

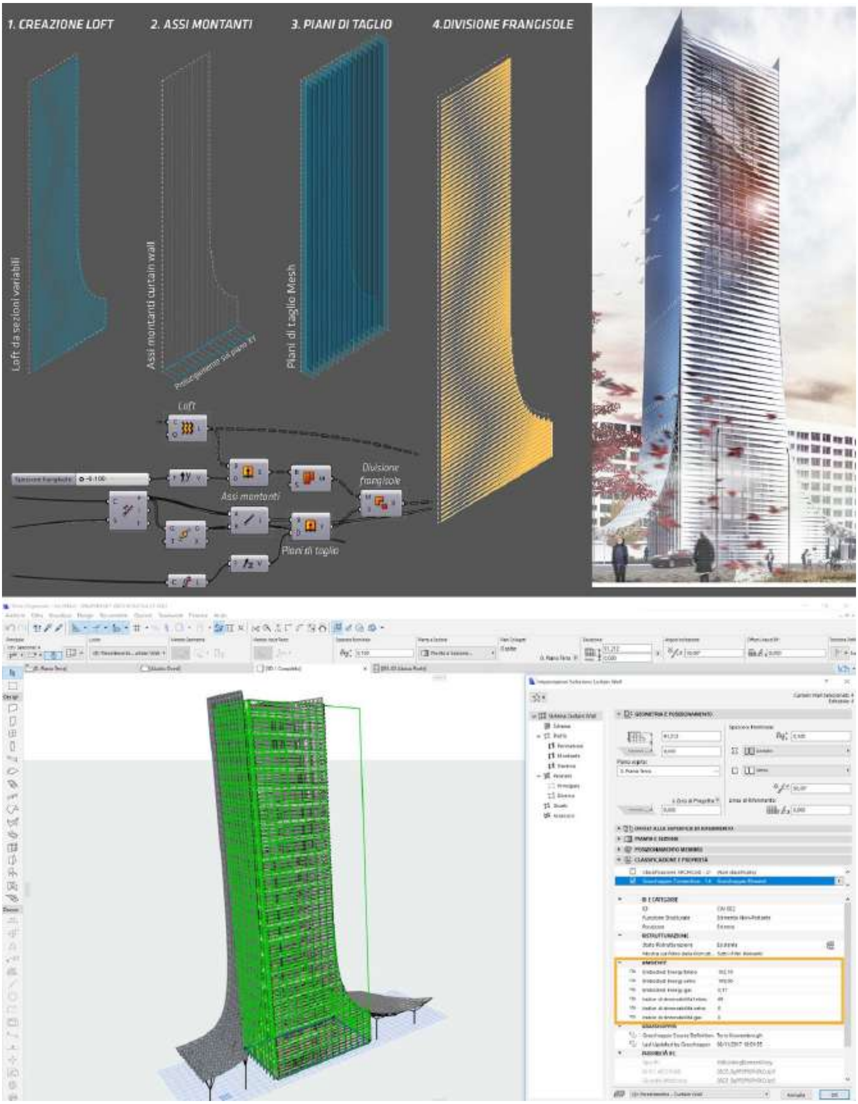


Fig. 1 - The Hide building.
Left, top: relationship between the modular subdivision of the continuous facade and the shading system managed through Grasshopper® visual programming.
Right, representation of the case study.
Below, display of the IFC parameters relating to the EE values for the curtain wall elements imported into the BIM application (ArchiCAD®).

2.19 CONCRETE INNOVATION BETWEEN DEMATERIALIZATION AND INDUSTRY 4.0

Jenine Principe[*]

Abstract

Concrete continues its evolution becoming an advanced material thanks to the possibilities offered by matter manipulation, which allows a modification of its structural capacity and performances, above all in terms of durability. At the same time, the innovations introduced by Industry 4.0 model push towards a personalized and parametrizable design, while overcoming standardized production, through 3D printing and contour crafting techniques. Therefore, the conventional ways of thinking the concrete project are changing, requiring, once again, a redefinition of the qualitative threshold of the new mass-customized products and introducing a new level of complexity, which cannot be ignored by the contemporary design research.

Keywords: De-materialization, Nanotechnology, Industry 4.0, UHPFRC, De-standardization

The variability inherent in the plastic nature of concrete has recently contaminated the deepest levels of matter, determining some changes even in its molecular structure. The rapid technological advancement has led to a series of innovations whose absorption process is still ongoing, slowed down by cultural, economic and productive obstacles.

In particular, the Ultra High-Performance Fibre Reinforced Concrete[1], can be defined as advanced material, demanding, for this reason, a less conventional approach to structural and technological design. However, UHPFRC still suffers the constructive tradition coming from more than a century of architectural experimentation.

The plasticity, in part the aesthetic features and the structural strength (still based on the optimization of the compressive behaviour) recall some works of Musmeci, Saarinen and Nervi, who have been able to exploit properly the structural performances of reinforced concrete. Equally significant is the relationship with the Industry 4.0 model's new means of production.

---

[*] Jenine Principe is a PhD student at the Department of Architecture of the University of Naples Federico II, Italy, jenineprincipe@gmail.com.

[1] The French Association of Civil Engineers defines the Ultra High-Performance Fibre Reinforced Concretes as composite materials with a cement-based matrix with a characteristic compressive strength between 150 and 250 MPa. UHPFRCs are characterized by a high tensile strength (7 MPa), obtained thanks to the use of organic or steel fibres.

In fact, digital fabrication allows to overcome the traditional construction sequences based on the combination of prefabricated components assembled on site, using material moulding techniques.

However, while unfolding the concrete revolution, the shift from the artificial to the hyper-artificial has to be considered as a fundamental starting point. After this transition, materials are characterized by a complexity able to cast doubt even on their recognizability (Manzini, 1986), making the new ways of the "production of matter" one of the essential aspects of the analysis.

Dematerialization and nanotechnologies for the "production of matter"

Since the Nineties, the dematerialization approach, i.e. a reduction in the use of materials and energies for the production of goods and services without affecting their performances, begins to be considered a cornerstone of a more sustainable economy.

Furthermore, a new concept of products was introduced. It was based on the MIPS (Material Inputs For Service) notion (Schmidt-Bleek, 1994), through which products became service-producing machines, dematerializing themselves in their function or, better, in the needs they are going to satisfy.

The term dematerialization indicates, therefore, also the shift of productive and economic processes towards services and information. In this way the initial definition of dematerialization, which was referred to the miniaturization of the product or of its fundamental components, was overcame. Even the term miniaturization ends up not only denoting the realization of smaller elements, but also the elimination of part of the components of an object by intervening on the deepest qualities of the materials. The latter are "rematerialized" in order to integrate the properties, the surface characteristics and the information previously contained by the external element (Manzini, 1986).

This led to the advent of nanoscience which, manipulating the chemistry, the microstructure and the architecture of matter[2] (Fleck et al., 2010), has determined a huge expansion of the material's design space, often causing the introduction of new disruptive technologies[3].

However, not only products are changing, but also the memory of the materials and the experiential relationship coming from construction issues.

---

[2] Through manipulation of the chemistry of the materials new composites are introduced, while intervening on the microstructure leads to the reduction of material defects by repositioning its molecules. Finally, the architecture manipulation works on the combination of different substances.

[3] The birth of selective, photochromic and thermochromic glasses is due to the presence of nanoparticles of metal oxides on the sheet surfaces. Silicon nanoparticles are used to make transparent photovoltaic films, while fly ashes and silica fume at the nanometric scale are fundamental additives of the ultra-high-performance concretes. By introducing carbon nanotubes into a cement or polymeric matrix, materials with high mechanical strength are obtained.

For UHPFRCs, the improvement in durability and mechanical strength due to the nano-silica addition in the mix-design has caused the abandonment of the fundamentally empirical approach that governed (almost completely) the construction of concrete buildings.

The possibility of minimizing or even eliminating steel reinforcements, the intense use of prefabrication and the precision necessary to obtain a high-quality mixture require a design characterized by scientific meticulousness.

If previously the load bearing capacity of a structure was determined by the resistance of the material utilized for its realization, today, on the contrary, the material obeys to structural design characteristics. This leads to an inversion of the subalternity relationship which used to link the design to the original performances and properties of the materials.

This alteration implies the use of new classification methods, based on the recognition of the performance levels and of the evocative images that materials generate not as themselves but as parts of manufactured goods. At this point it is impossible to separate materials from their production processes, which thus assume a new centrality (Manzini, 1986).

Industry 4.0's new means of production in concrete field

The principles underlying the Second Industrial Revolution, such as standardization, specialization, synchronization, concentration, maximization, centralization (Toffler, 1980), often led to a lack of convergence between technological design and construction, marking the disappearance of the direct relationship between «materials and object configuration», between «crafts and abilities to produce» (Zanuso, 1983).

On the contrary, today the project is again «intrinsic and contemporary to the concept of production» (Zanuso, 1983), although there are many differences with the past.

The knowledge exchange takes place on the web, the artisan becomes digital and, above all, every artefact, thanks to the design-to-fabrication systems, is at the same time a prototype and an element of a diversified series.

Working on the interface between information and its physical representation, the relationship between material and immaterial changes and, in a certain way, becomes simpler: so, it is possible to create objects starting from their virtual definition.

For ultra-high-performance concretes, this is particularly true in the case of prefabricated elements.

For example, the prototyping phase, which is extremely delicate also because it is required for structural verifications, is facilitated by the application of digital fabrication tools to obtain models through direct printing or pouring in printed moulds.

In the same way, form finding processes are able to transform users' request, environmental specificities and characteristics of the material into parametric constraints for an interactive design, so supporting the design complexity typical of architectural applications. These, in fact, tend to exploit at most the plasticity of the material, proposing organic and articulated forms, often with customized finishes and colours.

However, despite the complex morphologies, casting process continues to be preferred to other prefabrication systems ("shotcrete", lamination[4] and 3D printing). This is probably due to its capability of covering the widest range of possible applications[5], while offering a still unreached finishing quality, besides being the most consolidated technique.

On the other hand, this has ensured an evolution of the formworks, now parametric, deformable, movable, printable and texturized. This led to a significative change in the mould design which, in turn, greatly impacts the project of the material. In fact, concrete starts to get rid of its "container", gaining degrees of formal and structural freedom. In any case, since prefabrication companies' commissions mostly concern the realization of small or very small series, mainly aimed at the construction of a single building, the casting processes are often unable to supply the required production line flexibility.

The use of 3D printers would seem to be the ideal solution. The possibility of producing unique components at competitive prices is undoubtedly the most significant advantage of this technology, which also offers a noticeable formal freedom and an almost complete lack of waste material. However, there are still difficulties related to the creation of protruding geometries, to the printing resolution and, in general, there is a lack of knowledge of the real performances of the printed products, especially with regards to the structural characteristics, strongly influenced by the adherence between the individual layers.

It is clear, therefore, how digital design and production processes begin to permeate the building sector, in close correlation with new materials introduced in the market. The infinite variability and the formal articulation granted to the designers require the same effort needed to produce modular, repetitive and symmetrical elements.

After having lost the security provided by the homogeneity of the standardized and uniform products of the old Industrial Revolution, it is necessary to redefine the quality and the reliability of the mass-customized products, starting from the processes.

---

4 The "shotcrete" technique consists in spraying, with the help of compressed air, the binder on a support, so obtaining a very small thickness. The fibres are put in the mixture or pre-positioned on the support. Lamination is mainly used for the realization of two-dimensional elements, usually with glass fibre layers. The concrete is casted into sheets, compacted and put into shape after a partial hardening.

5 The lamination is not suitable for the realization of three-dimensional elements, while 3D printing is still in the testing phase.

The quality of the new industrialized systems between mass-customization and de-standardization

The transition from closed to open prefabrication required a rethinking of the relationship between the system and its component. In fact, while the first one was characterized by «a strict interdependence between the system as a product and as a project» (Nardi, 1977), the second gave the design the role of coordinating the building components by defining its dimensions, its quality levels and its connections.

Mass customization once again redefines this relationship, definitively depriving the "part" from the concept of standard, here defined as a «qualifying form, tending to the perfectibility of the object in relation to a repeatable optimum» (Reichlin, 1969).

However, if by standard we mean the «definition of a phenomenon general and particular characteristics, in order to allow the formulation of a judgement on the phenomenon itself from the point of view of its usability» (Nardi, 1977), the concept can be expanded, losing the quantitative aspects in favour of the qualitative ones. Standardization thus becomes a cultural bond linked to ease of use and assembly, to the reliability of the solutions used and to their coordination and interchangeability (Norman, 2013). In fact, the persistence of recognizable and standardized factors makes the models of thought and language, which require a specific time to meet the accelerated rhythm of technical transformations, able to know and recognize the surrounding environment (Manzini, 1986). This need for recognition and compatibility, cultural and factual, rather than a total destandardization, will probably lead to its partialization, standardizing interfaces, microcomponents and, more generally, the "infrastructure" of the product, still guaranteeing the possibility of designing using open systems. In fact, a completely customized building could only have a closed building system, probably having some of the limitations of its historical predecessors. Precisely for this reason, mass customization, in its most concrete definition, refers to a noticeable increase in the variability of the offer accordingly to the users' needs. In particular, by grouping these needs for "communality", series of product families (genotypes) are specified with respect to the will of the individual client (phenotypes) (Tseng, Jiao, 1999).

Yet, it is exactly the manufacturers' internalization of the visionary aspect of mass-customization, i.e. providing the customer with "anything, anytime, anywhere and anyway" (Hart, 1995), which brings, in practice, to a complete integration of the users in the production process, creating a true "prosumership" (Toffler, 1980), that is an intense collaboration between producers and consumers.

Therefore, if the product quality is given by the satisfaction of requirements, which are interpretations of user needs, a production process that starts from the users fixes a priori the level of quality which is going to be achieved.

The search for quality, therefore, is solved in an interactive way within the entire production process, no longer separated from the design phase and from the users, which are its raison d'etre.

In the building sector, where the project characteristics often require specific solutions, the implications deriving from the customization of the components open up to what could almost be defined as a participated production, also emphasized by the opportunities of managing complex data without the need to carry out simplification operations aimed at controlling the design phase. Users, designers and producers find, on a much larger scale, «that particular atmosphere of the artisan workshop where the unifying language constituted the connective tissue of specialized and non-specialized collective contributions at the planning and operational level» (Zanuso, 1983).

References

Antonelli, P. (2011), "States of Design 03: Thinkering", available at: https://www.domusweb.it/it/design/2011/07/04/states-of-design-03-thinkering.html.

Fleck, N. A., Deshpande, V.S., Ashby, M.F. (2010), "Micro-architectured materials: past, present and future", *Proceedings of the Royal Society*, vol. 266, pp. 2495-2516.

Hart, C.W.L (1995), "Mass customization: conceptual underpinnings, opportunities and limits", *International Journal of Service Industry Management*, vol. 6, pp. 36-45.

Jiao, J., Tseng, M.M. (1999), "A methodology of developing product family architecture for mass customization", *Journal of Intelligent Manufacturing*, vol. 10, pp. 3-20.

Kolarevic, B. (2001), "Digital Fabrication: Manufacturing Architecture in the Information Age", *Reinventing the Discourse - How Digital Tools Help Bridge and Transform Research, Education and Practice in Architecture,* proceedings of the 21st Annual Conference of the Association for Computer-Aided Design in Architecture, ACADIA, Buffalo, New York, October 11-14, 2001, pp. 268-278.

Leone, M. F. (2012), *Cemento nanotech. Nanotecnologie per l'innovazione del costruire*, Clean, Napoli.

Manzini, E. (1986), *La materia dell'invenzione. Materiali e progetto*, Arcadia, Milano.

Naboni, R., Paoletti, I. (2015), *Advanced Customization in Architectural Design and Construction*, PoliMI SpringerBriefs.

Nardi, G. (1977), "Prefabbricazione chiusa e prefabbricazione aperta", in Nardi, G. (ed), *Progettazione architettonica per sistemi e componenti*, Franco Angeli, Milano.

Norman, D. (2013), *The design of everyday things*, Basic Books, New York.

Reichlin, A. (1969), "Standardizzazione", *Dan*, Istituto editoriale romano, vol. VI, Roma, p. 67.

Schmidt-Bleek, F. (1994), *Wieviel Umwelt braucht der Mensch? MIPS - Das Maß für ökologisches Wirtschaften*, Birkhäuser Verlag, Berlin.

Toffler, A. (1980), *The third wave. The classic study of tomorrow*, Bantam Books, New York.

Zanuso, M. (1983), "Cultura progettuale e cultura industriale", *Caleidoscopio*, Gruppo Industriale Businelli, vol. 29.

2.20 NEW TOOLS FOR ENVIRONMENTAL DESIGN. A PARAMETRIC MODEL FOR THE ENVELOPE

Paola De Joanna, Antonio Passaro*, Rossella Siani**

Abstract

The parametric design process amplifies the design complexity by introducing new tools for controlling the variables of the configurative process in order to improve and refine the performance results in relation to all the parameters that contribute to defining the spatial form, the functional model and the technical components.
The work presents an experimentation for the construction of a parametric model for the building envelope in relation to the data of the sun and wind.
In the case under examination, the morphogenesis process is deepened starting from environmental parameters for the definition of architectural components realized with an architectural scale digital manufacturing process.

Keywords: Environmental Design, Parametric Model, Digital Manufacturing

Introduction (A. Passaro)

Newly enacted regulatory instruments at European and national level pose new instances relating to the aspects of environmental protection and energy efficiency of architectural heritage.

This scenario includes studies and research aimed at developing and testing integration technologies for building adaptation; this involves experimenting with new design technologies, able to specialize each project in relation to specific environmental conditions.

The energy retrofit of buildings requires the definition of tools aimed at perfecting the design techniques according to the characteristics of the structures, to the environmental context and the functional model of the architectural body. Particular attention in the retrofit interventions is placed in the energy redevel-

* Paola De Joanna is an Associate Professor at the Department of Architecture of the University of Naples Federico II, Italy, dejoanna@unina.it.

* Antonio Passaro is a researcher at the Department of Architecture of the University of Naples Federico II, Italy, passaro@unina.it.

* Rossella Siani is PhD at the Department of Architecture of the University of Naples Federico II, Italy, arch.rossellasiani@gmail.com.

opment of the envelope, which is in most cases resolved by the overlapping of insulating layers which, even if partially, guarantee an adequate thermal gain.

These solutions, however, have the disadvantage of integrating with the preexisting building system in an uncritical way and they are unlikely to find a formal synthesis and, even, they conflict with the historical and monumental architectures. Nevertheless, the integration of new technical systems as well as greater energy efficiency can guarantee greater quality to the entire built system. Therefore, it is necessary to provide interventions that modify the current formal and spatial configuration to hypothesize solutions and construction systems designed to adapt over time and space according to the pre-established parameters and those that would take over when specific needs change. In recent times, the linear, centralized and hierarchical models managed by rigid expert systems focused on the automatic control of the processes, have been overcome by new possibilities for managing the support grids and the integrated representation model that allow to visualize the multiplicity of the variables generated from differentiated parameters allowing the simulation between alternative choices. From the definition of a family of initial parameters and from the elaboration of the formal relationships that we want to maintain between them, the parametric design allows the generation of complex geometries. The use of variables and algorithms to generate a hierarchy of mathematical and geometrical relationships allow to originate not only a specific model, but to explore the full range of possible solutions that the variability of the initial parameters permit.

In other words, we do not simply want to solve a specific mathematical problem, but, moving from intentionally chosen values and according to certain rules that we have imposed on the system during its setting, we are able to immediately obtain very complex results, which can also be immediately recalculated simply by changing the original parameters. Thus the parametrization of the project should not be intended as the only search for the formal limit to which certain materials can arrive[1] in order to produce unnecessarily complex forms, identifying suitable input parameters and their geometric logics, families of formal possibilities can be obtained conjugated to the different combinations of offered performances, using resources at the same time more efficiently. The next objective, in fact, of the parametric design can be the development of a new organic model that, if in the past was essentially aimed at a close dialogue between the architectural project and the nature that contains it, today can go further in the search for a balance between structure, function and form in an organic key. All this is not new in terms of engineering best practices, but, thanks to these tools, it is now possible to plan the indeterminacies and possible variations of the environment during the life cycle of the building. But if parametric modelling is currently an ideal activity for the design of products that

1 Frank Gehry, modelling the coating of the Guggenheim Bilbao, employed a parametric software to determine how much could be curved without determining the yielding of the material.

foresee slight variations on a standard production, based on keys parameters for the product's optimization, in the future one can imagine to make interactive changes, so that the model updates automatically assuming the modification of the solutions. Parametric thinking introduces the change in mentality between the search for a specific static and defined formal solution in a new horizon where different parameters take over the design process to create and manage the architectural product.

The envelope of the functions (P. De Joanna)

This study is aimed at investigating the possibilities of optimizing the performance of the building envelope according to both the energy performance and the functional model with which the architectural space is used. The interest is turned to school buildings whose organizational-spatial model has, in recent years, been the subject of profound modifications that have radically transformed the traditional order in which the teaching identified a single, almost universal, configurative scheme. Studies and research, at international level, have brought to the attention of educational institutions how and how much the environmental context can influence learning by identifying the sensitive parameters of the educational model and of the school space. In Italy, MIUR (Ministry of Education, University and Research) in May 2016 announced the "Innovative Schools"[2] competition with the aim of acquiring design ideas for the creation of innovative schools from an architectural, plant, technological, energy efficiency and structural and seismic safety point of view, characterized by the presence of new learning environments and openness to the territory.

The flexibility of the interior spaces is the strength of the innovative school, the architectural space is changeable and multi-functional, able to adapt to new teaching rules and new practices in the teacher-student relationship (Di Nardo, Fumo, 2018). The adaptability of the building envelope should correspond to the adaptability of the internal space, able to modulate the performances in line with the functions performed in the rooms. The general perception of comfort does not necessarily correspond to pre-established parameters but in the judgment intervene some physiological and psychological random variables (Kim, de Dear, 2012), so it is not easy to isolate the environmental factors on which depends the best condition for school performance.

The University of Salford - Manchester conducted a study in 2015 aimed at identifying the effects of different combinations of environmental parameters on learning. The HEAD Project[3] for the first time finds that, fixed on average

---

2. Ministerial Decree n.860 dated 3/11/2015, Law 107 dated 13/07/2015 and art.156 of the Legislative Decree n.50 dated 18/04/2016.

3 Holistic Evidence and Design (HEAD), starts from the conclusions of a research by the Education Endowment Foundation, an independent welfare body dedicated to facilitating the possi-

values of the functional, organizational and social parameters, the variation of the only environmental parameter has a 16% relevance in the learning of specific disciplines (Barret et al., 2015).

The environmental parameters linked to factors such as natural light, temperature and air quality are the same as all the other parameters taken together (spatial configuration and organizational model).

Priority: the control of brightness and temperature from solar irradiation.

Natural light, essential for psychophysical wellbeing, must not produce glare effects, also for the ever more widespread use of interactive multimedia systems; equally the effects of overheating by direct radiation are counterproductive. These parameters highlight the need for performing shielding in relation to the activities carried out in the internal environments, which can guarantee perfect control of the foreseeable conditions. On the basis of these reflections, our study is aimed at defining a design method that allows to adapt the performance of the architectural envelope to the multifunctional model of the innovative school. The school building examined is the "De Filippo" Secondary School in Quarto (NA)[4], located near a large uncultivated land; in the hypothesis of adaptation of the educational offer to the principles of the innovative school it is assumed to enhance the wine production, among the most ancient local excellence, through the installation of educational vineyards in the land annexed to the institute and the establishment of multifunctional educational laboratories in the west wing of the school and in the outdoor areas for processing and preserving the wine product. Educational labs vary their function during the school year; there are lectures, experimentation and laboratory exercises for the understanding of the process of culture and winemaking, research on the history and development of oenology and still preparation of exhibition and tasting routes. In the research and experimentation laboratories the microclimatic conditions assume a fundamental role, in relation to the different phases which, in very specific periods of the school year, contemplate different activities with variable environmental needs.

For each activity it is necessary to define the descriptive parameters of the environmental quality and of the expected users; among the sensitive parameters are considered: seasonal period, time slot, time of use of the spaces, quality of light necessary for activities, distribution of light within the spaces, temperature and humidity appropriate to the type of activity, number and age of users. The study here presented is aimed at the implementation of the building envelope in order to modify its permeability in relation to the external environmental conditions through the use of shielding that will guarantee natural lighting

bilities of access to training regardless of family income, which highlighted how the research on the relationship between learning and context environmental was still very limited.

4 Degree thesis "Valorisation of an urban void in the municipality of Quarto" of Salvatore Junior Sica, Degree in Sciences of Architecture at the Department of Architecture of the University of Naples (Italy) Federico II.

for the different layouts of functions that the same environments assume during the school year.

For each activity, times and procedures are established and the corresponding environmental parameters are set; starting from the specific result you want to achieve, the parametric design returns the definition of the component fully responsive to the performance it has to offer, each space can thus be equipped with a card that indicates the natural lighting characteristics returned for each intended layout.

The algorithmic generative process (R. Siani)

In this study we use a particular design approach that works, through specific software, to define a set of rules, the algorithms, which determine in this context exclusively formal compositions; the shapes thus composed may vary in size, composition or partition based on numerical parameters. The designer, therefore, does not make up a form, but describes a rule that determines a family of possible forms. This is also called genotype, to describe the generative rule, and phenotype, to identify the contingent solution, differentiated (Deleuze, 1971), or the composition valid for a specific numerical set of parameters. The meanings genotype and phenotype are terms borrowed from biology, in fact there are many references of this design approach to biological sciences and natural generative processes.

To define this model different terms are used: algorithmic (Tedeschi, 2014) or parametric (Bucci, Mulazzani, 2006) design, form finding, morphogenesis (Pugnale, Sassone, 2007) or computational design. Each of these meanings emphasizes one of the aspects that define this model. The algorithms are the genotypes or generative projects, the parameters are the numerical data with which the phenotypic or differentiated solution is defined, the computing design underlines the use of computers and calculators, the morphogenesis is the process that determines the definition of an optimized form for a specific function, and works, of course, with algorithms, parameters and computers. The parameters are numeric only, and such numeric data can refer to size, quantity, partition number, weight, temperature, strength intensity, and so on. Qualitative aspects are difficult to define in this approach.

If in the traditional approach we start from a project draft, then it occurs with analytical tools, both analogical and digital, and the process is reiterated until a result conforms to the required functional values, in this case the process is reversed. In the algorithmic approach, in fact, a virtual machine is constructed capable of responding to a particular geometrical/numerical requirement, therefore the values to be obtained as a result of that particular object are entered and the sequence of programmed rules generates one or more valid solutions. More performance aspects for the same project can be defined in the design phase.

The more complex the network of relationships that is triggered between the definition of the form and the endogenous (material) and exogenous (environmental) factors, the more the project is in equilibrium with the context and the closer it is to the systemic or ecosystemic logics that generate the organisms natural. At this point one can speak of a systemic project[5].

The design of a parametric shielding (R. Siani)

The proposed screening system is an application of morphogenesis based on formal composition by algorithms combined with a series of environmental sensors capable of collecting the data that are valid as numerical parameters of the system. The need for this project is the improvement of the thermal and light conditions of the interior of the building; the work is done by controlling the different formal combinations of the screen according to the environmental factors with which it is related.

The climatic factors that intervene in the calculations are solar radiation, the vector of the sun's rays changed at different times of the day and on different days of the year, the temperature, the direction of the wind and its intensity. All of these numerical data are processed in a complex system and related to the desired temperature, brightness and ventilation data for indoor environments. The system works with two input groups: the numerical data of environmental factors and the internal environmental temperature and brightness data; the outputs consist of the formal compositions of the shielding system.

The shielding consists of a set of aluminum strips combined with plastic materials fixed at the ends and capable of twisting. The structure is designed to be applied to the facades of buildings and therefore works as a second skin; the buildings of destination can be of new construction or preexistences not subject to constraints. The destination façade must have a suitable percentage of glazed openings to create the right external/internal exchange. The size of the shielding structure, the number of bands and the size of each band varies according to the size of the façade to which it is applied. The bands can have a vertical or horizontal orientation based on functional or compositional choices (Fig. 1).

Each band is connected for each end to a mobile system, which, through an engine capable of a rotation, generates the torsion of the band. The bands can have a synchronous or differentiated rotation. The formal combination of bands is in opposition or in favour of solar radiation and wind fluxes, with a range of variations that allow you to customize the control of external environmental factors. Each band includes an inflatable element, which contributes to the modification of the shape.

---

5 Siani, R. (2005), *Il processo biomimetico sistemico nel progetto tecnologico di architettura. Strumenti metodologici, informatici e meccanici,* PhD thesis, University of Naples Federico II.

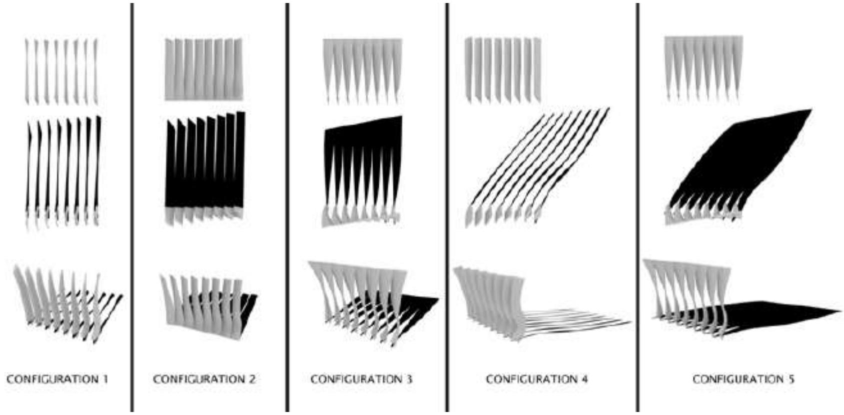


Fig. 1 - The image show some shielding configurations.
In configurations 1 and 4, we see how the adjustable slats are composed so as to let direct sunlight enter. In the configuration 2 and 5 instead, we have the maximum possible of shadow, but the same time the ventilation is favored, thanks to the particular rotation of the bands. The configuration 3 represents an average choice of light and shadow.

For each indoor environment it is possible to modulate the amount of light, heat and ventilation at the entrance, even with different percentages between one extreme and the other of the same environment. This allows to reduce the amount of conditioning or artificial lighting of indoor environments, sometimes to exclude their use.

The project thus described, by virtue of its nature as a parameterizable object, can be adapted to a large number of examples; in this study the project is applied to a school building. The shielding is combined with the west façade of the building, in a part of the building where the laboratories are located. The activities of these laboratories vary during the phases of the day and the year, therefore an environmental personalization in these spaces is very advantageous.

References

Deleuze, G. (1971), *Differenza e ripetizione*, Il Mulino

Tedeschi, A. (2014), *AAD _ Algorithms-Aided Design. Parametric strategies using grasshopper,* Le penseurpublisher.

Bucci, F., Mulazzani, M. (2006), *Luigi Moretti opere e scritti*, Electa, Milano, pp. 204-208.

Pugnale, A., Sassone, M. (2007), "Morphogenesis and structuraloptimization of shellstructures with the aid of a geneticalgorithm", *Journal-International Association for Shell and Spatial Structures*, 155, 161.

2.21 POSSIBLE INTEGRATION APPROACHES OF LIFE CYCLE ASSESSMENT IN BIM

Elisabetta Palumbo, Stefano Politi**

Abstract

The construction sector is moving towards digitization. One of the effects of this is the adoption of BIM (Building Information Modelling) technology, which includes, correlates and integrates a large variety of different kinds of information.
At the same time, as of today, Life Cycle Assessment (LCA) implemented to quantify the environmental impacts generated by all the building process phases such as constructing, using, maintaining and decommissioning a product at the end of its life, are not fully integrated in this environment. The article, by recognizing the state-of-the-art, provides a summary of the analyses undertaken in the literature on the interoperability grade and on the possible integration techniques of the environmental profiles of LCA-based materials within BIM tools.

Keywords: BIM, LCA, Life Cycle Assessment, Life Cycle, Environmental Sustainability

Introduction

The International Energy Agency (IEA) for the Global Alliance for Buildings and Construction (GABC) coordinated by United Nations Environment Programme, affirms that buildings energy demand could increase by 50% by 2050 (Global Alliance for Buildings and Constructions, 2017).

This analysis shows that buildings and construction together account for 36% of global final energy consumption, of which 82% is supplied by fossil fuel, making buildings responsible for 39% of carbon dioxide (CO_2) emissions.

Over the last decades, many actions have been undertaken aiming at fostering a more sustainable development in order to mitigate the environmental impact caused both anthropogenic activities and built environment (Ortiz et al., 2009). In support of policies and regulations on environmental matters, measurement and control tools together with methods aimed at empowering more sustainable building processes have been developed (Kang, 2015).

---

* Elisabetta Palumbo is a Senior Researcher at the Institute of Sustainability in Civil Engineering, RWTH Aachen University, Germany, elisabetta.palumbo@inab.rwth-aachen.de.

* Stefano Politi is a PhD candidate at the Department of Architecture, Università di Bologna, Italy, stefano.politi2@unibo.it.

The main objectives for the optimization of the environmental conditions related to buildings, have been initially focused on improving energy performance during the operation phase, with regard to heating and cooling.

During the past ten years, the mitigation strategies were addressed in an effective manner towards aspects related to whole life cycle of buildings, in particular to materials and products, as shown the Construction Products Regulation (CPR) 305/2011, the European Directives 2014/23/EU, 2014/24/EU and 2014/25/EU (Pachego-Torgal, 2014; Lasvaux S. et al., 2017). LCA approach is already included for almost than ten years in some EU regulations related to the environmental impacts of buildings products (Lasvaux S. et al., 2017). In order to monitor the results of these actions and to better focus on buildings performance, a variety of tools and methodologies aimed at measuring and assessing the sustainability levels of the built environment have been introduced and improved in the course of time (Chong et al., 2009). As announced by CRESME as a consequence of the digitalization of processes, products and systems, the construction sector, through the introduction of new methods and technologies, is transforming the entire design/assembling/monitoring and management course (CRESME, 2015).

Building Information Modelling (BIM) and Life Cycle Assessment (LCA) could enable a better understanding of the management of construction processes, from design to end of life (Antón, Diaz, 2014).

Building Information Modeling

Since the last decades, as a consequence of the introduction of the Computer-Aided Design (CAD) tools and, lately, of the Building Information Modelling (BIM) tools, the construction industry has been subjected to significant changes with respect to design approaches and managing processes, defining new scenarios at local and international levels. A comprehensive interpretation of the BIM concept is suggested by the US National Building Information Model Standard Project Committee, which defines it as "a digital representation of physical and functional characteristics of a facility" and qualifies it as "shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition". Other authors (Wong, Zhou, 2015) define it as a set of interconnected policies, processes and technologies able to support a systematic approach to the management of key project information in digital format with respect to the entire life cycle.

The BIM tools, therefore, enable the creation of buildings digital models characterized by a series of physical and functional data that, depending on the purpose of the model, can reach different Level of Development (LOD), corresponding to several levels of detail and reliability of information.

Moreover, if the data contained in the digital model are employed for the improvement of energy performance and to facilitate the achievement of predetermined sustainability goals, this technology meets the definition of Green BIM (Wong, Zhou, 2015).

As for the energy aspects, for which the BIM tools can empower the integrated management of high efficiency design and the simultaneous monitoring of the performances over the life cycle, similarly, the integration of sustainability indicators and metrics in the model, can enable the analysis and the assessment of environmental aspects since the early design phases. Likewise, operating data, maintenance and end-of-life scenarios (Wong, Zhou, 2015) can also be included and managed. This capability is potentially able to optimize the entire process information flow both favouring the transparency and interoperability among the operators, thus improving communication, and minimizing errors during design, execution and management phases (MacGraw Hill Construction, 2010).

Within the Italian regulatory context, BIM is mentioned in the new Code of Public Procurement (Legislative Decree 18 April 2016, n. 50), but its actual enforcement, in terms of timing and procedures, is regulated in the most recent 2017 decree, also known as BIM Decree (Ministerial Decree n. 560 of December 1st) which implements the provisions contained in the European directives 2014/23/EU (Art. 181) and 2014/24/EU (Art. 23).

While, the operative application is regulated by the UNI 11337:2017 standard (Digital management of construction information processes), which is structured in 10 parts, some of which have not been released yet.

LCA integration in BIM

Currently, a number of BIM applications are available covering a number of activities such as: 3D modelling, simulation of building performance in relation to materials and component, topological integration of networks and installations, quantity take-off and cost estimation, maintenance and facility management (Chong et al., 2017).

While, with regard to the emerging issues of mitigation of greenhouse gases, reduction of raw materials and global sustainability over their life cycle, less flexible tools are available, thus limiting the benefits that BIM can enable. Within a highly demanding regulatory scenario regarding buildings energy efficiency (almost zero energy and emissions), the accurate control of the impacts produced during the building’s life cycle, such as the emissions embodied in materials and components, becomes more significant (Eleftheriadis et al., 2017). The complexity of buildings, result of the combination of multiple products, composed in turn by different materials, makes the environmental assessments over the life cycle a challenging activity (Rønnin, Brekke, 2014).

The variety and heterogeneity of buildings materials and products employed, the heterogeneity of their environmental profiles resulting from different production processes and further conditioned by the uncertainty related to their operational performance during their service life, to the transport and disposal phases, involves the development of hypothetical scenarios that make complicate the uniform definition of the embodied impacts (Buyle et al., 2013).

Although LCA-based tools are subject to continuous methodological updates (Lavagna, Palumbo, 2017), the multidisciplinary, analytical and systemic approach on which it is based, makes it one of the most effective means for the analytical evaluation of environmental profiles. Moreover, in the majority of cases, LCA is conducted at the end of the process, when the main design choices have been already defined, rather than in the initial phases when greater flexibility and control over the environmental variables can be achieved (Meex et al., 2018). However, it is also true that during the early stages of the project, the level of detail of information about materials, products and technical solutions is limited and incomplete. Many authors (Röck et al., 2018; Najjar et al., 2017) argue that employing BIM at the beginning of the project, provides a benefit to the decision-making process, harmonizing both the information flow of the materials and the assessment of the related impacts.

For all these reasons, the importance of the implementation of LCA approach within the BIM models appears obvious (Meex et al., 2018). Moreover, it would empower the optimization of data management, reducing manual processing, thus decreasing the probability of incurring mistakes (Antón, Diaz, 2014), as well as time optimization. In this respect, Najjar et alii (2017) state that the early project stages require about 60% of the time, to which is added the iterative management of data related to the various lifecycle phases.

The importance of having tools that simplify the evaluation operations also emerges from the literature recognizing the integration between LCA and BIM as a valid and significant opportunity to optimize the evaluation process (Soust-Verdaguer et al., 2017).The main benefit of this interoperability results from the easy access to the information contained in the model - quantity and functional characteristics - and consequently, from the capability of drafting detailed and precise Building of Materials (BoM), essential for LCA analysis (Antón, Diaz, 2014).

Several authors consider the BIM-LCA integration as an important opportunity for the construction industry (Jrade, Abdulla, 2012), as potentially able to meet comprehensive sustainability requirements including, besides environmental aspects, also economic and social features since the early design (Antón, Díaz, 2014).

With respect to possible integration manners, the latter study identifies two possible ways. The first, involves the interaction between BIM platforms and LCA external tools, exploiting the access to the building main information contained in the model.

Certain plug-ins like OneClick LCA© and Tally®, linked with databases as Gabi 6 and Ecoinvent LCA (Mazzucchelli, Calandri, 2018), already employ this mode. The second way, instead, consists in including LCA impact indicators directly in the BIM objects information sheets and imported into the BIM platform. This second path, although representing a further simplification of the evaluation procedures, is still considered immature, less accurate than a global evaluation of the entire life cycle of the product. This approach requires further developments, since it should incorporate a range of data concerning all the phases of the process, such as transport or installation and maintenance operations. According to the authors, the main advantages of such an approach are: avoiding complex manual data entry, performing real time analysis as the project evolves and conducting generally more complete LCAs in terms of indicators and life cycle phases. An overview of the integration between LCA and BIM was conducted through the revision of a series of papers, highlights this following methodological aspects: input information, data management with reference to LCA phases, management and exchange of data concerning the properties of the materials, exchange of data with regard to BIM interoperability and effectiveness of results (Soust-Verdaguer et al., 2017).

The main observations that emerged by this study, besides the common ones related to the complexity of carrying out complete and reliable LCA, concern the difficulty of incorporating heterogeneous data into BIM databases if specific data fields are not designed to contain them, thus requiring the use of external application, involving manual data-entry, in case the interoperability between the platforms is not automatic. In addition, this work deals with the identification and evaluation of several data exchange modalities such as: the drafting of a template containing materials environmental data, the development of BIM software extensions able to connect the model with external LCA calculation software and the use of external applications able to access the quantitative information (bill of quantities) contained in the BIM databases.

In the same direction, other authors introduced an integration method between the BIM platform and external programs, employing visual programming (or computational designs) applications, which, through the development of graphic algorithms, are able to extend the functionality of the BIM platforms. In this case, the use of this tools would be particularly advantageous in order to exporting/importing data from/into the model (Shadram, Mukkavaara, 2018; Röck et al., 2018). Among those currently used in architecture, the most common are Dynamo© and Grasshopper©.

In particular, by limiting the scope of LCA analysis to materials only - thus excluding operating energy and water consumption - and structuring both model data and environmental data in an aggregate and shared way, it is possible to obtain an effective integration between LCA and BIM, starting from the initial design phases and enhancing the accuracy of the analysis as the level of detail of the model increases (Röck et al., 2018).

Conclusions

This work starts from two emerging aspects which are involving buildings processes in recent years: the evolution towards digitization of buildings design/construction/management process which is happening through the adoption of BIM, and the crucial changings of current regulatory frameworks and market scenarios which are becoming increasingly attentive and demanding to the environmental aspects of buildings during their life cycle, requiring the employment of more significant and accurate sustainability assessment methods.

This has led firstly the literature review about the implementation of LCA in BIM. Despite many authors agree in recognizing the opportunity and the priority of incorporating life cycle analyses within BIM platforms, the literature review concerning integration between LCA and BIM highlights that there are still many unresolved issues.Strengths and weaknesses that characterise each of the alternatives presented, if on the one part, promote the achievement full interoperability BIM-LCA, on the other, highlight the need for further developments.

The various advantages of implementing the LCA in the BIM environment include:

- easy access to data on the BoM of the materials with the assistance of the BIM model, consequently limiting computational errors and the complexity of manual data-entry;
- the possibility of easily comparing different scenarios/design and technological configurations from both a performance and environmental perspective;
- the opportunity of performing real time assessments starting with the initial project phases and increasing the accuracy of the analysis to increase the model’s level of detail.

At the same time, all authors agreed on the need for further developments in this area, again recognizing a variety of shortcomings and complex aspects that reduce its reliability and completeness.

The determination of impacts concerning operational scenarios, such as transport, assembly and the end of life, still give rise to doubts on the accuracy of the evaluation (Peng, 2016).

Even the difficulties in obtaining the optimal and automatic interoperability of BIM platforms with external tools generate scepticism about the actual simplicity of the actions, which remains an important and still open challenge (Soust-Verdaguer et al., 2017).

Future developments in this area must shift in the direction of a shared and structured framework capable of operationally placing environmental and material profiles in relation to LCA-based products within the BIM dimension (Najjar et al., 2017) thereby completing the integrated project process, which represents a key factor for achieving sustainable objectives (Antón, Diaz, 2014).

References

Antón, L. Á., Díaz, J. (2014), *Integration of LCA and BIM for Sustainable Construction*. Int J Soc Manag Econ Bus Eng, 8, pp. 1345-1349.

Buyle, M., Braet, J., Audenaert, A. (2013), "Life cycle assessment in the construction sector: A review", *Renewable and Sustainable Energy Reviews*, 26, pp. 379-388.

Chong, H. Y., Lee, C. Y., Wang, X. (2017), "A mixed review of the adoption of Building Information Modelling (BIM) for sustainability", *Journal of cleaner production*, 142, pp. 4114-4126.

CRESME (2015), *Il mercato delle costruzioni 2016*, XXIII Rapporto congiunturale.

Eleftheriadis, S., Mumovic, D., Greening, P. (2017), "Life cycle energy efficiency in building structures: A review of current developments and future outlooks based on BIM capabilities", *Renewable and Sustainable Energy Reviews*, 67, pp. 811-825.

Global Alliance for Buildings and Constructions (2017), *The Global Status Report 2017*, available at: https://www.globalabc.org/, retrieved on July 2018.

Jrade, A., Abdulla, R. (2012), *Integrating building information modeling and life cycle assessment tools to design sustainable buildings*. In INTERNATIONAL CONFERENCE OF CIB W78, Vol. 78, p. 29.

Lasvaux, S., Favre, D., Périsset, B., Mahroua, S., Citherlet, S. (2017), *Life Cycle Assessment for Cost-Effective Energy and Carbon Emissions Optimization in Building Renovation (Annex 56). Energy in Buildings and Communities Programme.* International Energy Agency, University of Minho, Portugal.

Lavagna, M., Palumbo, E. (2017), "Obiettivi, metodi e strumenti operativi per la valutazione della sostenibilità ambientale" in Antonini, E., Tucci, F. (eds) (2017), *Architettura, Città e Territorio verso la Green Economy. La costruzione di un Manifesto della Green Economy per l'Architettura e la Città del Futuro | Architecture, City and Territory towards a Green Economy. Building a Manifesto of the Green Economy for the Architecture and the City of the Future*, Edizioni Ambiente, Milano.

Mazzucchelli, D., Calandri, A. (2018), *Una progettazione integrata per costruire sostenibile*.

Meex, E., Hollberg, A., Knapen, E., Hildebrand, L., Verbeeck, G. (2018), "Requirements for applying LCA-based environmental impact assessment tools in the early stages of building design", *Building and Environment*, 133, pp. 228-236.

Najjar, M., Figueiredo, K., Palumbo, M., Haddad, A. (2017). "Integration of BIM and LCA: Evaluating the environmental impacts of building materials at an early stage of designing a typical office building", *Journal of Building Engineering*, 14, pp. 115-126.

National BIM standard-United States™ Version 2 (2014), "Frequently Asked Questions About the National BIM Standard-United States™, What is a BIM?", available at: nationalbimstandard.org, retrieved on December 2017.

Peng, C. (2016), "Calculation of a building's life cycle carbon emissions based on Ecotect and building information modeling", *Journal of Cleaner Production*, 112, pp. 453-465.

Röck, M., Hollberg, A., Habert, G., Passer, A. (2018), "LCA and BIM: Visualization of environmental potentials in building construction at early design stages", *Building and Environment*, 140, pp. 153-161

Rønning, A., Brekke, A. (2014), "Life cycle assessment (LCA) of the building sector: strengths and weaknesses" in Pacheco-Torgal, F., Cabeza, L. F., Labrincha, J., de Magalhiies, A. (Eds), *Eco-Efficient Construction and Building Materials, Life Cycle Assessment (LCA), Eco- Labelling and Case Studies*, pp. 63-83.

Shadram, F., Mukkavaara, J. (2018), "An integrated BIM-based framework for the optimization of the trade-off between embodied and operational energy", *Energy and Buildings,* 158, pp. 1189-1205.

Soust-Verdaguer, B., Llatas, C., García-Martínez, A. (2017), "Critical review of bim-based LCA method to buildings", *Energy and Buildings*, 136, pp. 110-120.

Wong, J. K. W., Zhou, J. (2015), *"Enhancing environmental sustainability over building life cycles through green BIM: A review"*, *Automation in Construction*, 57, pp. 156-165.

PART 3.

DESIGNING THE PROJECT, INVENTING THE FUTURE

INNOVATION OF KNOWLEDGE FORMS
AND COGNITIVE STATUTES OF THE PROJECT

3.1 DESIGN RESEARCH: FROM THE TECHNOLOGICAL CULTURE OF DESIGN FOR SOCIAL INNOVATION TO THE ANTICIPATORY AND CREATIVE FUNCTION OF DESIGN

Fabrizio Tucci, Laura Daglio**

Abstract

The text has the function of providing a critical introduction to the third part of the book, which is focused on the moment of conceiving the design process, and then investigates the potentials of cognitive, experiential, and design models connected to the new forms of collective/cooperative intelligence for providing a response to the main challenges of the future: to design in a time of "crisis" in "emergency" conditions, in a state of "scarce resources" and under conditions of "uncertainty". The objective is to probe how ability to govern decision-making processes is developing – or may be developed in the near future – in what are now structural conditions shaped by the challenges raised here, by recovering the exploratory and creative aspect of the design activity and the dialogue between the different intelligences involved.

Keywords: Technological culture of design, Social innovation, Technological design, Predictive approach, Anticipatory function

Framework

The reflections collected in the third part of this book start from an assumption: the evolving modes of access to information, marked by continued mobilisation of skills and by the expression of a widespread intelligence coordinated in real time, are leading us to rethink the cognitive statutes and the factors driving design, by valorising the relational dimension of knowledge and its management implications.

This third part focuses on the moment of conception of the design process, to investigate the potentials of cognitive, experiential, and design models connected with the new forms of collective/cooperative intelligence in providing a response to the main challenges of the future, which were also discussed in the Introduction: designing in a time of "crisis" in "emergency" conditions, in a state of "scarce resources" and under conditions of "uncertainty".

---

* Fabrizio Tucci is a Full Professor at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, fabrizio.tucci@uniroma1.it.

* Laura Daglio is an Associate Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, laura.daglio@polimi.it.

The objective is to probe how ability to govern decision-making processes is developing – or may be developed in the near future – in what are now structural conditions shaped by the challenges raised here, by recovering the exploratory and creative aspect of the design activity and the dialogue between the different intelligences involved. The possible topics that we may take as a reference to reread the meaning and reflections contained in the contributions are essentially three in number:

1. design culture and social innovation;
2. research and the predictive and anticipatory function of design;
3. which creativity for architectural design.

The considerations made by Schiaffonati and Ferrara introduce all the issues in a cross-cutting way, on the one hand with a theoretical/guiding contribution, and on the other through the possible articulation and exemplification of these perspectives in the specific dimension of a real case that stands out for the specific nature of the methodological contribution.

The central nature of the role of the architect active within the society in which he or she works, and to whose needs he or she attempts to respond, is achieved through an integrated conception of design that becomes a tool of research and knowledge, joining together scientific and humanistic aspects, an analytical and speculative dimension with a synthetic one more of the operational and experimental type – combined with an ability to anticipate problems that also requires innovating the very statutes of the design, in order to act proactively in the real world. The experience illustrated by Ferrara represents a possible (successful) road towards this renewal process which, through participatory processes among the stakeholders involved in the various phases of design development, introduces a new, shared and strengthened creativity, able to extend the horizons of exploration, thus heralding scenarios, even remote ones, but well rooted in a concrete economic and productive feasibility; it is the innovation of the process based upon broadening interrelationships and therefore upon the possibility for design to reinterpret the setting's demands.

Design culture and social innovation

The topic, on "Design culture and social innovation", opens with the contribution by Ferrante, reaffirming the central importance of the technological design approach, both from the historic point and, even more, from that of a contemporariness, marked by a new social demand and by the construction sector's transition to Industry 4.0. This is a design culture centred upon the designer's responsibility and upon the relationship that the designer establishes with the social context, customers, and business, aimed at satisfying the needs of society at large, also through forms of participation that are now extremely current in the development of programmes and projects for services and infrastructures.

In this sense, it is necessary to overcome national policies that reduce funding to university, research, and innovation, and instead to promote coordinated plans and strategies to relaunch collaborations between industry and university research in strategic sectors, at the service of society at large, in order to bring research and social innovation together.

A strong emphasis on some of the risks and problems characterising the topic may be seen in Ridolfi's contribution, which discusses the formation and transmission of design for which Ridolfi identifies certain critical areas particular to the rise of the digital era. Starting from a brief reconstruction of the evolution of information technologies in the postmodern condition, until the most recent repercussions on contemporary society, the author casts a light on the risks derived from the spread of computer tools simulating design practice and teaching, thereby signalling how it can in fact be reduced to an automatism where "knowing how to do" can be confused with "knowing" and with "knowledge" until even eclipsing them, losing the centrality of shared human and social feeling, also in spite of the evidence of the data.

Battisti deals with the issue of the complex relationship between "Design Culture and Participation" which provides the title for the contribution and is central to the topic's critical development. Probing the condition underpinned by issues for which there has been talk of the "end of the social" with reference to forms of relationality in contemporary communities in the age of globalisation, the paper analyses the development of inclusive processes, which during these years has been accompanied by their diversification, identifying their main variations: the inclusive processes inspired by the principles of participatory democracy; those inspired by values of deliberative democracy; and hybrid ones, that fuse participatory with deliberative aspects. This combination of legislative measures and axes of actions can bring interesting impacts, in the search for innovative processes, thanks to which design can less and less resemble a preset programme, and more and more multiply the players to be networked, in the conviction that only a polyphony of interests can yield appropriate solutions.Some contributions underscore methodologies and approaches of design for social innovation by way of research and experimentation projects that explore solutions for the regeneration of degraded settings, through the introduction of new public functions, different models for involving the community in the participation processes, and a rethinking of public space to amplify its role is theatre of social exchanges. In the essay by De Biase, Franchino, and Frettoloso, the relationship between the culture of design and social innovation takes concrete shape in the real case of regeneration of a neighbourhood in Castel Volturno, dealing with the issue of urban quality as an outcome of a systemic approach to design. The proposals, in fact, attempt to offer a response to the challenges of the multiethnic city through interventions on technological quality that also include endowments of public spaces and services for reception, integration, and intercultural exchange, able to adapt to continuous social changes, without neglecting environmental quality through specific attention with regard to green infrastructures, biodiversity, and the protection and conservation of natural areas.

Bagnato and Giusto recognise a major role of social innovation in a new design culture that concentrates on redesigning and rethinking the public spaces of the street. The objective of this design commitment is to go beyond a construction of the city that impedes relations between the individual and the environment, denying the socialisation above all of "weak users" and to be oriented towards a cross-cutting approach that considers open space as a place of integration, of exchange, of easy, pleasant pedestrian availability for all users, with a view to Universal Design, aimed not only at residents but at Tourism for All.

Fabbricatti and Viola illustrate the outcomes and methodologies developed in the context of a project to recover the historic urban fabric of Torre Annunziata, promoted within a PRIN (2010-2012) research effort. Starting from the adoption of protocols mapping the resilience of the settlement system to define the potential of adaptability/transformability derived from the critical reading of the social, environmental, and productive resources and the resources of the constructed elements, from the scheduling of meetings with stakeholders and facilitators, and from dialogue with good international practices, design can generate social innovation with a shared vision of promotion of the built environment's production/business, through which to agree upon scenarios for progressively implementable urban and construction recovery.

Following the principles of the circular economy in a regenerative and systemic perspective, the research illustrated by Bosone and Ciampa casts light on the adopted methodology and the results of a recovery project for the city of Ercolano. The proposed degree of innovation resides in defining solutions not only on the physical, social, economic, and cultural level to create circular relationships and dynamics among local resources, but also in the players' involvement and in the interaction among decision-makers, stakeholders, users, and designs in all phases of the information and decision process.

This also makes it possible to strengthen the relationships among users and with the setting in which they live, through a process that raises individuals' capacity building and their sense of responsibility towards cultural, tangible, and intangible heritage, thus becoming an occasion for social learning and training.

Research and the predictive and anticipatory function of design

Of the various contributions in the subsequent part that may be related to the second topic, Angelucci's has the explicit objective of providing some possible responses to the complex question of the "predictive and anticipatory function of design" and deals with the theme of technologies for urban liminal systems between inheritance and disciplinary evolutions, in which the main players in the reflections are in fact the "urban liminal" ones that, in their state of incompleteness, must be interpreted as thresholds of dynamic dialogue between technological and biospheric systems.

In these instances of unresolved spatiality, technological disciplines can contribute towards providing responses, thus determining outcomes important for the project's practices; tracing reasons and implications to link – through infrastructural, tangible, and intangible technologies – the cities' socioeconomic development with the connectivity and attractiveness of the territory and landscape; and operating for the reactivation of economic circularities, for natural recapitalisation, and for the qualitative reconfiguration of the very parameters of beauty.

In the essay by Ginelli and Pozzi, the productive dimension of design is understood as the ability to take on change as an intrinsic characteristic, to include an "adaptive/active" resilience capable of providing adequate responses to change through its own systemic nature of reaction to the transformation phenomenon.

The conception of "technological design of architecture", which by its very nature incorporates a specific attention towards feasibility and management, expands to include the functional transformability of the architectural work for a dynamic reuse. This definition of "design for time", understood as the design of intrinsic and continuative transformation, is in fact illustrated through numerous case studies and research projects.

Baiani deals with the issue of the relationship between speculative and design activity. In fact, given the transformations induced by post-industrial societies in the creative professions, design becomes part of the research activity, as a moment of critical synthesis for the elaboration of physical models, possible visions, and real images, to transition from the analytical/exploratory phase of research to the constructive/intentional one capable of heralding transformations.

It is also the task of training to transmit this notion of design as a multidimensional, synergistic setting among different technical knowledges and between theory and practice – a setting that may give rise to a degree of innovation capable of providing some responses to society's pressing new needs.

The contribution by Cellurale and Clemente raises questions on technological design as an instrument of simulation and of cognitive prefiguration. The reflections start from a question: What cognitive and conceptual abilities will have to be acquired or strengthened by the discipline of technological design, in order to sustain the role of interpreter of the built environment?

To try to provide some answers, the contribution dwells on the aspects connected to the modelling of the energy users' behaviour, in the processes of requalifying the existing heritage, and on assessing the weight of this variable in general structure of design.

The reasoning will be applied to a study in progress, the results of which will be presented, centred upon innovation in the use of spaces and upon the environment's impact in the cognitive strengthening of the occupants.

Gallo and Romano investigate the repercussions on design, on its capacity for viewing and rearticulating the problem, as the outcome of the introduction of digital technologies and of the new modes production connected to Industry 4.0, above all in order to grapple with environmental challenges. It is a matter of the possibility, thanks to BIM tools, of simulating and thus of assessing, contemporarily, geometric/formal characteristics, energy/environmental performance, and the cost for constructing and operating the building, as early as the preliminary and conception phases of the architectural work.

From an analysis of the possible impacts on the design of adaptive, high-energy-performance envelope systems, the text highlights the need to evolve from "collective" to "connective" intelligence, in which the designer is bearer of the knowledge connected to the operative and decision-making processes of horizontal skills capable of foreseeing, anticipating, and optimising solutions able to respond to scenarios in continuous change.

Cecafosso's contribution concentrates on expanding the possibilities for foreseeing, projecting, and anticipating the decisions provided by the introduction of the new digital technologies. In fact, the essay analyses both the potentials offered by software for building performance simulation, BIM, and parametric design, and the actual developments in progress in terms of parametric design and simulation of energy behaviour.

These developments are making it possible – and will make it possible with ever more efficiency – to control the technical/morphological variables of buildings in order to implement their energy performance in relation to the characteristics of the context.

It is an interesting and in certain ways fascinating exploration of the selected alternatives, based on comparisons, in measurable terms, of the respective performance profiles, for which the final choice always lies at any event with the architect.

Given the challenges of contemporary life, Rotaru identifies, as an important setting for expressing design activity particularly similar to the systemic approach of technological culture, "network design" also as an alternative to the traditional way of designing cities, and above all as the possibility of uniting theory and practice, individual thought and community action, research and reflection in action. In fact, "Network Urbanism" for the principles of flexibility and combined use of resources that it requires, represents a model to accentuate the holistic dimension necessary for designing the city.

Through the experience of a European research project in progress (*Civitas Prosperity*), obstacles and opportunities are highlighted, and the systemic and adaptive dimensions of the technological approach to design are confirmed, to guarantee the effectiveness of the transformations foreseen for the future.

Which creativity for architectural design

The series of contributions that may be related to the 3° topic, revolving around the search for new forum of creativity for the future of architectural design, focuses on the evolutionary dimension of the design activity in light of the environmental, social, economic, and cultural transformations in progress. There are two key concepts for interpretation that appear to emerge from the contributions: an initial one explores the possible future developments of the relationship between design and community, both understood as a collective and shared production, and as a commitment to society; a second one examines the ability/need to intervene on the environment in the future.

An interesting aspect emerging from the standpoint represented by the 1° topic is the one that wonders about the new responsibilities and the new roles and governances of technology in design *versus* the collaborative city, as investigated in Maspoli's contribution which stresses that, with a view to a city that is fairer, more resilient and democratic, the culture of technological design must deal with new, transdisciplinary scenarios and new instruments, and that it may play important roles of "qualification for design" with particular reference to the following three roles:

- an initial role, which regards accompanying citizen in realising possible and tangible technical results of his or her doings in the new way of dwelling;
- a second role, which concerns interactions with bearers of active citizenship in the design of public spaces or shared "third spaces";
- and a third role, which concerns the competences of public management and coordination of associationism and innovationism, in relation to spatial factors and putting into play complex competences and ethical responsibilities in choices involving future generations.

A possible contextual interpretative framework, the Anthropocene, traversed by epoch-making innovations, but still without a shared cultural positioning, is offered by Rigillo's essay, which outlines the significant characteristics of the change, as made clear in the contribution, in that they are capable of bringing about some impacts upon the configuration of space and upon lifestyles. At the same time, some lines of behaviour are identified, and some possible approaches are outlined, that might reassign centrality to design and to the technological culture that supports it. This is required to reformulate the logical structure of the design process, of the expected performance, and of the parties involved, in addition to new strategic alliances between the world of research and that of production, in order to develop new hardware and software, but also innovative practices of technology transfer.

In the paper by Celaschi, Fanzini, and Formia, design is "ongoing", interdependent, and collective, and represents one of the characteristics, along with enabling technologies, thanks to which the city can change and evolve in relation to the setting and to the needs of its inhabitants, and can monitor and analyse itself through the representation and social sharing of the elements of transformation. A widespread, aware, and responsible creativity is therefore possible, a collaboration through the shared design that not only responds to the requirements, but defines the framework of needs in order to overcome the functionalist paradigm of the smart city and top down governance models still based on setting the parties against one another.

Bucci and Starace, in the face of the condition of uncertainty characterising the contemporary world, also refer to a similar paradigm shift in design practice and the role of the architect, a figure no longer isolated, but part of a team capable of interpreting the context in a multidimensional, multisectoral way, with a systemic and dynamic approach, open in this case to collective, shared design as exemplified through the study case of the international *CivicWise* network.

Similar, but based on a more pessimistic reading of the current misalignment between design culture and society, is the position of Valente, who all the same appeals to the reaction through a renewed, active role of the architect, starting from an educational approach for a sensitisation that cuts across the strata of society. This refounding of the professional practice of designer, made possible in an epistemological sense through a theoretical speculation that accepts and cultivates uncertainties, means an ethical and concrete operativity in the real world, that is articulated in research applied to profession and in committed proactivity, both of which accompanied by the academy's formative and supporting role through the proposition of a strong and assertive cultural line.

Violano, through an assessment of the performance/environmental costs ratio of three different construction systems, highlights the efficiency of the new approach of "generative design", which goes beyond the notion of sustainability, proactively intervening in restoring/improving the ecological conditions of the habitat through the use of materials and components in synergy with the natural biological cycle, and with a limited ecological footprint.

In Block's contribution, environmental design, in dealing with the demands of climate change, is moved, expressed, and developed in the multiscale and multidisciplinary approach of adaptive design, finding solid bases in research and scientific activities in progress in the international setting including, as she cites, the evolutions of the proceedings of the States General of the Green Economy in Architecture, from the production of the "The City of the Future" Manifesto to the recent issuance of Green City Guidelines. Starting from a knowledge of the specific nature of the setting on an optimal scale of the urban district, through simulation of possible scenarios in a perspective of predictive and proactive design, Block's contribution sets out the possibility of making the delicate identification of the most critical factors that alter the city's space, and the impacts on the users and their behaviours, providing instruments and adaptive solutions directed towards responding to these alterations and optimising the cycle of urban metabolism.

Conclusions

Through theoretical explorations and critical reporting of applicative experiences in the field, the collected contributions offer a significant wealth of points for reflection relating to the evolution of the statutes of design in light of the rapid developments of the contemporary context. A dilated and strengthened dimension of the design activity emerges, thanks also to digital technological innovation that amplifies the architect's operativity, all round. The possibilities of intervening in the real world, of being a militant architect, and of developing social innovation therefore multiply, for example, in the different and new connotations of the participatory dimension, to include all the different phases in the building process, all the stakeholders, from defining demand to executive implementation and to the financing of the works, thanks also to the simplification of the connections of interrelationship and networking introduced by computer technology. This availability of means makes it possible to reinterpret creativity as a collaborative and widespread product, as a multisectoral and multidisciplinary synergy also in dealing with complexity as a trait of contemporary society.

And lastly, its anticipatory capacity is emphasised, both to respond in the most appropriate way to the inclusion of the time variable in design, and for the possibility of simulating and foreseeing the behaviour of buildings, of inhabitants, and of the reactions of the environment, in order to correct and refine intervention choices.

This expansion of the capacities of design, which finds itself having to govern a systemic dimension of growing complexity, refers directly to the approach of technological culture in its disciplinary assumptions, the functions of providing direction among different sectors and monitoring of feasibility for the real context. However, as clearly underscored in the contributions, it requires above all a concrete commitment, availing us of these capacities for society while overcoming a speculative, abstract dimension or "formalistic drifts" emphasising a "peripheralisation" of the design in progress. In the second place, reflection is needed on the ends connected to the means, on ethical action, and on the greater responsibilities that this entails, especially in a formative setting affected by the introduction of digital innovation, also as pertains to the evolution of cognitive and learning models.

3.2 FOR A NEW CENTRALITY OF THE FIGURE OF THE ARCHITECT

Fabrizio Schiaffonati[*]

Abstract

Starting from the recognition of the culture of design as an integrated approach to knowledge, which overcomes a dangerous cyclical separation between science and humanities, the contribution highlights the characteristics that allow redefining and renewing the proactive and directing role of the architect in society. This is even more essential facing a condition of crisis, with the emergence of aporias, ideological and formalist drifts that seem to affect the project and consequently also the training of the architect in the contemporary world. Through the work of emblematic figures of the Italian architectural culture after the Second World War, the civil and social dimension of the project is illustrated as a theoretical and practical search for answers to the needs of the context. The reaffirmation of the centrality of the role of the militant architect who collects and renews the legacy of masters such as Zanuso, Vittoria, Spadolini is based on a conception of the project as a formal, functional, social and economic synthesis, overcoming short-sighted specialisms and anticipating the demands of society.

Keywords: Culture of project, Environmental design, Social role

The geopolitics periodical *Limes*, which hosts analyses and contributions on the strategic evaluations of development, in the recent report on the socio-economic situation of our Country, poses the question: «How much is Italy worth?». The report places "culture", a primary element of continuity and stability, among certain values of our society, unlike other factors which are decidedly in decline. The term culture embraces a very wide range of knowledge and themes that are not purely utilitarian and refers to our unitary tradition that is both humanistic and scientific. Although Idealism has accentuated the gap between the two aspects, as already noted by the English writer and scientist Charles P. Snow in his famous pamphlet of the early Sixties. *The two cultures*, a text not devoid of stimulating polemical cues, recently republished by *Il Saggiatore*, maintains a poignant topicality at a distance of more than half a century: in the face of a scientism and an uncritical technicality and, at the same time, of a widespread irrationalism of theories and points of view without foundation that are opposed in the debate and in daily practice.

---

[*] Fabrizio Schiaffonati is a Full Professor at Politecnico di Milano, Italy, fabrizio.schiaffonati@polimi.it.

A dangerous aporia tends to move away from an integrated conception of knowledge. A perspective that belongs instead to the history of thought in the context of its highest affirmation, which has represented an exemplary synthesis of the multiple aspects of culture as a unitary process of knowledge, handed down for centuries with peaks of excellence in the most diverse fields.

Despite the serious shortcomings and the long crisis that the country's institutions are going through and the current opacity of its image, *Limes'* report shows that in Italy remains a pool of knowledge, an "heritage" with peaks of excellence unique in the world. Among these, it is certainly to be ascribed "the culture of the project", of the city and architecture, also of the design conceived as project of industrial products. What belongs, therefore, to the creative, ideative process; and at the same time to the analysis and organisation of a cycle that results in the production of high quality, aesthetic, functional and economic goods and services.

The rhetorical form "Designing the project", which is the title of this third section of the book *Producing Project*, well expresses a heuristic approach, both theoretical and practical, which is based on the method: a philosophy of knowledge. The Italian Society for Architectural Technology SIT*d*A does well proposing these themes, central to its cultural status, in a phase in which in the world of design hovering clouds, dangerous academic regressions, formalisms and mannerisms, contingent fashions, which have nothing to do with the revolution of modern design. Modernity has democratically changed the face of the world, expanding the satisfaction of needs. No theory will be able to disprove this, as we happen to hear instead, shifting the observation on contradictions and shortcomings that must be re-established in a more general balance sheet. An ideological approach, in the Hegelian meaning of "ideology as false knowledge", frequently repeated and which we find today with the unusual virulence of many falsifications, that in the planetary context of the diffusion of information finds a fertile field wherein to take root. In this reference to Italian culture of the project, as an aspect of our cultural heritage in the broadest sense, lies the strength of the ideas that SIT*d*A affirms in the "project community", with a particular emphasis on the training path. Since a dequalification of education (a dangerously ongoing trend) is a source of concern for those who understand the project as a social factor, production and civil coexistence. The project as an offer of solutions corresponding to a need, an answer therefore "structured" with respect to an "artistic conception" that privileges form to the detriment of the other aspects of the production of necessary goods. This distinguishes the architectural project from the "superstructurality" of the work of art: the state of necessity of architecture, its artefacts and objects of use, not as pure technicality, but as complexity of architecture, among the primary factors of the conformation of the environment. The reference, therefore, to the excellence of Italian architectural production cannot ignore the role that some figures have played in affirming the importance of a culture of design as theoretical and practical research, restating the centrality in this field of the method of scientific research in the broadest sense.

The thought goes to Ernesto N. Rogers who, in the Fifties, in the context of an International Style projected towards a conformist homologation of Rationalism, made a decisive difference to reaffirm the complexity of the "architectural phenomenon", with respect to the place, the tradition of building and living in every context. Heterodoxy as it was understood by Reyner Banham, in open controversy with him. Rogers' formulation on the "environmental pre-existences" is very topical, expecially today, as we can find the same skyscrapers of the Arab Emirates in the centre of Milan, and the "environmental question" is the development knot that no one claims can be unlimited.

The indication by Rogers marks the architectural production that will follow, where the themes of history and context will be placed at the centre of each work, combining it with the reasons of the production, the appropriateness of technologies (down to the detail), and the morphology of the artifacts. This line of thought releases considerable creative energies, and real schools. Let's think, for example, of the "Neoliberty" (brilliant formulation of a young Paolo Portoghesi), as well as the trends and characteristics of architecture that we find in Rome, Naples, Florence, Turin, not to mention Venice; cities that have delineated landscapes with testimonial values of great significance for the future of architecture, accumulated by the recovery of history combined with modernity.

I would like to recall that movement, with a long wave that still reaches us with its concentric rays, an important testimony so that that experience is not dispersed. I say this because not long ago at Triennale di Milano an event was held for the centenary of the birth of Bruno Zevi, another protagonist, with unmistakable features of an uncommon dialectic for cultural depth and critical acumen.

The attendance of the public was little more than that of the speakers. A worrying signal, when every conference of any exegete in the wake with the star system is always crowded.

This absence leads to underline that without a history and the warnings of the past it is difficult to think architecture as permanence and civil construction. A warning for those who are preparing to become architects, but also for those who have the function (the duty) to teach.

The "Environmental Design" to which our attention is focused is the result of those hints to which I have referred.

This formulation well summarises the complexity of a disciplinary horizon as the evolution of a school of thought that for years has investigated its boundaries and contents starting from the area of "Architectural Technology", from "Technological Culture of Design" to "Technological Design of Architecture", aiming to escape from a narrow specialist and ancillary field of design understood as abstract theory and research of new styles, even when cloaked by "hyper-technological" unscrupulousness.

For the youngest, it is worth remembering that the teaching of "Environmental Design", as a disciplinary denomination, was introduced into the university system in the 1970s at DAMS in Bologna, with Tomás Maldonado from Ulm.

But for some time now the ferment in the scientific-disciplinary field ICAR/12 was already underway and found direct application to the project of the city and architecture and not only in the field of design. Especially thanks to Salvatore Dierna and Virginia Gangemi. Environmental Design took on (*ante litteram* compared to many improvised ecologists to follow) the dimension of the habitat at different scales, affirming the inseparability of the links between artefacts and the natural environment, but also social and economic. At that time economic approaches considered the Club of Rome's Report on the limits of development as regressive. "Limits" is another aspect of "degrowth", but also a reference to the awareness of the irreversible effects of anthropic transformation. I cannot recall, of that period and the following, regressive aspects, when not caricatured, of an anachronistic perch on postmodernist styles that influenced the training and operation of architects for a certain period. However, there is no doubt that a fundamental and decisive role in incubating the turning point of Environmental Design, also with the experimentation of professional work and cultural animation in institutions; for example, at the Triennale di Milano it was played by Marco Zanuso and Eduardo Vittoria. They were intellectuals on different political sides, but of clear reformist inspiration, united by the common Olivetti experience, as well as friends. An attendance that should not be forgotten, a unique event for the social architecture of Ivrea but also for architecture for industry in the broadest sense, which highlights, in his circumscription, the difficulties of the country to take a reformist path, democratically assuming the values of the industrial revolution that would have generated at a different scale of the project. The key words were: planning, production, process, organisation, client, needs, users, standards, technology, environment, landscape, a Copernican revolution of the method: analysis and project as inseparable terms of a pragmatism and experimentalism of clear Enlightenment derivation. In the current, therefore, of a polytechnic and not beauxartistic culture.

This dimension of the project worked to recompose the vexed aporia between technical culture and humanistic culture, affirming at the same time the importance of the articulation of knowledge, thus outlining a new map of skills and specialisations necessary for the conception and development of the project, as well as for the realisation of the works. Thus, the articulation of phases and actors, which could only find coherence in a procedural concept of the whole arc, from the conception to the management of the work.

In addition to this reference to the disciplinary fundamentals of Architectural Technology, we have to add the contribution of Pierluigi Spadolini, for his particular and exceptional experience centred on the role of the public client for the infrastructural development of the city and the territory. A transversal scale of works and services that represent the plot of satisfying social demand. From theese contribution emerges, as for Zanuso and Vittoria, the figure of the "militant architect", the civil commitment of the intellectual; terms that today may sound obsolete and unpleasant.

However, it is more problematic than ever to talk about architecture without reproposing this dialectic between profession, intellectual work and political commitment in the highest sense of the term. The mentioned figures are examples of this and have left their mark for a proper school. It is therefore important not to forget their legacy, to develop analysis and knowledge for a disciplinary growth that will proceed with the new acquisitions that the complexity of the present requires. One of the tasks of a scientific community, like ours, is to take charge of it, for the recognition of fundamentals that must be reaffirmed today. Especially in the Schools of Architecture that have lost so much of this social vision of architecture: the foundation of a theoretical approach and a non-ideological and abstract practice, in continuity with a conception capable of making relationships that exist in the processes of transformation of the anthropised environment evolve positively, even radically changing.

The didactics and practice of the project today often appear far from this teleological charge, attested on the contrary to contingent and conjunctural practices, without a problematic horizon, conditioned by fashions that have nothing to do with the structurality of the architectural phenomenon, its having to be a progressive response to a complex and problematic change; thus confining itself to the ephemeral of consumption, fashions and artistic languages. A flattening of the architect to a marginal figure of the processes of regeneration and urban planning. A worrying regression that seems to be advancing also in the Schools of Architecture, between educational programmes and the contradictions of an academicism that distances the study of architecture from the knowledge of the social context. In order to reach a self-referential threshold, devoid of values and renewed technical knowledge, without a criticism and a proposal for change. At a time when the characters of the crisis appear obvious and new needs signal the unsustainability of the current model of development. Therefore, it is anti-historical to preside over a disciplinary field without authority, as executors of decisions completely external to the architect's proposal. Reaffirming the centrality of the figure of the architect, specifically, as an expert in the structuring of the space with urban, residential and housing functions, a scholar of knowledge and demanding parameters, is not an easy task today, in an increasingly accentuated tendency to transfer this role to other aspects of the decision-making process, economic and organisational. Moreover, without an adequate strategic evaluation, as proven by widespread discomfort. Those who today want to apply the project to the different scales, territorial, urban and architectural, must become aware of how the framework of political and technical roles that oversee the governance of the territory and architecture is articulated, and what can be done. Hence a conception of the architect's work that cannot be separated from an "intellectual militancy", to flatten into a subordinate role and a vague aesthetic proposal. In this sense, the cited Masters entrusted a central and decisive role to technological culture and knowledge of the possible means for the transformation of reality starting from aims for the improvement of social and material conditions.

It seems more difficult today to strengthen this point of view, also due to an undeniable retreat of the Technological Area in the architect's training process; in fact, it is easier to attest to a transmission of codified and derivative knowledge, in the illusion of a specific discipline of formal expression alone, as its main reason is not strictly related to the complexity of the works. Far from a map of knowledge open to continuous incursions, curiosities and projections, which are the meaning of scientific research and experimentation for change.

These are the topics of this third section "Designing the project, inventing the future". Contributions that also move from specific approaches, but with a general point of view, a critical framework; a condition for a unified recomposition of knowledge in a meta and transdisciplinary perspective, in the meaning and hope of the epistemologist Giuliano Toraldo di Francia, who identifies in the "infra" disciplinary excursus the space of the advancement of knowledge and technological innovation. A scientific discipline, therefore, as the consolidation and systematisation of knowledge and the shifting of the field of investigation beyond the perimeters and goals reached. The adventure and freedom of research.

The contribution wants to underline the awareness that this meaning has been blurred, when not completely disappeared, and that it certainly cannot be reaffirmed starting from mere and even sophisticated specialisms. Scientism goes hand in hand with the academicism of the project's disciplinary autonomy: an alliance, in the separateness and in the stronghold of its own disciplinary boundaries, that leads to a backward comparison between the cognitive areas of engineering and architecture for the project. A vision instead of the project that must be a synthesis of form, functional, social and economic, rooted in an environmental context; a centrality that refers to the concept of direction dear to Zanuso, of "governing decisions" that Spadolini has interpreted and practiced, of "educational mission" that Vittoria has pursued in her institutional commitment.

If the capacity of this claim, of a "specific discipline" in designing and developing the project, as a conscious aim of the transformation of the environment, is lost, this role is destined to disappear and to give us back an uncritical landscape of "objects that populate world", in the formulation of the philosopher Eleonora Fiorani: with aims other than those that modernity had entrusted to the architect.

Purposes opposed to the current anonymity of public space and building typologies, of the low quality (paradoxically also technological) of building structures and services, a consequence of the marginalisation of the project as an interdisciplinary synthesis and solution of problems with anticipatory capacity. The innovation of the project is such for a necessity, a need: aspiration and projection to escape from a state of need that oppresses and brakes change. Others have recalled this challenge, with effective and icastic formulations: *Survival through design* (Richard Neutra) and *La speranza progettuale* (Tomás Maldonado).

3.3 INNOVATING PROJECTS IN THE WISDOM ECONOMY

Luigi Ferrara, Caitlin Plewes*, Graeme Kondruss**

Abstract

This paper describes the "Progressive Charrette Process" for generating sustainable architectural projects as it was applied to the development, by George Brown College, of The Arbour, the region's first institutional tall wood, net zero carbon building. The process uses a framework to guide strategic decision-making by fostering collaboration between disciplines to realise synthesised design solutions that address the complexity of a systematically interconnected world. In this example, the process carried the project through a series of "research charrettes" and an international design competition to arrive at a final design. The paper also outlines the innovations developed in sustainable design during the process, and proposes a model for future investigations in green architecture.

Keywords: Sustainable, Architecture, Interdisciplinary, Charrette, Arbour

This paper will describe a method for conceiving, planning and generating sustainable architectural projects pioneered by the author in his work as George Brown College's Advisor for Master Planning and Design. The "Progressive Charrette Process" derives from the theoretical and practical learning gained over many years as the Director of the interdisciplinary think tank The Institute without Boundaries (IwB), at George Brown College's School of Design, and from over 30 years of experience managing creative projects.

The Progressive Charrette Process helps to guide knowledge synthesis into wise strategic decision-making that enables and fosters innovation in architecture, urban planning, interior design and construction.

Using the "thinksmithing" tool of temporal frameworks, organisations are able to develop strategic intentions and corresponding value sets to guide their activities. This, coupled with the use of the "Charrette" methodology of collective creation workshops, can foster an ecology of innovation.

---

* Luigi Ferrara is Dean of the Centre for Arts Design and Information Technology, George Brown College, Canada, llferrara@georgebrown.ca.

* Caitlin Plewes is a Faculty Academic of the Space Planning & Design Team, George Brown College, Canada, cplewes@georgebrown.ca.

* Graeme Kondruss is Manager Academic of the Space Planning, George Brown College, Canada, gkondruss@georgebrown.ca.

By encouraging collaborative creation, interdisciplinary teams can work together to create projects that challenge conventions in building performance. The Progressive Charrette Process is an iterative series of exploratory workshops that provide a pathway for the development and refinement of ideas throughout the progressive phases of a project.

This method is underpinned by a philosophy of sharing to increase personal and societal wisdom. Moving beyond the paradigms of the "information" and "knowledge" economies, this process creates a new "wisdom" economy that leads to more holistic solutions, embodying the creativity and experience of all stakeholders involved. The end result will be projects with synthesised solutions that address the challenges of a systematically interconnected world. To this end, wisdom – the quality of experience, knowledge and good judgement – includes a considered reflection of all input and data to build a deep foundational knowledge of outcomes and their impacts. The need for this kind of wisdom when approaching multi-disciplinary problems cannot be underestimated.

In 2014, George Brown College (GBC) commissioned a master space plan to guide the development of the institution over the next decade. The master plan was created using a process of inclusive consultation.

Four Charrettes were held involving the College's Boards of Directors, senior administration, academic leaders, faculty, students and staff. The local community, industry advisors and authorities having jurisdiction were also consulted. The Charrettes reaffirmed GBC's emphasis on integrating with the city, a key differentiator from other technical colleges, originally inspired by Marshall McLuhan's seminal work "The City as a Classroom". GBC situated education within context, placing students near their eventual employers, using the city's offerings to enhance learning. However, over the years, the College had strayed from that vision.

The new master plan set out to reinvigorate it, calling for the expansion of GBC's recently established Waterfront Campus, which had opened in 2012 with Daphne Cockwell Health Sciences Centre. Toronto's East Waterfront, an area of new interest and fast growth, is a perfect location to help realise GBC's intention to grow with the city. With the creation of new assets in this neighbourhood, GBC would be near the City of Toronto's new Innovation Centre, allowing it to launch its new academic programmes into a 21st century creative cluster. The College decided to build a new home for its School of Design as part of the new arts complex, and to ultimately move its School of Computer Technology into a future building next door to the Innovation Centre. This would further position the College as a vital contributor to the creative and tech communities, allowing for easy partnership between faculty, students and industry on research, training, and sector growth initiatives.

The School of Design moved into its new home in 2019. In 2024, The School of Computer Technology will move into its new 10-storey facility, dubbed the Arbour.

This new facility will be Ontario's first tall-wood, net zero carbon institutional building built to be a future-proofed and resilient, using the latest smart technologies. At this critical moment of the 21st century, when society is clamouring for models for climate positive architecture, this new building embodies the wisdom needed to lead building design culture.

The conceptualisation of the Arbour was the result of a long process of research, interdisciplinary Charrettes, design brief development, a call for proposals and an invited competition.

The process began years earlier when the IwB conducted a set of research projects around sustainable, universally designed, intelligent and resilient building systems. For four years the Institute conducted the "World House Project", exploring unique approaches to building systems for single-family residence and mixed-use housing. The project culminated in a partnership with the Canada Mortgage and Housing Corporation to develop a mobile residential prototype, called "The Canühome". It showcased local and national product innovations that embodied low carbon design, inclusive design, and sustainable products and services. The building form grew from a study of indigenous and vernacular Canadian house forms such as the igloo, the longhouse, wigwam and teepee, their key qualities translated into a computer aided design for a modular kit home. It was lightweight, mobile and responsive to its users and its environment. A key outcome of the project was the development of a successful approach to sustainable design.

The approach centred on using "high knowledge" passive systems and conservation techniques, and market-ready targeted "high tech" solutions. In the subsequent "City Systems" project that followed World House, this approach was expanded to the city scale through an examination of sustainable and resilient city planning and infrastructure design.

Throughout this 15-year period, the Institute continued to develop and perfect its unique Charrette-based working methodology using ideation and prototyping methods. When GBC was given the opportunity to acquire the land for the Arbour project, a deep approach had already evolved for bringing to market a systematically differentiated, sustainable building.

A list of key design themes and tactics that would inform the brief for the new building had been explored and tested and were ready for deployment.

Working from this emergent knowledge, the College, in partnership with the utility company Enbridge, conducted an interdisciplinary research Charrette to combine the best thinking from industry

Sixty professionals and ten international students participated in this "thinkubator" Charrette to identify potential concepts to guide the project.

The result was a "supersolution" that incorporated the wisdom accumulated by the sharing of knowledge from multidisciplinary professionals. "Out of the box" explorations were conducted in parallel by the international students to generate "outlier" ideas.

From these results, the master planning team was able to extract and synthesise the "Arbour Approach".

The four key characteristics of the "Arbour Approach" were as follows:

- The design should be developed in an interdisciplinary manner to ensure a holistic approach to solving the complex challenge that was being faced.
- The design would use a systems approach, creating not just a specific solution for the project but also developing new methods that could then be used by industry to accelerate performance outcome possibilities.
- The design would be developed co-creatively with users and relevant stakeholders.
- The design would be a demonstration of the best practices and learnings for George Brown College students, industry and society at large.

With these tenets in mind, the "Arbour Approach" was defined with four key pillars:

- Low Carbon – Reduce the building's carbon footprint through the use of mass timber construction leveraging the associated assembly and construction efficiencies.
- Net Positive – Establish a replicable net-positive carbon performance.
- Future Proofed – Incorporate strategies to ensure the long term success of the building in its programmatic use, as well as addressing the effects of climate change, while supporting the development of related practices and technologies within related sectors.
- Smart Building – Improve asset reliability, performance and utilisation by automating mechanical, life safety, user comfort, communication, facility management and systems monitoring.

With the "Arbour Approach" developed, and the intention for the building defined, the project moved through the Progressive Charrette Process. In this instance, that meant the following steps:

1. a research Charrette to determine the building's intentional character;
2. a design brief Charrette in consultation with Waterfront Toronto, and the City of Toronto Planning and Building Divisions to assure the building would be approved by government and authorities;
3. an international call for interdisciplinary teams, intended to spur the industry to identify and acquire partners to create consortia capable of exploring the "Arbour Approach" to prepare an innovative, yet practical design;
4. lastly, a three-month-long design competition from which the final design of the project would be chosen.

Nineteen consortia from around the world submitted their credentials and their understanding of the project parameters.

Four teams were selected and provided with financial compensation to, in essence, hold their own interdisciplinary integrated design Charrette and propose a schematic design for the proposed building.

The four teams were as follow:

- Shigeru Ban Architects with Brook Macilroy (SBBM);
- Provencher_Roy with Turner Fleischer Architects (PRTF);
- Patkau Architects with MJMA (PAMJ);
- Moriyama & Teshima Architects with Acton Ostry Architects (MTAO).

Joe Lobko, a partner at DTAH Architects Limited in Toronto, was retained to run the competition independently, and a jury was assembled with representation from the College, the City of Toronto, Waterfront Toronto and the architectural profession - Competition Jury:

- Rick Huijbregts, Vice President, Strategy & Innovation, George Brown College, Jury Chair;
- Fernando Carou, Community Energy Planning & Low Carbon District Energy, City of Toronto;
- Heather Dubbeldam, Dubbledam Architecture + Design;
- Christopher Glaisek, Vice President for Planning and Design, WATERFRONToronto;
- Anne Sado, President, George Brown College.

A Technical Review Committee was also established to review and provide comments to assist the jury:

- Luigi Ferrara, Dean, Centre for Arts, Design and Information Technology, George Brown College;
- Tammy Cook, Director of Facility Planning & Management, George Brown College;
- Ted Kesik, Ph.D., P.Eng., Professor Building Science, Daniels Faculty of Architecture, Landscape and Design;
- Iain MacDonald, Director, Tall Wood Institute, Oregon State University;
- Geoff Triggs, Life Safety Consultant, Evolution Building Science Ltd;
- Niall Finnegan and Emma Hickey, Cost Consultants, Finnegan Marshall.

During the schematic design process the client and proponent teams met at various points to provide feedback on the emerging design solutions and facilitate a continued process of co-creation.

These early meetings already hinted at the amount of exciting research being harnessed by each team to generate solutions for the ambitious brief.

To close the competition, a public presentation and exhibition of the four projects was organised to share the proposals with GBC community, industry, media and the Toronto public at large.

In this manner, the project could provide an opportunity to share knowledge, innovation and best practices, increasing the wisdom and capacity of the Canadian design community.

The final designs were revealed on March 28, 2018 at the public exhibition and presentation. The event was attended by over 500 people, leading to overflow rooms being set up to allow for everyone to view the presentations.

It was clear at this moment that the exercise had not only led to the development of four noteworthy projects, but that the brief had also pushed the teams to develop novel constructions systems, new approaches to reaching net positive and net zero carbon, and radically practical designs for future-proofing and resilience.

The four projects were markedly distinct from each other, and yet when viewed together gave a panorama overview of what a climate positive architecture of the 21st century could look like (Fig. 1).

Low Carbon Solutions

Each team created a unique pioneering approach to building a tall wood building: SBBM's standardised but unusually shaped dowel laminated mass timber with concrete core structure (Fig. 2.1); PRTF's double-height wooden truss building structure allowing for three-dimensional flexibility (Fig. 2.2); PAMJ's mass timber barn-inspired wood structure with hybridised wood and bubble-crete floors (Fig. 2.3); and lastly MTAO's highly practical large span CCT wood structure of wallums and shallow drop beams holding prefabricated CLT floor panels for flexibility (Fig. 2.4).

The Moriyama & Teshima/Acton Ostry scheme was deceptively simple, but its innovation lead to double the sequestered carbon of the other schemes, at 8005 metric tonnes, and the potential for wide spread adaptability for use in other markets through their innovative "wallum" and CLT slab band superstructure.

Future Proofing

Each scheme had different approaches to future proofing and resilience: raising the first floor and creating columnless spans from core to exterior (SBBM); developing "in frame" partitions and floor systems to infill the "superframe" structural truss systems (PRTF); utilising an atrium-organised building planning archetype (PAMJ); and employing a Japanese-inspired partitioning system that would enable adaptability of classrooms over time with mobile demising walls (MTAO).

Net Zero Performance

All parties struggled to reach the net positive goal, hampered as it was by the small site, reinforcing how critical community design is to the realisation of net positive buildings. This had been identified in the original research Charrette, and indeed proved to be a real challenge in the schematic design phase, and yet by focussing on this challenge, novel approaches were developed that combined the best of passive and active technologies.

A decentralised mechanical approach with high passive design and a distinctive solar chimney was proposed by the SBBM team, while the PRTF team proposed a distinctive approach titled "Opacity to Capacity", where the building's fluctuating façade was designed to work both passively and actively, providing shading where needed, and harvesting energy where possible.

The PAMJ project developed a double skin with built in photovoltaics, building on Canadian tradition of double skin research pioneered in the 1970's by John Hix, creating a wooden building nestled in a glass box.

The MTAO project developed the concept of a "breathing building" with super insulation on the north and south façades and solar chimneys on the east and west façades.

Smart Building

The smart building features were perhaps the most underdeveloped in all the projects, and the most susceptible to redundancy due to the rate of change in information technology. However, all the schemes proposed some level of responsiveness to occupants so that the building either learned from its users or used visualisation of building performance to influence user behaviour, or employed multimodal passive and active features influencing each other through advanced sensor interplay. After the presentations it was clear to all participants that the process of progressive examination, collaboration and sharing had generated a tremendous amount of knowledge and innovative ideas.

Most importantly, the public presentations had resulted in the growth of wisdom about a new climate positive architecture. Many of the seasoned professionals present thanked the College for creating an impetus for the sector to gain knowledge and wisdom, and for being given the opportunity to learn from their colleagues about the diverse and varied approaches they had brought to the same challenge. The IwB's supersolutioning Progressive Charrette Process had yielded unprecedented insight and wisdom.

After a difficult deliberation, the jury selected the Moriyama & Teshima Architects/Acton Ostry Architects proposal. The design stretched the benchmark for carbon sequestration; it presented a new, practical and highly transferable tall wood structural system; it offered a reasoned and reasonable approach to the political challenge of changing building codes, and lastly, it proposed an exquisitely orchestrated range of spaces and highly practical approach to future-proofing an academic building. Most importantly, through the Progressive Charrette Process, and the resultant efforts, the College was able to chart a model that other institutional and commercial clients can adapt to create their own innovative projects focused on climate positive architecture and design. Furthermore, the process itself stretched and inspired global talents to create new knowledge and synthesise it into a wisdom that could be shared with colleagues, authorities having jurisdiction and the next generation of students. If each and every institution or client dedicated one such project in their portfolio, and used a similar process, it is easy to imagine just how quickly and effectively we might be able to transform our built environment with new approaches to building systems that deal with the global climate change challenge.

Shigeru Ban Architects / Brook McIlroy Architects (SBBM) Provencher_Roy / Turner Fleischer (PRTF)

Patkau / MJMA (PAMJ) Moriyama & Teshima Architects / Acton Ostry Architects (MTAO)

Fig. 1 - Design proposal: Arbor Design Competition Finalists.

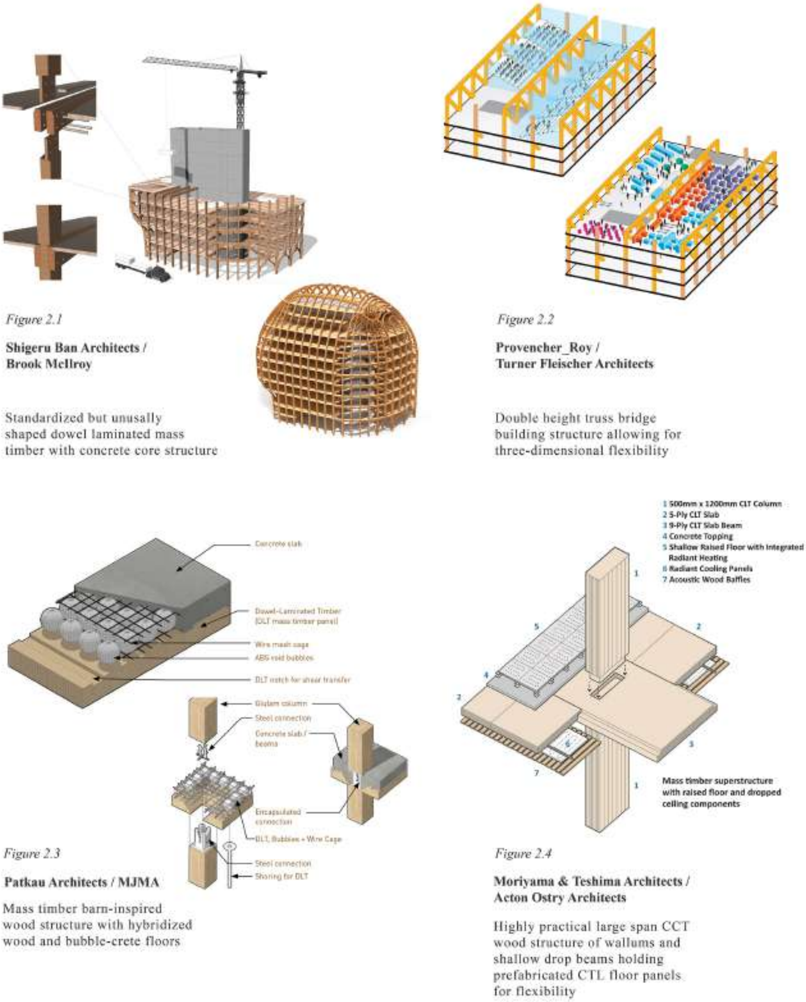


Fig. 2 - Innovative structural systems: Arbor Design Competition Finalists.

3.4 TECHNOLOGICAL DESIGN AND SOCIAL INNOVATION

Tiziana Ferrante[*]

Abstract

The Architectural Technology has always proposed a correct approach to design, considered as the core of the building process, by identifying appropriate tools in order to manage its complexity. Such tools are even more valid today in the perspective of a new social demand and a transition of the building sector to Industry 4.0. However, this is jeopardised by the budget cuts in welfare and the University: professional degrees and industrial doctorates are not enough. It is therefore more often necessary to refer to a technological design culture based on the responsibility of the designer and on the relationship he/she establishes with the social context, the clients and the company.

Keywords: Technological design, Social innovation, Industry 4.0, Education

The topic of the "design culture" and its responsiveness today to a new economic/social demand requires a preliminary consideration on how education can then be translated into a correct and appropriate design approach, as well as Architectural Technology has (always) proposed (Schiaffonati, 2011).

The latter is a disciplinary area that has always considered the "centrality of the design" as fundamental and for this reason located "inside" the building process, thus rediscovering precise links with each phase and identifying adequate tools and methodologies within that in order to manage this complexity that is normally a constant factor.

Over the years, the Architectural Technology has carried out a significant cultural and social innovation action, considering architecture as a tool of civic response to problems, the definition of solutions to problems of emergency housing arisen from migration, the response to seismic events and/or environmental disasters, in addition to the constant aging of the population together with a similarly constant increase of homeless people, in conditions of poverty.

The concept of social innovation has historically involved not only technological innovations themselves, but also the transformations of living environments and social structures - as Bellicini of Cresme reports when he states that it is the second industrial revolution in construction, after that of reinforced concrete in

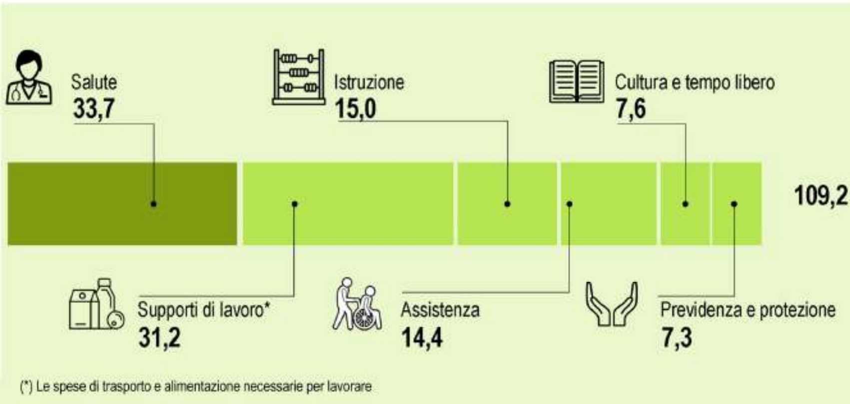
[*] Tiziana Ferrante is a Full Professor at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, tiziana.ferrante@uniroma1.it.

1850 and it is made of digitisation of design and building process, new materials, new measuring instruments, new construction technologies, renewable energy.

The supply models and the demand behaviours are reconsidered (Arona, 2017) and, consequently, the technological approach to the architectural design plays a key role because «Architecture itself often represents a communication tool "of" and "for" the social innovation; likewise, social innovation changes (also) through the architectural act. Architecture, together with the range of elements that make up the city, identifies tangible material translation as a result of the socio-economic needs» (Faroldi, 2017).

Such economic and social needs, for example, concern the severe shortages detected in the welfare sector during in the last few years, whose system imposes a step ahead: currently it costs to households 109.3 billion per year, equal to 6.5% of the Italian GDP[1].

Moreover, the increasing difficulty of access to services, detected in the growth of households who give up their services (equal to 36%), reports that for a family with an average income the cost for welfare is the third item of costs after food and home (Graph 1).



Graph 1 - Spending on welfare of Italian families (Data in bilions of euro). Source: Mbs Consulting, Observatory on welfare balance of Italian families, 2017.

The discipline of the Architectural Technology has therefore promoted and exploited research in the construction areas of universities, hospitals, socio-health facilities, schools, etc., as well as conducted surveys (Performance Design) and established Research Doctorates (monodisciplinary, interdisciplinary) and Masters (on management, technical-administrative procedures, BIM) in order to address clients, construction companies, public administrations.

1 Mbs Consulting Observatory on the welfare budget of Italian households, November 2017, http://www.uil.it/documents/RAPPORTO%20-%20osservatorio%20welfare%20familiare.pdf.

All this is today jeopardised for a progressive reduction of the university educational/training courses despite the growing demand from the production sector. Given that the education/training of graduates (in Architecture, but not exclusively) cannot only aim at achieving skills required in the labor market, it is (and will be) more often relevant a focus on continuous education/training, e.g. innovative Research and/or Industry Doctorates carried on in close cooperation with enterprises. Education/training cannot therefore include any form of obsolescence and must not even be based on information gathering (which, in any case, cannot bring a solid knowledge), but must aim at building a flexible structure able to fit, from time to time, the different occurring contexts.

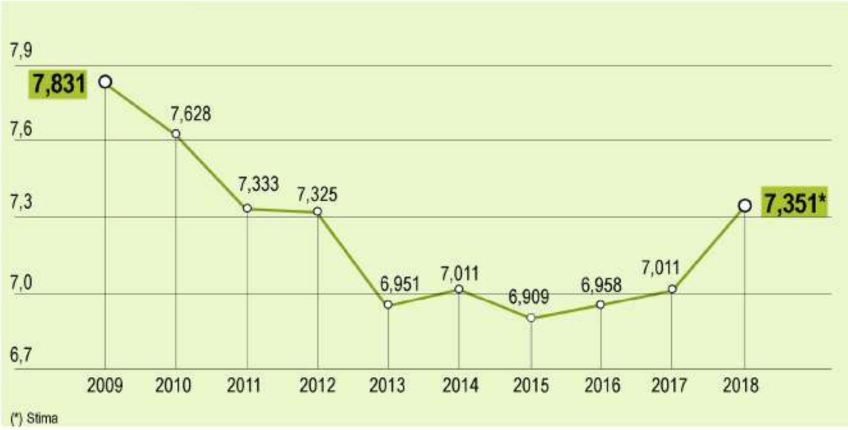
Education/training, especially when related to Industry 4.0 and the job market, will become more central in Italy in the next five years. This is not only to boost the economic and productive recovery, but also to tackle unemployment, with a priority for young people. From now to 2022, in fact, as from annual Excelsior report by Unioncamere and Anpal, more than 2.5 million workers, both employees and freelancers, will be required. Thus, more than 70% of these new entries - say 1.8 million workers - must possess quite high and qualified skills (for 35.8% we mention specifically high skills or specific and technical professions) (Tucci, 2018). Meanwhile, the professional degrees are being launched.

ANVUR (National Agency for Assessment of University and Research System), CUN (National University Council) and the Ministry of Education approved professional degrees for the AY 2018-2019 in 15 universities; these aim to train professionals in the approach of Industry 4.0 and establish two years of traditional study and one of practice at professional firms or companies. Therefore, in order to comply with this, it is necessary to avail materials, equipment and laboratories, but this is a rare situation within our faculties, more often facing severe critical issues. The Italian university work market is often "precarious", just looking at the teaching staff we can detect an average of less than two temporarily hired researchers every ten retired permanent professors/researchers. Most of the temporary research staff/groups include grant holders, doctoral students and scholarship holders: a variety of contracts whose figures are not always known: MIUR provides fairly updated data on the first two categories (13.350 grant holders in 2017 and 31.651 doctoral students in 2015), while the figure of scholarship holders is even unknown. However, the graph clearly shows the discrepancy between the new staff commitments and the budget reduction through the last decade (Graph 2).

The emphasis of the cultural contribution to the design disciplines by Architectural Technology was always on promoting the awareness that the relationship between design and construction is a complex matter to be managed with competence and appropriate tools[2]. However, here we face the (unsolved) problem of the integrated procurement, a source of continuous conflicts.

---

2 Excelsior Unioncamere and Anpal report, 2018, "Excelsior information system. Forecasting employment and professional needs in Italy in the medium term (2018-2022)".



Graph 2 - Ordinary funding of Italian Universities. (Data in bilions of euro). Source: Ministry of Education, University and Research, 2017.

The builders of the ANCE (Confindustria) and the National Association of Municipalities (ANCI) aim to a return to the integrated procurement. One of the main innovations of the 2016 Code was the obligation to contract building works on the basis of the executable project, as in the Law Merloni 1994 after the Bribesville age, in order to reduce the post-tender disputes and the work variations. ANCI and ANCE, however, report difficulties, especially in the case of small municipalities, in designing, and therefore require to go back to the free integrated procurement, i.e. to provide that contracting entities can entrust building companies on the basis of executable design and working plan as a result of the final design already approved (Arona, 2018).

Also, OICE (Association of organisations of engineering and architecture, that includes 350 companies, with annual profits of 2.4 billion and 17.000 employees, 85% of them technicians) reports that the integrated procurement is not a useless procedure, as the president Scicolone points out: «We only disagree with a generalised application of the integrated procurement».

Therefore it is necessary to address a technological culture (not technical, actually) of the design based on the responsibility of the designer as to the relationship with the social, economic, environmental context through correctly interpreting the "demand", on ability to feedback and support the client in identifying procedural paths appropriate to the nature and relevance of the interventions, as well as providing assessment tools for possible alternatives in the planning and programming phases (ex ante methodologies, feasibility studies), on ability to combine the different phases before and after the design development (ex post methodologies), on inescapable necessity of defining, as regards to the relevance of the interventions, the financial coverage and at the same time the work completion timescale, with the ability to interface directly with the building company to monitor the executive phase.

The designer's responsibility is involved in three themes: the first theme is "design, sustainability and circularity of processes" with the aim of reducing the consumption of raw materials and limiting the environmental impact and the circularity of processes, by reducing the erosion of the natural asset through waste disposal and cyclic use of raw materials, as a (definite) industrial reference context would establish; the second is therefore "design, digitisation and Industry 4.0"; finally, the third is "design, uncertainty and resilience" to deal with economic/social and environmental crisis (Campioli, 2017).

Facing the need of such skills, Architectural Technology firstly introduced methodologies able to interpret the social dimension of architecture through the performance-based approach, disclosing it in the definition of metaprojects, performance specifications, lines and/or design guides, feasibility studies, in order to guarantee the viability of an intervention.

The law-maker recognised such content as founding (and fundamental) prerequisites of the "technical and economic feasibility project"[3], in the definition of objectives, in the identification and analysis of all possible alternative design solutions in relation to the territorial, environmental and landscaping context in which the intervention is inserted, to the impact on environment and the specific needs to be satisfied and the services to be provided. This means that a predictive action starts and develops from feasibility (Del Nord, 2011), so that the designer brings it along with a design consisting of detailed analysis and targeted evaluations, where no component can be underestimated or excluded.

On this purpose, the role of Architectural Technology with regards to the "design culture" can still provide many responses in terms of social innovation because it has always been respectful of meeting the needs of the community (Palumbo, 2012), through the practice of those forms of participation currently of great interest in the development of programs and projects of services and infrastructures.

Such participation must not be limited, as it is currently, only to some works and only at one process stage with the *debat publique*, but it must be constant and open to all according to the open source policy.

In the participatory process, the Post Occupancy Evaluation (POE) is particularly relevant in the current time when the real estate sector cannot propose itself "only" through sale, but also with the offer of additional services (including those to the person). In fact, Industry 4.0 goes beyond and offers the opportunity to evolve and change operating models: in this context, companies can reconsider their production chain according to policies very different from the past, allowing to create business models with greater acceptance and therefore

3 Art. 23, D.Lgs 18.04.2016 n. 50, "Levels of design for procurement, for works contracts as well as for service".

loyalty policies for customers. Thus, enterprises can change from product companies into "product as a service" companies. Just for this reason, after years of indiscriminate budget cuts to the research and innovation sector, which instead is fundamental for the competitiveness of the country and its industry, it is now necessary to promote a coordinated research plan based not only (as it happens today) on a competitive basis, but on strategies for restarting the collaboration between industry and university research in strategic sectors, for the benefit of the community, in order to harmonise research with social innovation.

From the launch of Industry 4.0, much is expected from the competence centres (at the moment there are eight competence centres admitted to the negotiation phase with the Ministry of Economic Development to access public funding) that will be research facilities and technology transfer "4.0" with public and private partners. They will develop projects in certain areas of specialisation and shall provide services to SMEs. Overall, there are about 400 companies in alliance with about seventy universities and public research organisations, using the Third Mission as a driver of social innovation and as a bridge to fill the gap between science and society, transforming universities, research centres and scientific institutions into drivers of change. The integration of the different instances of companies, industry, work, government, universities and civil society - to the largest extent - is exactly what we need now.

References

Arona, A. (2017), "Costruzioni, la vera ripresa (+2,5%) arriva nel 2018, trainata dalle opere pubbliche", *Edilizia e Territorio,* Il Sole 24 ore, 15 November.

Arona, A. (2018), "Codice appalti/3. Ecco le 10 proposte Ance-Anci per la riforma: no alle Linee guida e ritorno all'appalto integrato", *Edilizia e Territorio,* Il Sole 24 ore, 20 July.

Campioli, A. (2017), "Il carattere della cultura tecnologica e la responsabilità del progetto", *Techne,* n. 13, Firenze University Press, Firenze, pp. 27-32.

Del Nord, R. (2011), "Quale ricerca per quale domanda", in *Techne*, n. 1, Firenze University Press, Firenze, pp. 70-75.

Faroldi, E. (2017), "Architettura come materia sociale", *Techne,* n. 14, Firenze University Press, Firenze, pp. 11-17.

Palumbo, R. (2012), "Nota", *Techne*, n. 4, Firenze University Press, Firenze, pp. 8-10.

Schiaffonati, F. (2011), "La finalità della progettazione nella formazione dell'architetto e dell'ingegnere", *Techne,* n. 2, Firenze University Press, Firenze, pp.52-59.

Tucci, C. (2018), "Più spazi per profili qualificati", *Il Sole 24 ore*, 15 May.

3.5 THE CONTEMPORARY CONDITION OF DESIGN. A REPORT ON DIGITAL MATHEMA

*Giuseppe Ridolfi**

Abstract

The essay analyses how, through different neologisms, the postmodern condition and information technologies have evolved into the contemporary condition affecting humanity and the environment. In this scenario, the essay examines the appearance of a new meta-regulation system represented by the Digital Mathema, made possible by machine language and by the technologies of calculemus, with evident repercussions on design and education where there is a serious risk that the "know-how" is confused with (up to the point of eclipsing) "knowledge".

Keywords: Modelling, Digital craftsmanship, New realism, Design & Education

Natural signs and artificial things

Forty years ago, Lyotard certified the advent of the postmodern condition by confirming the disappearance of the Great Narratives (Lyotard, 1979). This was the result of a process in which words had broken their natural relationship with things to reveal themselves as objects manufactured by an *artifex* (the modern man), subject/object, subjected to language like science and knowledge. This is the condition where reason, by declaring war against dogmatism, ends up delegitimising itself: a place where the real becomes populist "reality" and thinking increasingly weak in front of the *esprits forts* (Ferraris, 2012); a time without history where truth and justice derive from language in its two possible options: «formal coherence» or «shared interpretation» (Foucault, 1966), but even more from the structural manner through which knowledge is formed and transmitted as an exchange goods alienated from the knower. It is the state of a new humanity, of post-humanity beyond the times when the augur used to read correspondent signs of things to unveil the secrets of a continuous world. A new era where humanity writes artificial "things", arbitrary words to give order, truth and projectuality to a word of differences.

In spite of the fact that science has placed truth as inaccessible (definitely, as limits tending to infinity), humanity has castled himself on the discursive and

* Giuseppe Ridolfi is an Associate Professor at the Department of Architecture, University of Florence, Italy, giuseppe.ridolfi@unifi.it.

pragmatic aspect of knowledge (Habermas, 1981). By the dawn of the nineteenth century, linguistics had already paved the way by replacing object-roots with verb-roots as the matrix of language, therefore highlighting actions rather than *qualia*. As a result, pragmatics and performative rationality of language are welded to the centrality of proof to legitimise choices. Knowledge and its means of fabrication become, as well as instruments of Baconian *potentia*, devices enabling consensus, since consensus now surpasses feasibility, and the credibility of "things" surpasses the authoritativeness of the subjects. Technology has become pivotal to fabricate knowledge, science, consensus, and language until, as many points out (including Marcuse to Severino), it has risen to an *absoluto*, untied from any ethical constraint and reasonableness: the place of informal curvilinearity where medium becomes end (Severino, 2003).

Contemporary society

Information society and post-industrial society become overlapping terms, both cousins of digital technologies, opening up the condition of the contemporaneity where everything is possible and co-present; where spatial proximity, principles of before and after, hierarchies, subjugations, filiations decline. The ubiquity advocated by P. Valéry becomes the episteme, emancipating society in a liquidity made of the lightness of immateriality, freedom from space and time, flexibility, re-configurability (Bauman, 2006): freedom that, at the turn of the millennium, will be indispensable for corporations but impracticable for the majority of the people thrown into a «whateverness with no-destiny and scope», unlocked from any social bond and tied back into contractual clauses (Agamben, 1995). In spite of the proclamations, contemporaneity brings an accelerated proliferation of "things", reducing spaces for movement and producing an experiential density that leaves us stunned, unable to choose and approximates us to the «absolute horizon of the event» whose laws deny any escape. These are densities that evolve into real catastrophes such as the demographic one where the finitude of humanity occurs in the spatiality of the body and physical resources. Above all, it is the density of enabling devices accumulated in an asymmetrical way and where the only possible ubiquity is for the advantage of few and for the disadvantage of many.

Great Narration/Digital Mathema

If postmodernity announced the end of the Great Narratives, throwing us into the desperation of nihilism or into the euphoric and de-sublimating condition of *omnimoda determinatio*, we must instead assess the establishment of a new Post-liberal and Post-capitalist Great Narration supported by a *mathesis univer-*

salis embodied in digitisation and computing technologies. The result is an uncomfortable

> «Sartrian *"réalité visqueuse"* of dusty events centrifuged by the digital and "stuck to" the individual, limiting any faculties, and delivering him to a delirium of processes and immobility where, even, the "History…is exhausted in special effects, implodes in actuality"» (Baudrillard, 1992: 13).

The static *quadrillage* of the Cartesian space is replaced by self-learning mutant algorithms, able to measure – beyond physicality – sensations, opinions, to which are assigned the capacity to do an extensive and intensive "writing" on vegetables, animals and human lives. This is evidenced by the lawsuits brought against companies that organise work and profits through algorithms.

The Digital Mathema updates biopolitics by reassembling the *bios* in pure *zoe*, bare insignificant life, while also controlling even death. Google is already working to make algorithms that predict how much we have left to live with an accuracy of 95%. The Digital Mathema is the ransom after the Tower of Babel to return to the language that God gave us; the promise to return to knowledge that is no longer an interpretation, but an objective "mark" based on the *datum*. It is the promise to bring together the dispersion of the manifest, to produce a transcendental exegesis of the world through simplicity and performativity of binary coding, the passage «from a qualitative quality to a quantitative quality» (Carmagnola, 1991).

Untouchable Materiality

Sensors and data loggers weave an invisible network through which life and nature are trapped in the computational world, so much so that we can say that environmental computing has already begun.

At the same time, we are witnessing an impressive growth of actuators informed by data quantified in petabytes, capable of exactability and self-learning that, more and more, allow us to interact dynamically with the world. We are at the point where it is now possible to have *materia prima* (matter) and *materia operata* (material) available for predictable behaviour.

Mastering the matter is no longer designing forms, assigning meaning and uniqueness. It is an activity developed at the structural level of matter, at the scale of the invisible, and from which performative *objects*, «objectiles» incorporating multiple eventualities, and agent-based projects appear. We are in the presence of a new materiality (untouchable materiality) that is «farce» with that special matter that is information (Flusser 1991): "things", beyond the age-old real/virtual opposition, impalpable but capable of producing tangible effects on the physical world and on memories and affections.

End of the modern

When Lyotard's pamphlet appeared, the "dismantling" of the great narration of the modern in architecture had already begun, at least since 1972, through irony, learning from Las Vegas and more practically with the use of dynamite to raze the Pruitt-Igoe social housing blocks to the ground. The *Via Nuovissima* for the 1980 *Biennale of Architecture* represented only the seal of a new and long season of architectural debate on its languages and its poetics. More prosaically in front of the fiasco and in the face of a neo liberal evolution of the economy, the production of the project and construction business also remained involved in the new liquid episteme of weak knowledge, management, designing: «invisible technologies» (Sinopoli, 1997), devices of value of the "word", but even more grammatical devices of "language" that are definitively surrendered to digital "marking".

Digital building constructions

The information technology appeared in building construction in the 1950's with the School of Ulm and later with the «Open Systems» in the form of cybernetic reasoning applied to the project as a system. Due to the technological limitations, incapable of graphical functions different from numerical quantification and therefore only exploitable for office tasks or pure calculations. It is curious to note that 1979 will also be the year of new "things", significant from our point of view.Motorola ran the 68,000 chip, a 16/32-bit microprocessor that will become the heart of Macintosh, alias the first personal computer that became a commodity. The first commercial cell phone network was established in Tokyo. Daniel Bricklin and Robert Frankston realised VisiCalc, the first microcomputer computation language through which it was possible to "fabricate" applications without the knowledge of a programming language. Of the three, the last "thing" is apparently the most irrelevant, but undoubtedly decisive since the language of numbers is presented and is operable in natural form, through the iconic object-oriented approach already seen in the Smalltalk Xerox (1973) and subsequently used for the Macintosh Operating System. However, we will have to wait the 1990's in order to see the digital "marking" emerging in design: first in the form of automation with 2D CAD and, in the new millennium, when solid modelling and three-dimensional visualisation were available inexpensively. Nowadays its nickname is BIM: an acronym for Building Information Modeling. Its gestation is to be placed at Heathrow, in the period between the expansion of Terminal 3 (1987-90) and the construction of Terminal 5 (2001-2008), within the time frame necessary to move from the 2D and half of RUCAPS to the full 3D (Eastman, 2008).

A period of twenty years in which the acquisition/query of the *datum* extends the gestures of keyboard and digitiser to other sensorial-cognitive forms.

Visual Thinking

At the turn of the millennium, in 1999 Nvidia Corporation introduced GeoForce 256, an unprecedented microprocessor dedicated to graphics (Graphic Processing Unit) already seen three years earlier in 3dFx's Voodoo Graphic Card. A "thing" enabled to operate simultaneously on multiple computing centres that supported the CPU, even overcoming it and occupying the sciences, medicine, oil explorations, algebra, till the determination of the purchase/sale prices on the stock market.

In February 1998 Maya was born, materialising the access to precluded functionalities used in advanced manufacturing sectors like cinema, automotive, aerospace and opening up a new era whose genes were Silicon Graphics (1981), Catia (1982), Tron (1982) and Fish by F. Gehry (1989-1992): progenitor and icon of when visualisation designs unusual problems for construction.

Ecce BIM!

In the same year in which Fish was inaugurated, the neologism BIM saw the light, a workflow rather than a software, or better a «tangle of trajectories» (Deleuze, 1989: 11), which emerged from the integration of different applications able to talk each other since they are based on the same logic and information structure.

BIM is a work environment that evolves from syntactic structures of solid modelling and object-oriented language, integrating multiple information archives: parametric datascape operable through the indexing of the three-dimensional representation of the building (Eastman, 2008: 26-43).

It is a radical change in the way of generating geometries where the modules drawn by compasses, numerical measurements and then mathematical equations were replaced by parametric functions capable, first of all, of automating design activities, then working with objects incorporating morphological and semantic information capable of manifesting themselves, contextually, in a different way, therefore endowed with a kind of intelligence.

It is a language in which a column, as Louis Kahn said, really knows that it is a column because it is informed of all the ontological attributes (physical and social) and therefore over graphic conventions that asked to be filled with meanings and materiality.

It is a new enabling device able to generate various types of deliverables for different contractual purposes and activating «almost zero-defect tolerance» processes, from which opportunities for productivity, reliability and new frontiers of competitiveness are glimpsed.

Informative BIM/Performative BIM

In the initial phases, the development of BIM was mainly concerned with the so-called Informative BIM, focusing on the ability to produce user-specified reports for great benefits of management contracting. In addition to quantitative reports and a limited number of checks (geometric conformity, regulations), the basic BIM Authoring Tools offer little functionality for designing and design validation, entrusted to other specialised software. The needs, even commercial, to fill these shortcomings have opened interesting prospects for the so-called Performative BIM: an exploration and simulation device, capable of generating alternatives and supporting decisions (optioneering) no longer based on past experiences or authoritative intuitions, but on objective measurements of the building and its environment now operable in the language of the Digital Mathema, Information modelling and Performance Simulation.

Modellkonstrukteure. Design and education

Since the first phase focused on computational engines (kernels), the research has moved on to interfaces for their simplification until gamification, thus making the Performative BIM accessible to non-experts with non-negligible advantages and risks (Ridolfi, 2018). The freedom from scripting obtained through visual programming, user friendly simplification of the interfaces and the ability to display, in analogue and easily understandable forms (even in high resolution), the calculation results are elements that outline new possibilities for the performance simulation, especially in the early stage design when it is required to explore the largest number of alternatives and to participate different stakeholders into the project.

Differently from authoritative exploratory practices (not fully demonstrable and transmissible), parametric simulation offers the possibility of redefining design and education as the practice of Eupalinos who «conceives as if he was building» (Valéry 1921: 25), and to establish them as a scientific practice involving problem setting; framing feasible and operable experiments; running simulations inside the computer "white rooms".

It is therefore the opportunity to shape "knowledge" from critical awareness deriving from knowing how to run experiments, build models, and share results. It is that new craftsman, that *Modellkonstrukteure*, already pointed out in 1925 by Gropius, who – by hand – realised prototypes in laboratories looking at the methods of industry.

Know-How/ Knowledge

Digital craftsmanship is an oxymoron of contemporaneity where salvific desires seem to re-emerge, but more seriously it is the need to regain the "tactility" of doing in order to land a project abandoned in «thin air» and defined through "things" like management, briefing, marketing (Frayling, 2011). Digital craftsmanship is now happening in the design laboratories of university education where there is a serious risk that the know-how is confused with (up to the point of eclipsing) "knowledge" in a way that is possible to legitimise statements affirming that teaching architectural design is a matter for professionals of architectural business. In contemporary times, instead, my opinion is that know-how is different from simple dexterity, skills, acquisition of ways of doing, and styles to be repeated and disassembled until virtuosity. Contemporary know-how and new craftsmen no longer identify themselves with «stealing the trade with the eye», but in being able to run experiments, fabricate prototypes, adapt tools to «resume [as Tridone Sidonio] things at their origin» (Valéry 1921: 62). It is a haptic form of knowledge, rooted in the traditional process of trial and error, but today with speeds and savings that were previously unimaginable until the application of evolutionary software allowing the selection between quasi-infinite populations of variants.

Models, transcendences and common sense

In forty years, the information society finds itself enriched with redundant things, "augmented" beyond the hi fi described by Maldonado, which leads to experience a materiality otherwise invisible, but distracts us from the molarity, from the common and convivial sense of life with not negligible consequences on the formation of architectural projects and designers.

Digital is a viscous meta-language that if on the one hand opens up unimaginable opportunities, on the other entangles us in tautologies that are uttered in the forms of natural language, which poses an emergency (more serious than environmental) that is the destruction of our symbolic habitat. If you touch fire you get burn and without an umbrella you get wet, as Ferraris warns us to reaffirm the unamendability of reality. It is also unamendable that man finds his "transcendences" in desires, in work, in suffering, in joys until death: universalities capable of putting humanity in communion with fellow humans and for this reason they deserve a voice.

The reappropriation of language – or as Agamben suggests – of «staying in language with subversive tension» thus becomes a possibility: that design and construction still continue to speak, as Gioffrè wrote, also the language of mythopoetic, of the Vichian «impossibile credibile», or better and in the words of Latour of the «*fétiches*» because, in the end «we have never been modern».

It is the hope that the common feeling of humanity remains unamendable in the verification of the results produced by any experimentation; sometimes even in spite of the evidence of the *datum*, of the indifferent quantity, of the power of the technologies or the authoritativeness of the experts. It is the hope that the built could be an exegesis of humanity in its finitude and a speech among humans.

References

Agamben, G. (1995), *Homo sacer*, Einaudi, Torino.

Baudrillard, J. (1992), *L"illusion de la fin*, Editions Galilée, Paris.

Bauman, Z. (2006), *Modernità liquida*, Laterza, Bari.

Carmagnola, F. (1991), *Luoghi della qualità*, Domus Academy, Milano.

Deleuze, G. (1989), *Qu'est-ce qu'un dispostiv?*, Éditions du Seuil, Paris.

Eastman, C. et alii (2008), *BIM Handbook*, Wiley & Sons, Hoboken.

Ferraris, M. (2012), *Manifesto del nuovo realismo*, Laterza, Bari.

Flusser, V. (1991), "Form and Material" in Lange-Berndt, P., *Materiality*, Whitechapel-MIT, Cambridge, 2015.

Foucault, M. (1966), *Les mots et les choses*, Gallimard, Paris.

Frayling, C. (2011), *On Craftsmanship*, Oberon Books, London.

Gioffrè, R. (2016), "La famiglia degli ossimori", in Lauria, M., Trombetta, C. (eds), *Building Future Lab*, Maggioli, Santarcangelo di Romagna.

Gropius, W. (1925), "Grundsätze Bauhausproduktion" in Gropius, W., Moholy-Nagy, L. (eds), *Neue Arbeiten der Bauhauswerkstatt*, Bauhausbücher 7, München.

Habermas, J. (1981), "*Moderno, Postmoderno e Neoconservatorismo*", Alfabeta, III:22.

Latour, B. (1996), *Petite réflection sur le culte moderne des dieux fétiches*, Synthélabo, Paris.

Lyotard, J.F. (1979), *La condition Postmodern*, Feltrinelli, Milano.

Maldonado, T. (1992), *Reale e virtuale*, Feltrinelli, Milano.

Ridolfi, G. (2018) "Bim e simulazione ambientale nelle fasi iniziali del progetto" in Ceccherini Nelli, L. (ed), *Soluzioni innovative di risparmio energetico per edifici Nearly Zero Energy*, Didapress, Firenze.

Severino, E. (2003), *Tecnica e Architettura*, Raffaelo Cortina, Milano.

Sinopoli, N. (1997), *La tecnologia invisibile*, Franco Angeli, Milano.

Valéry, P. (1921), "Eupalinos ou l'Architecte", in *Architectures, Nouvelle Revue Française*, Paris.

3.6 THE CULTURE OF PLANNING AND PARTICIPATION

*Alessandra Battisti**

Abstract

The purpose of the essay is to draw up an overview of the ongoing development of the process of participation, as it relates to the culture of planning, in light of the Public Contracts Code promulgated under Italian Legislative Decree no. 50, and in particular its art. 22 "Transparency with Regard to the Participation of Stakeholders and Public Discussion". The approach taken stresses the integration of the planner's strategies with the local communities' views, which may express their assessments of the merits of feasibility plans prior to their final formulation, in a manner resembling the French practice of débat public.

Keywords: Participation, Public debate, Inclusive project, E-democracy, Open source Architecture

Introduction

The ties between research into planning and processes of inclusion trace their roots back to the 70's, when, as part of the urban struggles of the time, residents associations proliferated throughout the western world, from the United States[1] to France[2] while in Italy architects[3] engaged, in those years, in critical discussions of planning, presaging the model of participation that was to be codified under the Contract Code, through the mechanism of public discussion.

Before reflecting on the decree, it is worth noting the variety of meanings that can be attached to the underlying concept of public discussion in the course

* Alessandra Battisti is an Associate Professor at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, alessandra.battisti@uniromal.it.

1 In 1966, the reformist policies of President Johnson led to the launching of federal programmes meant to counter social inequality, with the creation of model cities meant to provide the organisational framework for public and private initiatives of urban renewal. Such policies served as an occasion for the development of what was known as advocacy planning, a participatory approach in which the weaker, less technocratic sectors of the population gave direct expression to their needs.

2 «*Sous les pavés, la plage!*» a well known motto used by French situationist movement against bourgeois society during the 1968 protests.

3 De Carlo was among the first theorists and experimenters of public consultation in Italy in the Matteotti village in Terni (1969-1974).

of giving expression to outlooks, scenarios and planning solutions which must be met with precise responses within a social reality that proves increasingly difficult to decipher, seeing that there can be no automatic assumption of a shared set of principles of equity and solidarity, nor of a reciprocal desire to establish relations, much less to promote social inclusion and cohesion, to the point where a *maitre à penser* on the order of De Carlo warned that: «for participation to succeed, positions of reciprocal mistrust must be overcome, conflicts and adversarial positions must be acknowledged seeing that it represents an event which is not only intellectual and mental, but physical as well, being driven by heat of human pulsations» (De Carlo, 2013). And this in an era that was characterised by analogue procedures, as opposed to the modern-day digital technology which «expands space and collapses time», as observed by C. Ratti (Ratti, Claudel, 2014). Such topics have led to talks on the end of the social sphere (Touraine, 2008) in terms of the forms of relations to be found in contemporary communities during an age of globalisation.

In the specific case of active participation, promoted through the energy of human pulsations, there is no denying the results achieved, whereas modern-day co-creation, left to exchanges that take place over the internet, must still arrive at similar outcomes.

In delving into this condition, the text analyses the processes of inclusion which have developed over the years, examining the ways in which they have diversified while pointing out their main variants.

The set of legislative measures and courses of action that have arisen can have interesting repercussions, which is why attempts are made to come up with mechanisms under which planning increasingly resembles less of a pre-established programme and more of a network designed to take in an ever larger number of participants (Sclavi, 2014), in the firm belief that only by considering a polyphonic array of interests can appropriate solutions be reached (Lewanski, 2016).

Transparency in the participation of stakeholders and public discussion

The White Paper on the European System of Government (Commission of the European Community, 2001) recognised the principle of participation through the open consultation of citizens and their associations as one of the cornerstones of the government of the European Union. In July of 2001, the European Council published the "Recommendations of the Committee of Ministers to the Member States regarding the Participation of Citizens in Public Life on the Local Level", in which it stated that: «the key challenge for ongoing participation in local policies is the implementation of decision-making processes able to satisfy the shared expectations of citizens». Under paragraph 1 of art. 22, the categories of pertinent initiatives are identified as «feasibility plans regarding large-scale infrastructural and architectural works of social relevance, and which have an impact on the environment, on cities and towns and on the overall make-up of the territory»[4].

Paragraph 2 of art. 22 provides an overview of the procedural framework used to structure the application of the mechanism of public discussion. The goal of the approach is to integrate the planner's strategies with the outlooks of local communities by allowing the latter to express their assessment of the feasibility studies prior to the drafting of the final versions through a process that closely resembles the *débat public* system utilised in France[5].

The discussion can be organised in a number of different ways, within a time framework of four months and in compliance with the requirements of public disclosure of the procedure: publication on the proponent's website of the technical and economic feasibility study, and of other documents regarding the project; collection of observations via electronic mail; the holding of public discussions in the territory affected by the initiative; publication on the proponent's website of the results of the consultation and the discussions, and of the observations received, eventually in the form of summaries.

The pertinent regulatory measure (art. 22, paragraph 4) calls for the outcomes of the public discussion, as well as the observations collected, to be «evaluated at the time of the formulation of the final plans» and «discussed during service conferences regarding the project that was the subject of public discussion» (Pillon, 2016).

Under this approach, the discussion constitutes a mechanism of participation-consultation meant to favour the presence of a wealth of opinions rather than forge a consensus among the various participants.

The hope is that direct contact with citizens who have an interest in safeguarding and upgrading the places where they live will reduce levels of protest while ensuring increased social acceptance and contributing to the resolution of problems in collaboration with the body or authority proposing the public work.

Reference experiences in deliberative democracy

Proper application of the Environmental Impact Procedure, though it can take different forms in different countries, already includes, among its key prerequisites, a thorough integration of the technical-scientific functions, on the one hand, and the need for participation of the communities affected, on the other.

---

4 With spending thresholds from 200 million to 500 million euros, depending on the type of project: infrastructures of roadways, highways, railways, ports, airports, interports, power lines, industrial plants, energy infrastructures, urban developments.

5 A procedure introduced on 2nd February 1995 under the Barnier Act to reinforce environmental protection.

The function of the environmental impact statement is not limited to its technical-scientific role, given that the procedure, in order to provide valid support for the ultimate decision, must achieve the two fundamental goals of predicting and estimating the effects of initiatives by ensuring that the points of view of the different subjects involved are rendered both explicit and legible.

In recent years, Italian cities and towns involved in the projects Urbact and Urban Innovative Actions, together with those that have implemented the regulations for joint oversight of shared assets, have undertaken innovative measures to promote the involvement of citizens in the formulation of policies of urban sustainability. The participatory experiences introduced in these instances serve as a compendium of practices and outlooks for the enactment of local decision-making procedures. Two other initiatives of interest – in terms of both the scope of the policy issues addressed and the significant geographic entity of the forum of deliberation – are the regional laws on participation approved by Tuscany and *Emilia-Romagna* regions[6].

Finally, in what represents the first use in Italy of the “French style” procedure for public discussion of a major infrastructure, the planning/construction of a roughly 20-kilometre segment of highway known as the Gronda di Ponente in the territory of the City of Genoa has been addressed. For roughly three decades now there has been debate over a new route for this obsolete, badly congested artery carrying urban, regional and international traffic. The participatory process was backed by the city’s then mayor to overcome the impasse that had arisen due to popular protests, with a thorough review to be conducted of the rational and technical planning proposed by the highway operator, so as to arrive at a solution that had a less drastic impact than that of the routes initially considered and was supported by at least a partial consensus.

The primary methods for involving citizens in ongoing transformations

«What is the city but the people» is the rhetorical question posed by *Sicinius* in Shakespeare’s *Coriolanus*[7] reprising the underlying concept of Roman civitas, according to which the *cives*, or citizen, is he who abides by a bond of belonging that is no longer tied to the origin of his blood, but to a set of rules which govern relations with others, and under which the possibility of obtaining citizenship, and of benefitting from the related rights, is open to all.

---

6 The Tuscany Region, Regional Law no. 69 of 27 December 2007, modified by Regional Law no. 46 of 2 August 2013, “Public Regional Discussion and Promotion of Participation in the Formulation of Regional and Local Policies”. The *Emilia Romagna* Region, Regional Law no. 3 of 9 February 2010, “Measures Governing the Definition, Reorganisation and Promotion of Procedures for Consultation and Participation in the Formulation of Regional and Local Policies”, plus the Guidelines for the Planning of Procedures of Participation.

7 *Coriolanus*. ACT III, Scene I, W. Shakespeare.

Seen in this light, *civitas* also provides the underlying idea for civilisation itself and, it goes without saying, for urbanised territories. Unlike the *polis*, which arises in a given morphology for the purpose of catalysing the cultural and anthropological features of the place in question, reinforcing the development of an organic identity, the founding idea of a Roman city is that of an inclusive project which subsumes cultures, territories and distinctions (Pucci, 2015). A similar concept brings to mind the ideal city hypothesised by Lefebvre as an ongoing project implemented by its inhabitants (Lefebvre, 1968).

The conviction that representative democracy is in a period of crisis, and that only the introduction of tools of political inclusion can allow it to move beyond this stalemate, has led to the development of a series of innovative methods for involving citizens (Bobbio, 2002).

Though these approaches may differ in terms of the issues addressed, as well as with regard to their participants, structures and effects, they constitute the primary tools for the development of procedures of participatory democracy. Such initiatives are "deliberative" in nature, meaning that the procedure leading to the decision is carried out «by means of arguments proposed by and to the participants, based on considerations of rationality and impartiality» (Elster, 1998), as opposed to the negotiation and aggregation of preferences.

> «They are "democratic" experiences, seeing that participation is open to all those affected by the consequences of the decision, and who consider the deliberative approach to be an irremovable prerequisite, as well as a process that increasingly stands as a fundamental precondition to a mature democracy» (Marchionna, 2016).

The experiences in question[8] occurred in widely varied set of cultural and geographic contexts, involving very different issues, as well as working methodologies and levels of resulting effectiveness, with the breadth and timing of the instances of participation also corresponding to a wide range of outcomes. This despite the fact that their underlying premises also present shared characteristics which clearly set them apart from other forms of participation enacted in the past, as well as from ordinary policy-making procedures.

Distinctions are often drawn, when utilising the different types of techniques and tools available, between:

1. Information: provided in a one-way relationship in which citizens are passive subjects.
2. Consultation: a two-way relationship in which citizens' opinions are expressed but are not binding.
3. Participation: an effective exchange between government officials and citizens, with the latter being involved in the decision-making process.

---

8 Worthy of note are: Deliberative Polling, Citizens' Juries, Consensus Conference, Town Meetings del XXI secolo, Bilanci partecipativi, Community Dialogues, Consensus Building, Open Space Technology, Appreciative Inquiry, Planungszellen, Citizens' Panel, Wisdom Council, ScenarioWorkshop, World Cafè, Conferenze sul Futuro.

The role of innovative technologies in deliberative democracy: the new tools of e-democracy

«*Ceci tuera Cela*» (this will kill that), murmured the enigmatic monk Frollo in Victor Hugo's *Notre-Dame de Paris*[9] as he pointed to the Cathedral, the symbol of knowledge embodied by stone, but soon to be replaced by a new process of knowledge marked by printed characters. The phrase underscores the importance that the French writer placed on the invention of the printing press, which marked and provided the organisational structure for the onset of contemporary history as a whole. But that ultimately proves to be only a limited view of the significance of the phrase, with further study showing that Hugo meant for it to refer to nothing less than a transformation of both society and identity. Indeed, this dual revolution constitutes a watershed moment in historiography, exerting a far greater influence than any subsequent revolutionary event by bringing about a radical change in society's relationship with knowledge, as well as in the very nature of knowledge itself.

By killing the Cathedral, it was as if man had lost the narration of architecture, of the territory, of the entire culture of the society that could be found inside the Cathedral. Among the major changes brought about by the printed word was the transformation of knowledge into a merchandise subject to exchange, while the changes ushered in by the web include our newfound conviction that we are all wellsprings of knowledge.

In ancient Greece, knowledge and democracy lived and were nurtured in collective sites: squares, theatres, gymnasiums, schools, banquets, sites redolent of that society of dialogue and participation par excellence. What has changed today? Is it the fact that we have moved from the public square to the technological platform?

The founder of Architecture for Humanity, Cameron Sinclair, deserves credit for having been the first to involve as broad a public of individuals and stakeholders as possible in what amounted to the introduction of open source architecture. It was the year 1999, and faced with the challenge of finding a solution to the crisis of housing the refugees of the Kosovo, he came up with the highly successful idea of managing the planning remotely, using the web to coordinate the operations of reconstruction and humanitarian aid carried out by his supporters. Roughly ten years later, in 2011, Carlo Ratti introduced the features of "open source planning".

Ratti writes: «Osarc (Open Source Architecture) replaces static architecture and its geometric forms with dynamic, participatory procedures, networks and systems of information». The end goal is an ambitious one: «to transform architecture from a fixed mechanism of production operated from on high to a transparent, inclusive, ecological system that takes its cues from below».

---

9 Livre V, Chapitre 2.

Under this conception, participation comes to represent the very archetype of the principle of subsidiarity, seeing that both approaches exist only when the network cooperates, shares, makes available to all, engages in collaboration, dialogue and exchanges, and takes action that brings everyone into play (Iaione, 2013). Fitting examples of this strategy are the initiatives undertaken in Barcelona in the last ten years[10]. Experiences which show how digital technology can give rise to opportunities for innovation, though it is important to be aware that, while the use of such tools can have positive effects, it can also prove unsatisfactory, which is why similar platforms must provide: transparency, increased participation, discussion, deliberation, information, accessibility.

Conclusions

Future approaches and procedures for organising and defining experiences for the involvement of citizens in public decisions call for, above all else, a "control booth", preferably interdisciplinary in nature, for the coordination of efforts pertinent to all the different categories of functions carried out by the public administration. In the final analysis, future developments in the involvement of citizens in public decisions can be summarised in four key.

1. The pertinent issues and the formulation of an agenda: the overriding question in drawing up an agenda for participatory initiatives is deciding which issues should be proposed for discussion by citizens, meaning which problems should be addressed and what limits should be placed on the public discussion. In essence, the question boils down to "how" to set the agenda and "who" should set it.
2. Identification of the participants: participation is obviously intended for all citizens, though it goes without saying that only a small percentage of those entitled to take part in the forum of deliberation can actually do so. This difficulty may lead to different types of imbalances in the format of the deliberative setting, seeing that the core group of citizens taking part must adhere to the criterion of maximum inclusivity.
3. The structures and methodologies of participation: the common feature of participatory initiatives is their noteworthy degree of structuring. The processes shall be designed and developed in phases, based on timing and procedures established in advance.
4. The effects of procedures of participation on the decisions of government institutions and on the participants: the strength of the outlooks that arise from forums of participation shall lie in the influence they manage to exert, and most definitely not in any legal powers that may be attributed to them.

---

[10] A platform of participatory democracy, decidim.barcelona (wedecide.Barcellona), was created in 2016 to house all the city's participatory procedures.

References

Bobbio, L. (2002), “Le arene deliberative”, *Rivista Italiana di Politiche Pubbliche*, n. 3.

Codice dei Contratti pubblici, D.Lgs. 19 April 2017, n. 50.

De Carlo, G. (2013), *L’architettura della partecipazione*, Quodlibet, Roma.

Elster, J. (1998), *Introduction in Deliberative Democracy*, Cambridge University Press, Cambridge.

Iaione, C. (2013), “La città come bene comune”, *Aedon*, n. 1.

Lefebvre, H. (1970), *Il diritto alla città*, Marsilio, Venezia, ed orig. Lefebvre, H. (1968), *Le droit à la ville*, Editions Anthropos, Parigi.

Lewanski, R. (2016), *La Prossima Democrazia*, Lulu Press.

Marchionna, G. (2016), *La democrazia deliberativa*, Fondazione G. Brodolini, Roma.

Pillon, A. (2016), “Public debate, an opportunity also for Italy”, *Techne*, n. 11, Firenze University Press, Firenze, pp. 45-49.

Pucci, G. (2015), *Il Coriolanus di Shakespeare, o l’afasia dell’eroe*, Quaderni del ramo d’oro, n. 7.

Ratti, C., Claudel, M. (2014), *Progettazione open source. Verso una progettazione aperta*, Einaudi, Torino.

Sclavi, M. (2014), *Avventure urbane. Progettare la città con gli abitanti*, Elèuthera, Milano.

Touraine, A. (2008), *La globalizzazione e la fine del sociale*, Il Saggiatore, Milano.

Fig. 1 - Professor A. Battisti of Sapienza University of Rome is working on a participatory project in the Bastogi area in Rome with an interdisciplinary Framework Agreement between the following actors:
Sapienza University of Rome, Italy with:
Local health authorities Rome1 ASL ROME 1
INMP - National Institute of Health, Migration and Poverty
Municipality XIII of Rome
Framework Agreement born with the will of the aforementioned National and Local Institutions and Authorities to implement the project called "Bastogi Health" aimed at action research and the promotion of bio-psycho-social and environmental well-being of the Bastogi community with a view contrasting inequality.
The project was funded by the Prosolidar Foundation.
(Image processed by A. Barnocchi).

3.7 SOCIAL, ENVIRONMENTAL AND FUNCTIONAL RE-CONNECTION OF RECEPTION SPACES AT CASTEL VOLTURNO

Claudia de Biase, Rossella Franchino*, Caterina Frettoloso**

Abstract

To transform the delicate theme of acceptance from problem to resource it is necessary to manage and direct the transformations that migratory phenomena generate, starting from a cultural and then physical reorganisation of the city. The authors will delve into some of the themes mainly related to the opportunity to work on both the environmental and technological quality of urban spaces and their systematisation, in order to create a more performing space-functional structure capable of adapting to continuous socio-environmental changes. In addition, the design strategies proposals deal with particular attention with the aspect of ecological biodiversity protection that passes through the network connections of the habitats, and more generally of natural areas.

Keywords: Interethnic City, Recovery, Urban Network, Places of Sharing, Eco-systemic Quality

Urban recovery as a tool for the interethnic city: Castel Volturno[1]

The concept of a multi-ethnic city refers to an urban space that attracts more ethnic groups or - in other words - a spatial and social system in which people with different ethnic origins (these people belonging to groups that share a geographical area of origin and a culture common) live together.

This is what Beguinot wrote in 2003, hoping that in Italy, as in the overwhelming majority of European Union countries, faced with the epochal phenomenon of immigration, urban planning would do its part to cushion the emergence of social frictions, phenomena of marginalisation and ghettoisation, identifying actions and spaces that can promote integration between cultures on the territory. In short, the scholar hoped for a transition from the multi-ethnic

* Claudia de Biase is an Associate Professor at the Department of Architecture and Industrial Design, University of Campania Luigi Vanvitelli, Italy, claudia.debiase@unicampania.it.

* Rossella Franchino is an Associate Professor at the Department of Architecture and Industrial Design, University of Campania Luigi Vanvitelli, Italy, rossella.franchino@unicampania.it.

* Caterina Frettoloso is an Assistant Professor at the Department of Architecture and Industrial Design, University of Campania Luigi Vanvitelli, Italy, caterina.frettoloso@unicampania.it.

1 The paragraph is edited by Claudia de Biase and is the result of a research conducted with Arch. Marina Manna.

city to the interethnic city: a functional city able to recover and highlight the semantic, human, social, and urban values expressed by all the cultural components present in the area (Beguinot, 2004). To this passage, so that the culture and the local traditions can be combined with the multicultural instances of the new city, it is preliminary, as Beguinot pointed out, the process of recovery of the urban quality of a given place, strictly connected to that recovery of urban identity. In particular, in the transformation phase of the city, the rehabilitation and refunctionalisation of the areas degraded socially and physically become the dominant actions: most of the times, in fact, these spaces are also the places of marginality (Clemente, Esposito, 2008) and ghettoisation of others. An exemplary case, which will be analysed here, is the district of *Destra Volturno* in Castel Volturno, a municipality in the province of Caserta. The choice is linked to two motivations: Castel Volturno is one of the municipalities of Campania region with the greatest concentration of foreign population; there are 3,880 immigrants on a total population of 25,281 inhabitants, making them 15.3% of the total population (D'Ascenzio, 2014). The second reason concerns, instead, the high state of degradation in the territory. This is not only due to the problem of the numerous abandoned or semi-destroyed houses that dot the streets of Castel Volturno, but also, and above all, to the absence of suitable services for the population that lives in those places, or services that can respond to the needs of a population now changed.

The district of *Destra Volturno* is a predominantly residential area, crossed by a road axis - Viale Antonio Gramsci, that continues into via Filippo Brunelleschi - which cuts through the entire area. This road axis is - or better, it must become - an element of connection between the innermost part of *Destra Volturno* and the coastal strip. The project starts from the identification of urban voids and large areas made available for obsolescence or change of intended use: open spaces, disused areas, degraded areas, undeveloped interstices, or any other open space in a state of neglect and degradation, regardless of their scale. All these elements draw on the territory a sort of chessboard with respect to the main road axis, which most of them face. In this sense, the operation of "re-sewing" is to create a physical and logical continuity of the voids that become "full" through reconversion, in order to recover them and transform them mainly in multifunctional places of public life, in which time, spaces aggregation and growth of collective social life can be found. With the same criterion, it was decided to highlight all the buildings potentially subject to recovery: they were distinguished in abandoned, highly degraded and non finished buildings. Each of these also becomes an opportunity to refurbish the neighbourhood, as most of them are expected to include services for the community. To define the functions to be included, however, a detailed analysis of *Destra Volturno* was preliminary made.

Specifically, a Christian church, two Pentecostal churches, and a supermarket have been firstly identified, then a private post office and the headquarters of ASL district 23. Immediately it was clear how the district offers few opportunities for development for the citizens and for the city itself, few occasions, in spatial terms, to cultivate a community and integrate with those who are different. Therefore, it was decided to focus on the sum of punctual interventions, connected with each other and with the city through road layouts. Roads become the guiding threads of this restyling operation: through them it is possible to reach each of the services provided in the neighbourhood and, therefore, making possible to experience it in its entirety. Specifically, the project is divided into three macro areas: the first is linked to urban green, with the construction of a new pine forest beyond the Volturno, and green spaces with sensory paths; the second refers to the places of productivity that is expected to create communities; the third area aims at the development of spaces for integration, leveraging on the issue of the lack of services for the community, especially for immigrants and, therefore, it takes the form of the introduction of new services that encourages integration.*"La linea dei popoli"*, title of the project, is therefore a decisive but non invasive sign for the district of *Destra Volturno*. That sign responds productively to a changed society, which "claims" a physical change in a city that is not yet able to respond to the citizens' needs.

Integration and sustainability: definition of the urban network[2]

Safety and integration are two highly critical issues felt by local administrations and communities especially in contexts already characterised by a series of functional and environmental fragilities as in the case of the city of Castel Volturno. The common idea tends to evaluate urban safety conditions and integration as two closely related aspects according to an approach introduced in the Sixties by Jane Jacobs and later developed by other scholars in specific design terms. This approach to crime prevention, which will be considered as a real science in the Seventies, is known as Crime Prevention Through Environmental Design (CPTED) and provides urban planning and design in which spaces are designed to create and encourage a sense of belonging to the territory. We must be able to perceive and identify those physical characteristics (being open or closed, visible or hidden, bright or dark, accessible or inaccessible, either public or private) that can help or hinder the possibility that a criminal event is realised (Musarra, 2016; Roccari, 2011). It is obvious that the complexity of the issue of safety and integration intensifies when in the dynamics of development and organisation of urban spaces, and issues related to the reception of migrants come also into play.

In fact, the conflicts that is generated between citizens and foreigners requires the construction of mediation processes that help to promote and imple-

2 The paragraph is edited by Caterina Frettoloso

ment a network of knowledge and solidarity. In Italy, *Coordinamento Nazionale Comunità di Accoglienza* (CNCA) (National Coordination of Care Communities), which shares this logic, is testing several projects with the aim of achieving physical and virtual spaces in which different stakeholders can interact and communicate. The current migration policies push towards a critical reflection on the spaces dedicated to reception and integration that should allow and facilitate new ways of relating, not only among immigrants but also with host populations, changing from places of conflict to places of sharing.

> «The city, in fact, with its space and its infrastructure, as individual and collective life "environments", is the privileged "space" for the development of wellbeing, the emergence of citizens' rights and the realisation of coexistence between diversity» (Bellaviti, 2011).

In order to offer informed design strategies based on integration and sustainability criteria, the need to work on the environmental and technological qualities that reception and inclusion spaces should possess has emerged. The idea we worked on aims at defining, in terms of performance, "active/productive" areas with different variations (power generation, food, resource recovery, production of civic values) that include the opportunity to integrate internally (for example according to the temporary use mode), even unused parts of the city according to a logic of reuse and recycling (artefacts, open spaces, infrastructure). Moreover, the growing demand of public buildings for the reception and integration of migrants, currently a reason for conflict, should be an opportunity for many disused properties that, properly redeveloped, would be re-entered into a vital circuit that would ensure their maintenance and preservation. Sharing the reticular urban organisational logic, along with the idea that is emerging of widespread acceptance, it is also interesting, especially for a context like that of Castel Volturno, to support reception centres with other "satellite" spaces that can accommodate any additional activities. It is worth re-calling that the overcoming of what is called "trauma", will require the participation of immigrants in recreational activities or in any way related to the learning and socialisation activities. The aim is to reduce the impact of migration on the population and to encourage integration, working with small groups of migrants to make the entire process more feasible.

From a methodological point of view, the functional-spatial redefinition of the areas dedicated to reception and integration, required the preliminary construction of a framework of needs that, in the case of a man-made emergency, expresses both the needs relating to the access to basic necessities as well as specific assistance (medical, linguistic, religious and bureaucratic-legal). This set of articulated needs, which must be integrated with those of the resident communities, has directed the testing towards the environmental and technological dimension of the areas to be redeveloped according to a systemic view of the same in relation to the context in which they are located.

The improvement of eco-system characteristics: the infrastructure system[3]

In order to complete the proposal of Castel Volturno urban transformation focused on interethnic city system also with the ecological and environmental aspects, a study on the infrastructural networks with innovative logics aimed at self-sufficiency of resources is presented below.

The study starts from the assumption that the city as a whole, consists of a set of important architectural and functional features that are interrelated with the environmental matrices. In this regard, the intervention should be configured by technological strategies validated through a more general environmental compatibility debate. The overall aim of this environmental compatibility study is divided into a number of specific objectives, which essentially consist in the ability to detect the natural and anthropic environmental aspects while containing its transformations within the context of secure sustainability.

As part of a correct and sustainable development of the city, it is particularly important that the system of networks that provides supplies and services is structured in a manner consistent with the sustainable changes of the environment in which they are located. With these premises, the proposed network system, characterised by the design criteria of integration with the surrounding climate and environment, by appropriate mitigation and improvement strategies of the ecosystem characteristics and by a complex of networks structured according to the logic of green infrastructures, becomes a system with a large technological and environmental potential of protection of the sub systems: air, water and soil. The infrastructure system manages the primary needs (energy, water) and disposals (wastewater, solid waste) using the available natural resources in the area. In order to achieve this goal, the system must be structured obligatorily using recoverable and renewable uses of both energy and water.

The area related to the proposed case study is structured with buildings or other constructions, open spaces for collective use and must be suitably equipped to ensure that the allocation of essential services is primarily guaranteed. These services include the hydraulic and energy ones. It is clearly appropriate to use systems with low energy consumption, energy and water recovery as well as with the use of renewable energy resources, according to consolidated sustainable architecture canons. The hydraulic local networks should also be realised using all the available devices to contain water consumption, the reuse of the rain waters with active and passive systems (Kinkade Levario, 2007) and the natural treatment of wastewater. Regarding the energy resources, the use of renewable ones has interesting potential ensuring a good operational autonomy.

The climatic analysis of the area of Castel Volturno, shows that the renewable energy that meets all these requirements is the solar one, originating from radiative Earth-Sun exchanges.

[3] The paragraph is edited by Rossella Franchino

With some limitations wind energy also has good potential for application.

The management of the infrastructures, according to the above-mentioned logic, through the use of the green infrastructures, makes it possible to structure the network system in a manner compatible with changes that are sustainable from the environment in which they are located.

The principles guiding the promotion of the use of green infrastructures to support the regeneration processes of the anthropic contexts allow to explore the possible interference between the natural and the anthropic aspects and the issues related to the sustainability of urbanisation, the control of land use and territorial fragmentation in line with the strategies set by the European Union by 2020 in order to stop the loss of biodiversity and degradation of ecosystems in Europe (Commissione Europea, 2011)).

The conservation of biodiversity, with the consequent preservation of the natural processes that underlie the survival of ecosystems, is one of the factors that most influences current interventions in a sustainable redevelopment of an urbanised territory. It is now well known how the protection of biodiversity passes through the connection of habitats, and therefore of natural areas. The fragmentation of the natural environment, i.e. in the gradual division of a natural basin into smaller and smaller fragments and blocks due to the direct anthropic action, is one of the most serious threats to ecological diversity. The main causes of the fragmentation process are mainly found into the urban growth, land exploitation through intensive agriculture, but above all into the territorial distribution of the infrastructure networks responsible for the flows of matter, energy, etc. In urban redevelopment interventions, studying the control of the transformations of the environmental state with the aim of conserving and preserving, through the strengthening of the green infrastructures, means adopting a complex model that can be traced to easily assimilated syntheses. This model highlights a highly significant fact: in the design, construction and operational phases of networks connected to infrastructure or urban complexes in general, it is possible to add quality, safety and reliability that not only valorise the environment but also does not cause any damage. Improving the environment means recovering it to the quality levels it had before the anthropic interventions carried out over time or, in some cases, bringing the quality to possibly even higher levels.

References

Beguinot, C. (2003), Città di genti e culture da “Megaride ‘94” alla città interetnica (Europea). Riflessioni (dal 18 giugno 2002) Fondazione Aldo Della Rocca, Giannini editore, n. 25, Napoli.

Beguinot, C. (2004), Città di genti e culture da “Megaride ‘94” alla città interetnica (Europea), Fondazione Aldo Della Rocca, Giannini editore, n. 26, Napoli.

Bellaviti, P. (2011), “Stare male/stare bene in città”, Territori, economie, diseguaglianze, *Proceedings of the XIV Conferenza SIU - Abitare l’Italia*, March 24-26, available at: http://siu.bedita.net/atelier-6-1.

Clemente, M., Esposito, G. (2008), *Città interetnica. Spazi, forme e funzioni per l'aggregazione e per l'integrazione*, Editoriale Scientifica, Napoli.
Comunicazione della Commissione al Parlamento europeo, al Consiglio, al Comitato economico e sociale e al Comitato delle regioni (2011), *La nostra assicurazione sulla vita, il nostro capitale naturale: strategia dell'UE sulla biodiversità fino al 2020* [COM (2011) 244 def. 3 May 2011], available at: http://eur-lex.europa.eu/legal-content/IT/TXT/?uri=LEGISSUM:ev0029
D'Ascenzo, F. (2014), *Antimondi delle migrazioni. L'africa a Castel Volturno*, Lupetti, Milano
Kinkade Levario, H. (2007), *Design for Water*, New Society Publishers, Canada.
Musarra, G. (2016), "La città "si.cura". Pianificare la sicurezza urbana", *Life Safety and Security*, July, vol. 4, issue 4, pp. 79-82.
Roccari, R. (2011), *Sicurezza Urbana. Analisi della relazione fra ambiente costruito e criminalità*, Exeo edizioni, Padova.

Fig. 1 - The line of peoples: proposal for the district of Right Volturno (Maria Manna).

3.8 CITY AND NEED OF CITY

Francesco Bagnato, Daniela Giusto**

Abstract

This quote by Italo Calvino, focuses attention on the evaluation of the quality of the city through the relationship that it establishes with the people that populate it; the af-firmation of the "demand for city", of desires, dreams and all the needs expressed by its citizens. Cities are built by mankind, but they do not seem designed to satisfy their needs; they are organised in spaces and times that prevent the relationship between the individual and the environment and deny socialisation especially of weak users. The right to "non exclusion" goes through a transversal design approach that considers the uniqueness of each individual.

Keywords: Accessibility, Liveability and urban quality, Wayfinding, Tourism for All

Originally, walking was the means to satisfy the human curiosity to discover new worlds, new lands; it was the only available means to travel. Strolling was an opportunity for relaxation, walking was something sacred so that the urban space was adapted above all to such a purpose and favoured social rela-tionships by offering varied and comfortable pathways and resting areas.

Over time, the technological development in the industrial sector has led man to abandon his body to use other modes of transfer: train, car or plane.

"Walking to reach a place" has become a challenge people face to reach a place in the shortest possible amount of time, or an action to cover the distance between the vehicles they use to move and the buildings they have to reach. Such faster transfers did not give more time to people and opportunity for so-cial relationships: higher speed only meant being able to cover longer distances in shorter time[1].

Therefore, it can be said that the decline of walking and the biggest barrier to the pedestrian movement, are to be ascribed to the lack of time, to the ab-

---

* Francesco Bagnato is an Associate Professor at the Department Heritage, Architecture, Urbanism, Mediterranea University of Reggio Calabria, Italy, fbagnato@unirc.it.

* Daniela Giusto is a Phd at the Department Heritage, Architecture, Urbanism, Mediterranea University of Reggio Calabria, Italy, daniela.giusto@unirc.it.

1 «The development of high speed rail travel took off after the 1974 petrol crisis. […] Italy was the first European country to inaugurate a high speed line (between Florence and Rome) in 1977», UE Special report (19/2018), p. 12.

sence of suitable places, to the «volume and speed of traffic and infrastructural provision for it» (Grant, Herbes, 2007) and to the supremacy of cars.

The data of the European Community Project SMILE[2], have shown that around 80% of the European population use cars, preferring them to other public means of transport. Over time, the huge number of motor cars has changed the way of designing roads [3]: roads were supposed to support car movements, thus pedestrian pathways and the richness and variety of the public space use were reduced. People on foot have been forgotten and pedestrian spaces, deprived of any comfort, security and attraction, have become areas of hurried transit. In communities across the world, there is a growing responsibility to provide options that give people the opportunity to walk, to walk more often, to walk to go to school, to work or to visit a place, and to feel safe while doing so[4]. This happens because there is a wide support for the idea that:

> «improving the quality of the walking environment and enabling more people to walk safely and conveniently to more destinations has a large number of benefits. The economic benefits of better walking conditions can be substantial when more people find the environment safe and welcoming, and they browse, shop and spend money on goods and services. The benefits also include improved personal health, safety and fitness, reduced traffic (as people walk rather than drive), less pollution and decreased greenhouse gas emissions and climate change» (Grant, Herbes, 2007).

Before promoting walking, conditions need to be adequate and safe. The freedom to walk, to securely access places and services, according to the timing, modes and needs expressed by users, profoundly affects the quality of life and the wellbeing of individuals, the achievement of social inclusion, and the quality of urban environment.

The *Manual for Streets* (Department for Transport, 2007) applies a design approach, also shared by *Urban Design* (DETR and CABE, 2000), which modifies the observation point and identifies a hierarchy of users where pedestrians hold the most important place in the achievement of the quality of public realm, thus meeting the requirements of the road "weak users", i.e. children, elderly people, women with pushchairs, people with disabilities, etc., and not of cars, though finding more balanced solutions for all.

Only walking transforms a common situation into a significant opportunity and it is important that all the meaningful social functions, intense experiences,

---

2 The project, funded by *Civitas II* programme in 2005, provides strategies to reduce the damaging emissions from city traffic by promoting sustainable alternatives of city transport system. http://www.civitas.eu/content/smile.

3 In Europe, 6 cities, out of over 160, record over 500 motor cars per 1,000 inhabitants. The city of Rome peaks at 732. Source: III Rapporto Apat Ambiente Urbano.

4 The result of a 2007 Eurobarometer survey shows a change in the way of thinking of the European population, which is in favour of measures to promote the use of public transport and to encourage more sustainable mobility.

http://ec.europa.eu/transport/strategies/facts-and-figures/all-themes/index_it.html.

conversations and displays of affection take place while people are walking down the street, or simply standing, sitting or lying down on a bench, or carrying out other activities (Gehl, 1971)[5].

Human dimension and social function are the parameters to take into account in urban design in order to obtain a lively and sustainable public realm. That is the reason why, during the design process, it is crucial to understand how people "live" the urban space and the relationships that are established between people and the urban space and, only then, proceed to build (Gehl, 1971).

This belief is strongly supported by the *Project for Public Space* (PPS), a non profit planning, design and educational organisation, dedicated to helping people create and sustain public spaces that build stronger communities.

Through its project *Street as Place*[6], the organisation has based its research on the concept that it is possible to recover the social function of roads, pathways and squares as interesting and pleasant spaces, suitable to social interaction, by improving their usability, accessibility, perceived security level, liveability, sense of belonging and of community with the place people live and work in or visits. The Urban Design Compendium (2007) includes "five C" principles to evaluate the design of pedestrian and cycle-friendly streets. Among them, *Conspicuousness* is particularly interesting since it answers the questions: «How easy is it to find and follow a route? Are there surface treatments and signs to guide pedestrians?» It is clear that information is considered as a significant design parameter to take into account so that «well-designed streets encourage people to use them, and make going outside a safe and pleasant experience» (DETR and CABE 2000).

The improvement and easy availability of the information needed to access places, services and activities favour the knowledge of the urban space and increases the user's capacity of action. Actually, the possession of knowledge positively influences pedestrian mobility, containing the feeling of uncertainty normally associated with unknown places and activities. To understand the difficulties and needs of people moving in the urban space and to act by promoting accessibility and usability means to promote non discrimination by removing those conditions which negatively influence the quality of life of all people and, in particular, of people with disabilities.

The *Disability Discrimination Act* (DDA) defines a disabled person as «someone who has a physical or mental impairment that has a substantial and long-term adverse effect on his or her ability to carry out normal day-to-day activities».

---

5 Jan Gehl describes three types of pedestrian activities: *Necessary activities*: going to school, waiting for the bus and going to work; *Optional activities*: activities people are tempted to do when climatic conditions, surroundings and the place are generally inviting; *Social activities*: these activities occur whenever people move about in the same spaces: watching, listening, experiencing other people, passive and active participation. Cf. (Gehl, 1971).

6 PPS: initiatives *Street as a place* http://www.pps.org/reference/streets-as-places-initiative/.

Nevertheless, it might be said that disability should be considered as a condition of distress caused exactly by the "*existing social context*", rather than by a personal capacity to move, speak, hear, etc. with different skills. In other words, there exists a cultural incapacity of society to ensure equal opportunities of action and lifestyle to individuals using different capacities, different speeds, different intellectual qualities. Furthermore, there exists a disabling environment which has physical and perceptive barriers, since it has been built without considering the needs of all the possible users. The Convention on the Rights of Persons with Disabilities, in order to enable persons with disabilities to live independently and participate fully in all aspects of life, establishes the adoption of measures that guarantee accessibility to the physical environment, to transportation, to information and communications, including information and communications technologies and systems, and to other facilities and services open or provided to the public[7]. Referring to independence and autonomy, the UN Convention shares the goal of social inclusion with Universal Design, whose objectives are

> «to simplify life for everyone by making products, communications, and the built environment more usable by more people at little or no extra cost. The universal design concept targets all people of all ages, sizes and abilities».

The principles and objectives of Universal Design have been developed by the Centre for Universal Design[8], which defines it: «Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaption or specialized design».

This definition goes beyond the concept of "removal of barriers", which implies a modification following the creation of the built environment, or of the product and the construction of universal solutions immediately usable by as many people as possible. Secondly, it no longer refers to so-called "standard users", meant as adult-healthy-men, but to "real" users, including children, young and elderly people, people with disabilities, pregnant women, etc. (Lauria, Felli, Bacchetti, 2004). The objective is not to create a new style for design, but rather a new attitude or design approach, which may contribute to building "sustainable communities". In fact, the development of cohesion and social inclusion, as fundamental principles to maximise the quality of life, are key aspects of both sustainability and Urban Design. In this regard,

> «universal design reflects a belief that the range of human abilities is normal and results in inclusion of people with disabilities in everyday activities. The most significant benefit to the proliferation of universal design practice is that all consumers will have more products to choose from that are more usable, more readily available, and more affordable» (Story, 1998).

---

[7] Art. 9 *Accessibility, Convention on the Rights of Persons with Disabilities,* December 2006. ww.un.org/disabilities.

[8] It is a research centre of the College of Design at North Carolina State University (NCSU) in Raleigh, NC. It conducts original research on usability and evaluates, develops, and promotes accessible and universal design. http://www.ncsu.edu/project/design-projects/udi.

To ensure equal opportunities of access and fruition of urban spaces contributes towards this objective: solutions and way of designing, which meet different needs and enable independence, restore the dignity of each disabled person and benefit all.

Reflecting on the physical and sensory capacities of the real users in order to provide solutions that, by using information and an identifiable and comprehensible linguistic code, inform and orient pedestrians, is a prerequisite to contribute to improving the sense of security, the accessibility as well as the knowledge and "comprehension of a city".

However, a large part of citizens is still unable to enjoy its city or to visit a city: it is a serious problem, which is a limitation for people with disabilities and their families too.

As to the influence of the characteristics of the space on the pedestrian's journey experience, an effective information supply on the opportunities of a place undoubtedly plays a crucial role in its capacity to attract travellers, to prolong their stay and to repeat the experience. An effective wayfinding combines the search for tourism competitiveness, aimed at meeting the visitors' expectations and different needs, with the achievement of urban quality, meant to improve well being and social inclusion. Therefore, wayfinding has a double impact: on the economic development, on the one hand, and on the development of urban liveability, on the other, through the improvement of accessibility and usability. It offers visitors a unique and original experience and meets, as far as possible, the residents' aspirations for a harmonious economic and social development. Many cities have been specialising their offer by relying on *accessible tourism*, i.e. on the proposal of services and competitive facilities able to meet the requirements of people with special needs in a different way, allowing them to enjoy their holiday without obstacles and difficulties.

Information and data on the phenomenon are available: the first research on the study of tourism for people with disabilities and on the consequent projections of economic development was presented in London during the meeting *Tourism 2000 Tourism for All in Europe*, in October 1993.

Other studies have shown that a considerable percentage of people with disabilities would be willing to move if certain basic conditions were fulfilled so as to ensure the usability of places. The *Touche Ross* research[9] reports a percentage of 72%, that is, about 36 million people willing to travel but excluded from tourism for various reasons.

Today, accessible tourism is a growing market, also owing to that demographic change that, in the next few years, will lead to an increase in the population over 60. Then, the majority of the next population of tourists will also be characterised by an age entailing unavoidable discomforts.

---

9 Reference is made to the research Touche Ross (1993) "*Profiting from Opportunities – A new market for tourism*", Touche Ross, London.

According to *ENAT* (*European Network for Accessible Tourism*)[10]:

> «lack of general accessibility has a direct and negative effect on tourist numbers: without good access, many people simply cannot travel, and the income they represent to businesses and communities is lost»[11].

Therefore, in Europe, the ageing population has transformed accessible tourism from a niche market, primarily devised for people with disabilities, into a mass phenomenon, taking into account the needs of the former but changing it into *Tourism for All*[12]. Tourism for All meets the possible requirements of as many people as possible: people with disabilities who travel with their friends and family for various reasons, pregnant women, elderly and young people, young children or people with temporary or permanent health problems, ensuring equal rights for all.

Ensuring an even access to natural resources, to the environmental and cultural heritage and to tourist or cultural attractions contributes to a positive improvement in social inclusion, of the freedom of movement and of the quality of life of local communities, as recommended by the latest EC framework programme *Horizon 2020*[13].

For a tourist destination to be successful, it is essential that the whole hospitability chain is accessible, from transport systems and accommodation facilities to the services supplied and the information support system.

Thinking about the environmental system in a different way, where accessibility can be viewed as a complex (not complicated!) innovate design process approach to reach social and economic goals, which considers the importance of cultural and strategic value of project.

It is therefore necessary to build a programme of strategies and shared actions in the various institutional, political and technical contexts that are focused on appropriate decisions that respect the autonomy needs.

A novel architectural culture is to be built, in which the architect role is to evaluate the problems of every person in order to identify technical solutions that do not discriminate the characters of urban spaces, but which rediscover the fundamental function of places.

---

[10] The mission of the European Network for Accessible Tourism is to make European tourism destinations, products and services accessible to all travellers, with a view to promoting accessible tourism all over the world. www.accessibletourism.org.

[11] The potential market for European accessible tourism is estimated to be 130 million people, with an annual spending power of over 68 billion Euros. Source: ENAT.

[12] Cf.www.tourismforall.org.uk.

[13] In particular, subobjective "Inclusive, innovative and safe society" of the third objective "*Society challenges*" is consistent with the aim to study the social and economic processes generated by innovative systems of Tourism for All.
www.ec.europa.eu/research/horizon2020/indexen.cfm.

References

Department for Transport (2007), *Manual for Streets,* Thomas Telford Publishing, Thomas Telford Ltd, London, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/341513/pdfmanforstreets.pdf (accessed 17 September 2018).

Department of the Environment, Transport (DETR) and the Regions and Commission for Architecture and the Built Environment (CABE) (2000), *By Design: Urban Design in the Planning System: Towards Better Practice*, Thomas Telford Ltd, London, available at: https://www.designcouncil.org.uk/sites/default/files/asset/document/by-design_0.pdf (accessed 18 September 2018).

Gehl, J. (1971), *Life Between Buildings: Using Public Space*, Van Nostrand Reinhold Company, New York.

Grant, J., Herbes, B. (2007), "Kew Junction Walkability and Wayfinding Study. Making places more walkable, legible & liveable", *Main Report*, September.

Lauria, A., Felli, P., Bacchetti, A. (2004), *Comunicatività ambientale e pavimentazioni. La segnaletica sul piano di calpestio*, Edizioni ETS, Pisa.

Story, M. F. (1998), "Maximizing Usability: The Principles of Universal Design", *Assistive Technology: the official journal of RESNA*, 10(1), pp. 4-12, available at: http://dx.doi.org/10.1080/10400435.1998.10131955 (accessed 5 August 2017).

Relazione speciale dell'UE (2018), *La rete ferroviaria ad alta velocità in Europa non è una realtà, bensì un sistema disomogeneo e inefficace*, p .12, available at: https://www.eca.europa.eu/Lists/ECADocuments/SR18_19/SR_HIGH_SPEED_RAIL_IT.pdf.

3.9 DESIGNING KNOWLEDGE FOR RECOVERY: BETWEEN COLLABORATIVE APPROACHES AND ADAPTABILITY SCENARIOS

Katia Fabbricatti, Serena Viola**

Abstract

An awareness of the relationships between environmental, social and economic capital contributes to outlining new design strategies for the built environment, linked to the enlargement of the network of stakeholders traditionally involved in the decision-making process. The paper describes the knowledge management model promoted within the PRIN research "The defence of landscape between conservation and transformation. Eco-nomy and beauty for sustainable development" (call 2010-2012).
Within a 36-month experimentation, the research identifies resilience thinking as the basis for a design approach that, by combining the dynamic and adaptive dimensions of socio-urban systems with the need to strengthen and innovate their identity values, encourages the construction of a shared settlement demand.

Keywords: Productive urban landscape, Heritage community, Adaptive capacity, Collaborative knowledge management

Introduction

Symbiotic conditions have characterised for centuries the built environment and the manufacturing activities there located.

Matching technological appropriateness and experimental commitment, communities design settlements, promoting synergies between the spatial-functional and structural conceptions of the built environment and the production processes rooted in territories.

During the 20th century, the integrity and authenticity of urban landscapes entered in a crisis due to a cultural misalignment between established technologies and communities. The lack of a customary cooperation caused an impoverishment of planning, failure to satisfy the client's requests, lengthening of the time required to execute the works, increase in costs.

The recovery project, always characterised by a wide involvement of experts in the information-decision process (Pinto, Viola, 2016), is characterised,

---

* Katia Fabbricatti is a research assistant at the Department of Architecture of the University of Naples Federico II, Italy, katia.fabbricatti@unina.it.

* Serena Viola is an Associate Professor at the Department of Architecture of the University of Naples Federico II, Italy, serena.viola@unina.it.

in recent experiences, for the promotion of collaborative knowledge management strategies, based on the cooperation between research, entrepreneurship, public administrations, NGOs and citizens.

Within the framework outlined by the Faro Convention (Council of Europe, 2005), the paper introduces the knowledge process experienced in the PRIN project "The defence of landscape between conservation and transformation. Economy and beauty for sustainable development" (call 2010-2012). It deals with a productive urban landscape, characterised by a rooted synergy between constructive culture and manufacturing processes.

The reference assumption is that the collective reappropriation of knowledge and memory can help to activate, in highly complex contexts, a gradual process of building a shared settlement demand (Magnaghi, 2010). Resilience to perturbative pressures is the object of the reflections carried out by an interdisciplinary research team with particular attention to the adaptive capacity of resident communities. A processual and iterative approach connotes the cognitive model for the well being and well living of people together (Chelleri, 2012).

State of art

The research deals with the urban productive landscape, implementation of the concept of historic urban landscape identified by UNESCO Recommendations (UNESCO, 2011), used for ancient settlement systems with a manufacturing vocation.

As a complex and adaptive system, the productive urban landscape is the result, over time, of procedures and methods of supplying and transforming resources, distributing the finished product.

The research matches the cultural assumptions of the Council of Europe Framework Convention on the right of communities to cultural heritage (2005, art. 12) with the sustainability and resilience objectives promoted by the Agenda for Sustainable Development 2030 (UN, 2015), which identifies in the reactivation of lost synergies between the built environment and the community, a key to govern the processes of technological transition (obj. 11).

A change in perspective introduced in the management of settlements with the promotion of heritage communities informs the definition of the theoretical research framework. Within the assumptions of the New Urban Agenda (UN, 2017), the research identifies in the hybridisation of culture and creativity a strategy of social cohesion, for identities recovery and the promotion of resilience in urban landscapes.

The adaptive capacity of the social capital, object of researches aimed at increasing the resilience of settlements in the transition to sustainability (Folke et al., 2010; Longstaff et al., 2018), outlines the scientific reference framework.

> «Adaptability is the capacity of a social-ecological system to adjust its responses to changing external drivers and internal processes and thereby allow for development within the current stability domain, along the current trajectory» (Folke et al., 2010, p. 20).

The Framework for Resilient Design specifies the relationships between heritage, cultural identity and resilience: «Buildings that help reinforce community identity can enhance community resilience» (EDR, 2014, p. 7). The paper links the productive urban landscape recovery to the promotion of social enterprises, to produce services with high relational content, giving rise to the latent potentials in the urban landscape to positive externalities for the community, equal opportunities and reduction of inequalities (D.Lgs. 3rd July 2017, n. 112, Revision of the regulations on social enterprise).

Research approach and methodology

The research identifies in the resilience thinking (Walker, Salt, 2006; Folke et al., 2010) the premise for a model of knowledge that, by combining the dynamic and adaptive dimension of the socio-urban systems with the need to strengthen and innovate the values identities, accompanies communities in the transition to sustainability.

In response to the perturbative pressures that erodes the sedimented qualities of the built environment, the research proposes a mapping of the resilience qualities of the settlement system in order to identify the potential for adaptability/transformability of the resources - social, environmental, built, productive.

The methodology is based on an iterative approach of actors' involvement: the recomposition of shared knowledge produces awareness, opens the concertation of project scenarios, contributes to creating a "community of heritage".

The participatory and shared explication of the resilient systems' qualities, developed in the City Resilience Framework (Arup, 2015), is a central step of the research. These qualities - reflectiveness, resourcefulness, robustness, redundancy, flexibility, inclusiveness, integration - can be considered as a performance support, which allows us to evaluate the existing strength and at the same time identify the critical areas of weakness, actions and programs to improve the resilience of the city.

The translation, for the case study, of the resilient systems' qualities in "performance indicators" is supported by scheduled and reiterated meetings between privileged witnesses of the social and entrepreneurial systems with the research group and facilitators.

Their definition is possible due to the direct involvement of stakeholders in the direct knowledge of the stakeholders about the resources connoting the urban landscape, valences and latent potentialities, pressures to which it is subjected. The indicators return the settlement's transition processes and help to identify innovative management paradigms of the relationships between built, context, events, communities.

Good practices drive the construction of a settlement demand with the involvement of small groups of stakeholders, towards a vision of productive-entrepreneurial promotion for the built environment, starting from which to plan scenarios of building and urban recovery progressively implementable.

Experimental data: case study Torre Annunziata, Naples

Innovation and experimentation in response to external pressures are the connotative aspects of the material culture along the Vesuvius Campania area.

Through the relationship between natural capital and human creativity, transitions processes here are an expression of the need to enhance the final qualities of dry food pasta, improving the procedures of mixing, drying, packaging.

Famous for the fertility of the soil, the coastal Vesuvian area has been characterised since ancient times by the presence of the volcano, that has conditioned the processes of changing referred to the morphological and dimensional, historical, cultural, symbolic, natural and anthropic dimensions of the built environment. From the second half of the 16th century, Torre Annunziata shows a manufacturing vocation in the building and urban dimension for the production of flour and the packaging of dry pasta.

The availability of hydraulic energy and the presence of a ventilated climate are predisposing factors of a productive adventure that combines local natural resources: an active port, an abundance of watercourses, builders able to work the volcanic stone. Despite the continuous additions, subtractions, modifications, the settlement is configured over several centuries with homogeneity and congruence, in terms of structural and environmental conception, of morphological and dimensional solutions, material construction. The whole economy revolves around the synergies between places and resources: exposure, size, constructive characteristics of the settlement, are the factors enabling production, increased by the presence of the port for the importation of wheat coming from Russia and the export of dry pasta food. Since the Second World War, the balance of the system is radically compromised by processes of uncontrolled anthropisation: the transforming dynamics are marked by expansions into areas for agricultural purposes, the abusive extension of the built environment, abandonment and degradation of terraces and courtyards. Production divestment and the domination of a residential vocation exposes the settlement to conditions of unpredictable physical and social vulnerability.

Political, economic and technological pressures are at the origin of the long process of knowledge spoliation that invests the material culture, with the lack of an entrepreneurship able to promote production processes rooted in the context and attentive to the search for appropriate solutions and innovative technologies. The cultural misalignment between established community and project action overwhelms places, times and ways of agrifood production.

On a constructive level, the process determines the reuse of productive sites for residential purposes with the impoverishment of consolidated maintenance and management practices. With a population density of 5,348.6 inhabitants per square kilometer, the system today shows worrying rates of social hardship and building degradation. The exceptional nature of the settlement quality is not perceived by the residents who progressively lose any relationship with the reasons that for centuries had oriented the technological transitions of the settlement system.

Results

The interpretation of the characteristics and phenomena affecting the urban historic landscape of Torre Annunziata was supported by the elaboration of a complex system of indicators of resilience qualities. These performance indicators are structured on four dimensions representative of the context - social, environmental, built, productive - and explained for temporal phases and territorial scales, in order to understand the changes that have occurred and the processes that generated them. By activating a participatory process, the indicators were used as a basis for coordinating the resilience qualities of the urban landscape among the actors involved in the research.

First of all, the community has been sensitised on the quality of robustness. It has been interpreted, as a prerequisite for persistence, as the «ability to preserve and renew the identity, starting from well conceived and managed resources”.

This quality, which is a prerequisite for persistence, has been interpreted as the “ability to preserve and renew the identity, starting from well-conceived and managed resources”, and has been referred to indicators that describe: the “quality of the built environment”, the “cultural identity”, the “security and the management of the resources”.

The need to protect the identity resources of the places derives, in fact, from the request of each community to pass on the memory of the past, its history, through tangible and intangible elements, capable of witnessing its evolution. These elements, which represent the complex system of factors, of a perceptive, morphological, relational, functional nature, through which the uniqueness of the landscape system manifests itself (UNESCO, 2011), must be rediscovered, reinterpreted and innovated, in order to prefigure their evolution.

The different role of the actors in satisfying the qualities of resilience provided by Arup in the City Resilience Framework has led to their progressive involvement, aimed at reducing possible conflicts and building convergence of visions and cooperative spirit, for example, in the explicitation of “reflexivity” and “integration”. The first concerns, in particular, the “planning and management of resources”, and concerns the “ability of institutions and community to update the regulations for the management of uncertainty and changes”.

The quality of “integration”, understood as the “ability to face change through the coherence of the decision-making process and the systemization of resources at different scales”, likewise highlights the value of sharing and social integration, in the processes of reactivation of the historic urban landscape.

This meant working in particular on the characteristics of diversity and civic engagement of the social component, but also on the characteristics of infrastructures and public or open spaces, which could lead to community and relational activities, and which, particularly in the Mediterranean area, recount a priority use and social interaction value.

From the comparison between the different actors on the quality of resilient systems, conflicts emerged, especially in relation to the values attributed to the landscape (robustness) and their ability to renew over time (flexibility, reflectivity), to decision-making actors and their involvement (inclusiveness), to the mode of disseminating the results (short period vs. long period), to the territorial vision (integration)).

Taking note of the strong entrepreneurial vocation of the historic-urban landscape of Torre Annunziata, the working group converged on the indispensability of rebalancing the symbiosis between built and manufacturing processes, restoring a productive identity to the settlement to counteract its physical and social degradation. The actors, having acquired awareness of the quality of resilient systems, have been involved in the explanation of the settlement demand through the definition of shared project actions (Tab. 1).

Technological innovation informs the prefigured process, entrusting a renewed role to the resources of the territory. The challenge for a resilient landscape is in connecting productivity to culture and creativity, for a consolidation of knowledge and the maturation of appropriate development models.

Dematerialization of processes, diversification of production chains, customization of the manufacturing offer are the paradigms of a new concept of productive urban landscape.

On the physical point of view, the resilience of the built environment favors the reuse of indoor and outdoor environmental units (ground floors, courtyards and gardens, terraces) for the supplying and storage, transformation, distribution, sale, communication of the finished product.

An entrepreneurship based on responsibility and cooperation gives rise to new employment opportunities for local actors, sensitized to the synergy between the quality of the settlement and technological innovation.

QUALITIES	INDICATORS	ACTIONS
REFLECTIVENESS	***Programming and management of resources***	Extension of decision-makers; Permanent table for the detection and monitoring of changes; Verification and updating regulations in force.
	Innovation capacity	Support for forms of adaptive comanagement.
ROBUSTNESS	***Cultural identity***	Recovery and renewal of material culture, starting from the productive identity; Prevision of cooperation actions for the care and maintenance of the building heritage; Prevision of temporary cultural actions for the promotion and enhancement of the built environment.
	Quality of the built environment	Adaptation of existing building heritage to quality standards.
	Security and resource management	Monitoring and maintenance of the settlement system; Prevision of rehabilitation and reuse of existing buildings; Adaptation of existing infrastructural services with the improvement of medium-short distance mobility.
INCLUSIVENESS	***Sharing and commitment to choose***	Prevision of recovery interventions for public and private common areas; Creation of new aggregation sites integrated with the green and small-scale systems.
		Co-creation and co-management models; Promotion of social enterprises.
INTEGRATION	***Intermodality of transport systems***	Adaptation of existing transport systems, with smart mobility systems.
	Interscalar mode of functions	Prevision of a fruition system for interscalar poles and networks.
	Network connectivity	Prevision of smart governance systems, smart mobility and smart living.
FLEXIBILITY	***Adaptability to new functions***	Recovery and reuse of buildings or their parts, open and/or underutilised open spaces.
	Modularity and decentralisation of infrastructure and urban management	Prevision of interventions to implement and diversify existing infrastructures according to a logic of modularity and decentralisation.
	Innovation capacity	Promotion of production models based on technological innovation of products and processes; Prevision of actions for "capacity building".
RESOURCEFULNESS	***Availability of resources***	Prevision of adaptation interventions of existing infrastructural networks according to a logic of diversification and autonomy.
	Coordination in the management of resources	Coordination units in the management of resources, including the activation of social networks; Programming of integration interventions between the different resource systems.
REDUNDANCY	***Diversification of infrastructure systems***	Mobility system; Integration between medium-short distance systems.
	Diversification of resources	Promotion of a new conception of productive urban landscape based on the dematerialisation of processes, diversification of production chains, customisation of the manufacturing.

Tab. 1 - Definition of actions in relation to the quality of resilient systems.

Conclusions

In the perspective of the 2018 European Year, heritage is the substratum of our communities and societies, a link that connects past to future, opportunity for personal and collective growth, new economy and quality employment.

The outcome of the research is a shared, implementable knowledge platform, able of intercepting the multiple needs of users, values and identities for the urban landscape, promoting new awareness towards the adaptability to change. The participatory explication of the resilient systems' qualities and of the related performance indicators favours the empowerment of a citizenship able of producing and actively reproducing the environment of life - built, social and cultural. In the experience conducted, a heritage community is activated through the sharing of material culture and inclusion in decision-making processes. Faced with the disappearance of public resources and large private investors, the community matures the need to promote new forms of entrepreneurship rooted in the quality of the production landscape, based on cohesion and on the commitment to technological experimentation.

References

Arup (2015), "City Resilience Framework", The Rockefeller Foundation, available at: https://www.rockefellerfoundation.org/report/city-resilience-framework/ (accessed march 11, 2018).

Chelleri, L. (2012), "From the «Resilient City» to Urban Resilience. A review essay on understanding and integrating the resilience perspective for urban systems", *Documents d'Anàlisi Geogràfica*, vol. 58, n. 2, pp. 287-306.

Council of Europe (2005), "Framework Convention on the Value of Cultural Heritage for Society (Faro Convention)", available at: http://conventions.coe.int.

EDR (2014), A Framework for Resilient Design, available at: http://www.eskewdumezripple.com/public/uploads/brochure-content/temp_file_EDR_A_Framework_for_Resilient_Design1.pdf (accessed July 2, 2018).

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T. and Rockstöm, J. (2010), "Resilience thinking: integrating resilience, adaptability, and transformability", *Ecology and Society*, vol. 15, n. 4, p. 20.

Longstaff, P.H., Armstrong, N. J., Perrin, K., Parker, W.M., Hidek, M.A. (2018), "Building Resilient Communities: A Preliminary Framework for Assessment", *Journal Homeland Security Affairs,* V. XIV.

Magnaghi, A. (2010), *Il progetto locale*, Bollati Boringhieri, Torino.

Pinto, M.R., Viola, S. (2016), "Cultura materiale e impegno progettuale per il recupero: Living Lab nel Parco del Cilento", *Techne*, n. 12, Firenze University Press, Firenze, pp. 223-229.

UN (2015), "Transforming our world: the 2030 Agenda for Sustainable Development", A/RES/70/1.

UN (2017), "New Urban Agenda (Habitat III)", Quito.

UNESCO (2011), *Recommendation on the Historic Urban Landscape*, UNESCO World Heritage Centre, Resolution 36C/23, Annex, Paris, France.

Walker, B., Salt, D. (2006), *Resilience Thinking. Sustaining Ecosystems and People in a Changing World*, Island Press, Washington, DC.

3.10 AN INCLUSIVE APPROACH FOR RECOVERY STRATEGIES

Martina Bosone, Francesca Ciampa**

Abstract

The research develops in the context of recent experiences of active citizenship and of the transformative processes carried out for the regeneration of urban spaces, recognised as "common goods". The contribution proposes a methodological approach for the elaboration of an inclusive reuse strategy, able to incorporate the needs of the actors involved in the transformation processes of the contexts. The principle of circular economy is at the basis of the approach, making it possible to create physical, economic, social and cultural resources for the establishment of virtuous dynamics. The experimentation analyses the case study of Ercolano with the aim of activating a process of social innovation with which to involve the various actors in all phases of the design process.

Keywords: Participatory processes, Adaptive reuse, Circular economy, Multiactor model

Introduction

Many cities at international level are experimenting innovative processes for the regeneration of urban spaces, carried out through actions of care based on sharing and collaboration.

These initiatives, constituted in unauthorised form, as well as affecting the physicality of the places, come as "common goods", also configuring new models of governance and management characterised by the active participation of the communities.

These practices act on built environment incorporating the needs of the community (Council of Europe, 2005) and of the actors involved in transformation processes of urban contexts. In this context, the recovery project (Caterina, 2016) represents a strategic action to favour the extension of the life cycle for settlement systems. In fact, it allows to define the actions that, satisfying new needs of users, integrate physical, economic and social values expressed by buildings and by their contexts.

* Martina Bosone is a PhD student at the Department of Architecture, University of Naples Federico II, Italy, martina.bosone@unina.it.

* Francesca Ciampa is a PhD student at the Department of Architecture, University of Naples Federico II, Italy, francesca.ciampa@unina.it.

Therefore, in the planning phases, valorisation of existing building resources is necessary to safeguard both physical and cultural values (Pinto, 2004). Object of the research are the vulnerable settlement systems in a state of advanced obsolescence and abandonment. Considering the historical-cultural value of these fabrics, the project describes the process aimed at recovering and overcoming the concept of waste, promoting a specific action for the valorisation of the territory. The perspective of approach is that of the *circular economy* (Ellen MacArthur Foundation, 2014), according to which the waste of a process becomes raw materials for another, triggering virtuous circles. In particular, the research focuses on the case study of Ercolano, a municipality of the Vesuvian area characterised by cultural heritage of considerable importance for the archaeological excavations, but at the same time subject to pressures of an economy strongly in crisis and of an increasing physical and social degradation.

The methodology consists of the characterisation of the settlement system, through the decomposition in its dimensions and in the analysis of the offered performance levels. The contribution refers to the identification of the waste of four sub-systems (physical, social, economic/productive, cultural) to rethink as input for the creation of a "circular landscape".

The result of the experimentation is the elaboration of a recovery strategy for the city of Ercolano based on the circular economy principle. In this systemic and regenerative perspective, it is possible to rethink the waste present in the territory (at physical, economic/productive, social, cultural level) as an input for the creation of new virtuous circles (Ellen MacArthur Foundation, 2017). This approach allows not only to reduce the waste but also to regenerate the potential of resources that, put in a system, can produce new positive externalities. In this perspective, the creation of new synergies for the recovery of the physical system become an opportunity to recast the ability to preserve specific identities by building new values, putting in relation the quality of built environment with the productivity and the innovation of local communities.

Research approach and methodology

The urban settlement can be considered as a complex of adaptive dynamic systems (Ciribini, 1984), able to modify their functioning in relation to the perturbative pressures that they suffer. The analysis and the understanding of performance levels of each sub system, in the more complex urban system, and the study of relations and mutual effects that pressures can determine among the sub systems, are the base of adopted methodology. Considering the results of recent experiences in the field of the recovery of the built environment, the research introduces a hybrid information/decision model, founded on the integration of the scientific contributes of expertise with the contribution of privileged interlocutors.

The consultation is strategic for the elaboration of design scenarios aiming to improve the closing of loop, in physical, social and economic sub system, between resources, waste and scraps (Ellen MacArthur Foundation, 2015).

In an ampler framework of perturbative pressures, able to modify the performances of each sub system, determining consequent effect in the other ones, the research analyses the nature's exogenous ones as catastrophic events and anthropic actions. They often are the result of settlement dynamics that have slowly taken root in territories, dependent from the progress and the sharing of a waste culture, able to permeate the individual and collective lifestyles. Adopting the perspective proposed by the Ellen MacArthur Foundation for the Circular Economy (Ellen MacArthur Foundation, 2014), the research group works on perturbative pressure able to determine waste conditions in settlement system: seismic event (in particular the earthquake in 1980); absence of maintenance for prestigious buildings and central urban areas. In the Ercolano settlement system, these perturbative pressures have determined in recent time a complex situation of modified performances (Pinto, Viola, 2016) not only at building scale but above all at the urban one.The widening of the work perspective, from the building scale to the settlement scale, required a multilevel knowledge system at different scales: from the building to the urban aggregate, from the municipal to the intercommunal.

With the aim to analyse the waste conditions derived from the impact of perturbative pressures, two working groups are organised:

- the first one, to activate a dialogue with the community, through the distribution of mixed-scale questionnaires on a large scale, has allowed to incorporate the lifestyles of the population and to grasp their predisposition for participation and interaction with other actors;
- the second one, to promote the consultation with the institutions, allowing to explain new management models for the identified waste.

The activated process through the working groups stimulates the elaboration of waste rebalancing scenarios that take into account the interconnections between people and places, activities and territories (Healey, 2005).

Discussion

The experimentation activates a process of social innovation that involves the stakeholders in all phases of the planning process: the institutions (Region and Municipality) interested to invest on settlement systems' cultural heritage with the aim to revitalise the economic and social systems too, through urban regeneration projects; the expertise represented by the University and by the research bodies in order to manage the quality of the project and to mediate the interests of the various actors involved; the Third Sector and the local cultural centres for the creation of a virtuous network able to enhance and promote the local cultural heritage; the community interested in the improvement of living conditions and in the reactivation of the local economy.

The discussion highlights how prevalent waste conditions are identified in:

- waste in physical sub system: abandoned buildings/areas;
- waste in social sub system: unemployment, crime;
- waste in economic/productive sub system: agricultural waste;
- waste in cultural sub system: loss of local know-how related to material culture (technical know-how linked to construction techniques and to excavation techniques for archaeological site) and to specific skills linked to specific production characteristics of the place (textile and agricultural sectors).

The dynamics that determine the waste/refuse condition in each sub system are analysed by expertise through the use of indicators for physical, social, economic and cultural sub systems (Tab.1).

PHYSICAL SUB SYSTEM				
Thematic area	**Sub-theme**	**Indicator**	**Description**	**Value**
Housing conditions and settlements	Housing heritage	Potentiality of housing use	Comparative percentage among the unused buildings and the total of the buildings	17,1%
		Incidence of buildings in worst conservation state	Comparative percentage among the residential buildings in worst state of conservation and the total of the residential buildings	0,2%
SOCIAL SUB SYSTEM				
Thematic area	**Sub-theme**	**Indicator**	**Description**	**Value**
Population	Demographic dynamic	Variation of resident population from 2001 to 2017	Growth rate of residents from 2001 to 2017	-6,9%
ECONOMIC SUB SYSTEM				
Thematic area	**Sub-theme**	**Indicator**	**Description**	**Value**
Work market	Unemployment	Rate of unemployment	Percentage incidence of residents looking for employment respect to active population (employed and looking for job)	27,3%
		Rate of youth unemployment	Percentage incidence of residents 15-29 years old looking for employment with respect to active population (employed and looking for job)	60,6%
CULTURAL SUB SYSTEM				
Thematic area	**Sub-theme**	**Indicator**	**Description**	**Value**
Tourism	Touristic flow	Percentage ratio of visitors	Visitors percentage of the archaeological site of Ercolano with respect to the total visitors of the archaeological site of Pompei	14,3%

Tab. 1 - Indicators of waste conditions in the Ercolano municipality (elaboration of the dates extracted by ISTAT census of 2011).

The comparison conducted with the privileged interlocutors (institutions and communities) has allowed to identify the expressed needs respect to the theoretical framework derived by indicators:

- the institutions identify as a priority problem the identification and the recovery of "urban waste", represented by the high number of unused buildings and areas in an abandonment and degraded state. This situation has determined the request from the institutions to elaborate a strategy of reuse at urban scale. The difficulties that emerged in the transition from a concertation phase to an implementation phase were related to a failure to assign tasks within the coordination processpongono come problema prioritario;
- the community and local cultural institutions identify as a priority problem the reduction of "social waste": the high unemployment and crime rate have a negative impact on the living conditions of citizens and on the construction of identity and belonging sense. The progressive separation between the community and the resource of archaeological excavations, which for centuries had represented an opportunity for exchange and cultural ferment, has led to its progressive expulsion from local development processes, especially from cultural ones. The difficulties encountered initially in the dialogue with the community were caused by diffidence and a lack of trust both towards the representatives of expert knowledge, and with respect to the purposes of the interviews and the distributed questionnaires.

The subsequent acquisition of awareness by the community about the importance of the contribution in the decision-making process, together with a renewed confidence in the institutions, has allowed the gathering of information from a large and heterogeneous sample of respondents.

The experience is oriented toward the creation of a research and formation circuit for the management of the territory, able to activate trials of "care" through the rediscovery of the affiliation sense of the local actors. Only in this perspective it is possible aim to the definition of an inclusive approach that satisfies the new needs of the users and, at the same time, integrates the physical, economic and social values expressed by the complexity of the vulnerable settlement systems.

Conclusions

The logic of "closing the loop" and reducing the production of waste is extended from the product to the process, decreasing the negative externalities and proposing virtuous production/consumption circles.

The creation of new synergies for physical recovery and the creation of new forms of economy based on local culture, improves the attractiveness of the considered system, determining positive effects on the production system in a sustainable social, environmental and economic perspective.

The monitoring of the implementation of this model in the city of Ercolano will contribute to produce empirical evidence on the role of culture and cultural heritage as a driver of the circular economy model.

The model proposed for Ercolano aims to act simultaneously on the physical, social, economic and cultural levels to create relationships and circular dynamics among local resources. Acting on the awareness and involvement of local communities in cultural processes, it is possible to recover and rebuild the local identity that, in the case of Ercolano, is specifically founded on cultural and productive specificities.

The innovativeness of the developed process consists in the involvement of the actors and in the interaction between decision makers, stakeholders, users and designers in all phases of the design process. This allows the definition of an inclusive approach that not only guides the choices, but at the same time also strengthens the relationships that users make between themselves and with the context in which they live. This process is also an opportunity for training and social learning as it increases the capacity building of individuals and their sense of responsibility towards the cultural, material and immaterial, heritage of which they are custodians.

References

Caterina, G. (2016), "Innovative strategies for the recovery of historic cities", *Techne*, n. 12, Firenze University Press, Firenze pp. 33-35.

Ciribini, G. (1984), *Tecnologia e progetto*, Cedam, Torino.

Council of Europe (2005), "Framework Convention on the Value of Cultural Heritage for Society (Faro Convention)", available at: http://conventions.coe.int.

Ellen MacArthur Foundation (2014), "Towards the circular economy. Accelerating the scale-up across global supply chains", available at: www.ellenmacarthurfoundation.org.

Ellen MacArthur Foundation (2015), "Growth within: a circular economy vision for a competitive Europe", available at: www.ellenmacarthurfoundation.org.

Ellen MacArthur Foundation (2017), "Cities in the Circular Economy: An Initial Exploration", available at: www.ellenmacarthurfoundation.org.

Healey, P. (2005), "Editorial, Planning Theory and Practice", *Taylor & Francis Online*, n. 6, pp 5-8.

Pinto, M.R. (2004), *Il riuso edilizio. Procedure, metodi ed esperienze*, Utet Università, Torino.

Pinto, M.R., Viola, S. (2016), "Material culture and planning commitment to recovery: Living Lab in the Parco del Cilento", *Techne*, n. 12, Firenze University Press, Firenze, pp. 223-229.

3.11 TECHNOLOGIES FOR URBAN LIMINAL SYSTEMS BETWEEN LEGACIES AND DISCIPLINARY EVOLUTION

*Filippo Angelucci**

Abstract

As we move toward a post-Fordist urban model, our attention has turned again to urban non-built-up areas. Here, urban liminals make up the new boundaries at which complex, unforeseeable and transitory relations between technologic and biospheric systems mix. Starting from the scientific legacy of the technological culture of design, this contribution highlights two fundamental cognitive aspects for research on urban liminals. The first is referred to the conceptual and methodological aspects necessary to reconstruct essential patterns for an evolutive, adaptive and vital future for urban life. The second are related to the qualitative, modelling and typological aspects to determine innovative outcomes both in designing and the training of future designers.

Keywords: Liminality, Transition/Metamorphosis, Urban space/environmental system, Urban quality, Technological-environmental design

Introduction

Ever since the arrival of industrial urbanism, theoretic-designing reflections on city quality have looked alternately at the themes of built up areas and the issues on non built up spaces. This alternation is a consequence of the modern idea of the city as a concentrative entity. In the classic capitalist view, the *urbs* takes on value by its attracting flow elements (labour, finance, resources, knowledge) and accumulating stock elements (capital, real estate). So cyclical problems from building, infrastructural and demographic concentrations are followed by cyclical phases to employ non built up spaces to restore quality to the city.

We are still in the passage to a post-Fordist urban model in which non-built up (i.e. empty or in between spaces) are being considered as reconnections of interrupted continuities of the modern or historic city, but based on a hypothetic homogeneity of the inhabitants' needs and presumed unmovable functions of space.

* Filippo Angelucci is a Researcher at the Department of Architecture, G. d'Annunzio University of Chieti-Pescara, Italy, filippo.angelucci@unich.it.

With our attention back on the innovative dimensions for the urban habitat, we note new spatial issues on the evolutive horizon of cities of the 21st century. Urban liminals: unexplored frontiers pose new interrogatives on whether, before construction, to apply cognitive intervention models on what good living in cities means. Aside from their separate meanings of limes, limens (liminals) are found in many contexts in nature, artifacts, knowledge, behaviours and practices, in metropolitan areas which have been deindustrialised, in the boundaries subjected to climate change, in small and medium-sized historic cities, in rural/urban environments and in new peripheral forms of the habitat (Friedman, 2014; Orange, 2016).

With their state of incompleteness between nature and artifacts, urban liminals are the new boundary-places in the dynamic interaction between technologic systems and the biosphere (Marchesini, 2002). For this reason, it is in them that we must retrace, reconnect and reconstruct the essential configurative elements for more evolutive, adaptive and vital future cities.

From border to boundary zone: future and legacies of technological culture

The issue of liminal spaces is at the centre of the cognitive statutes of the project when passing from the concept of border, as a barrier between cities' closed elements, to the concept of boundary zone, as a relational frontier among the open systems of the urban habitat. The boundary effect characterises all of a city's non built up spaces demonstrating the intrinsic liminality condition of the transition and metamorphic processes of the urban habitat where natural, human and technical systems apparently confront each other.

Liminal is the frontier (boundary zone) at which the biodynamic and ecosystemic processes between the parts of the city take place (Forman & Godron, 1986). Liminal is the ideation and adaptation path for the urban space-environment to improve its qualities if it is based on the intersection of the topologic, anthropologic and technologic dimensions (Guazzo, 2003). Liminal is the dialectic condition when developing an environmental project on the city's systems, always «on the edge as we search for quality of liveability, population health, social relations and ecologic processes» (Tucci, 2013).

The passage from the idea of border to the concept of boundary zone evolved originally within the sustainability design culture but has continued with the emergence of new environmental paradigms such as resilience, inclusion, healthiness, vitality and smartness. In the Italian cultural framework, technologic disciplines of design have faced the evolution of the complex dimensional, functional and performative relations that are established in the spatial systems between buildings and cities by investigating the effects on the quality of the urban environment.

In the field of architectural technology, the passage from border/limes to intermediary/inbetween spaces and then, on to dynamic boundary/limen is taking place within four main fields.

The first is overcoming the closed concept of the built up perimeter that, in the envelope system, becomes intermediate architecture of climatic-energetic equilibria between buildings and outdoor environment.

The second regards the space-temporal extension of the relations between technological systems and socioecologic dynamics: to re-establish connections among space, users and physical-environmental realities; to reinterpret the project of the environment as an interactive meso-cosmos between people and community; to lean toward technologies to produce and transform the habitat and to reactivate eco-systemic cyclicity and motility.

The third is related to the role of inbetween systems as generators/mediators of urban environmental quality. This role can regard: the extension of design responsibility in the morphogenesis of the city's spaces; the regulatory functions of intermediate spaces in the socio-environmental metamorphic processes; the reconfiguration of urban space as the central location for public/private interactions; the capability of non built up spaces to reconnect the urban bioecologic flows.The fourth field refers to the reconfiguration of the boundaries between buildings, nature, cities and inhabitants as systems of technological-environmental interfaces.

These interfaces are important: to support activities of collaboration, inclusion and access to knowledge; to plan material and immaterial infrastructure to improve connectivity and the attractiveness of the landscape and territory; to reactivate circularity and economic interaction between single objects, intermediary spaces and external resources.Though these issues have been explored, the challenges of sustainability and the quality of the urban habitat are anything but closed.

A methodological path in progress. Some scientific evidence

Unexpected modifications are again involving urban systems on various scales. These are changes in the geoclimatic, social, economic-productive and housing situation that are generating a state of continual instability and risks to the *urbs* and *civitas*. To use the words of Ulrick Beck, the real condition of today's cities annuls notions of change, transformation, evolution, no longer exhaustive in a picture that requires a "cosmopolitised" vision to describe, understand and act in constantly metamorphosing urban/territorial organisms.

Concomitant causes are acting in this scenario. To give some examples: climate change and settlement's increased vulnerability; deindustrialisation process; loss of attractiveness of the small towns; work reorganisation, delocalised or shortened term; the increase of inequality in access to resources; new transcontinental migration and the meeting/contrasts between differing civilisations and cultures; urban populations which have never more intense.

The new issues of the urban habitat have brought back to the centre of the project the urban non built up and collective space. It is a space which cannot however be considered infinitely resistant, available and malleable (Secchi, 2013), nor treated as absent, void, discarded and perhaps not even any longer as inbetween.

Contemporary non built up urban space possesses the specific elements of "liminal" contexts as described by Victor Turner as transitional locations where cultural, social and technical hybridisation take place. Liminals that Turner in transposing them to the urban environment he calls "liminoids": boundary contexts in which traditions and innovation, rituals and everyday practices mix and can recodify the rules of cohabitation, often through activities linked to leisure time, games or artistic performances. If up to today a city's non built up areas have been interpreted and transformed according to stable and standardised parameters, founded on continuity, homogeneity and permanence, on the contrary, liminals are characterised by their instability and variability, through spatial discontinuities, heterogeneities of uses/needs and transitory functions/performances.

The methodological and cognitive approaches to reconfigure such spaces must be reoriented toward interconnectivity to build a network, which can shift among technical innovations, nature, individuals, society and artifacts to manage a transition toward new unforeseeable forms of urban living.

From a methodological point of view, there is a change in both the projective vision of a city's non built up spaces and the concept of its physical and immaterial qualities. Liminal spaces can be interpreted and provisionally modified in their connective role only by accepting their intrinsic plurality, without sharp borders, treating them as a common good/space, neither public nor private, based on nearness, visibility and diversity (Henaff, 2008).

Coexisting in this approach are the vision of the process (several managements, strategic, tactical, operative and temporal levels over the short, medium and long terms) and the relational vision (several levels of actors and of scales of intervention). Moreover, the idea of quality of the liminal spaces takes on different and variable connotations. Reasoning about the fixed technical performances of separate entities is not sufficient. It is necessary to evaluate qualities individually/collectively, including the cost of care and maintenance, of adaptation and coevolution, of cycle and production chains. So, we also need a performative vision, in the meaning of the late Latin term *performare* (give form, build, produce) that allows us to work with several objectives (general, intermediary, specific), various control levels and several quality gradients (global, global/local, local) (Fig. 1a).

From a designing point of view, the cognition of liminal spaces loses its rigorously anisotropic, material and unchanging structure.

A city's liminal spaces can no longer be thought of as antithesis of built up, in traditional topic or atopic meaning, as monumental voids, exteriors to be furnished, junctions, sequences of streets/squares, non-places, exclusive spaces or "junkspace". They must take on a more isotropic, immaterial, open and porous connotation. As such they must be interpreted as heterotopic entities (to pick up on the explorations of Michel Foucault), to be read in their four-dimensional nature as free-space supporting additions and infilling, spaces for comparison/confrontation in transition between bottom up place making and top down planning that can probably be restored to natural processes.

Finally, this multiplicity of connective roles of physical, social and cultural values calls for a recodification of the internal and external technological relations and regulations of the liminal space. Going back to the theory of the three regulatory meso-environments of John Marston Fitch, a city's non built up liminal space could constitute a "fourth regulating and enabling meso-environment", triggering an ability in people, spaces and technical objects to adapt to the context's continuously changing conditions.

In this last hypothesis, urban liminals can be considered as an area for experimental designing, still little explored.

Patchwork, crossing and fringe limen. Some empirical evidence

Rethink our system of knowledge to intervene on urban liminals means seeking a wider relation between the use of technical innovations (today practically unlimited) and dynamic interactions that "find their place" precisely in the city's non built up areas. Among these interactions, we highlight productive and communicative processes of innovation, natural ecologic-metabolic capacities, people's well being and health and types of organisations among communities and individuals. Looking at local case studies[1] it is possible to highlight empirical evidence concerning the innovation of forms of knowledge for technological-environmental design of urban liminals (Fig. 1b).

The first concerns the shifting relation between technological innovation and the quality of life of liminal space. A relation characterised by a weak recognition that exogenous-global and endogenous-local aspects interfere with innovations and the quality of the space and that today get back to confront with two central concepts for the design technological culture. "Technological appropriateness" to be reinterpreted as the ability to interrelate development, context and local resources with intermediary, provisional and light solutions to direct the hybrid transformations characterising post-industrial urban environments (Gangemi, 1985).

---

[1] Research carried out or ongoing at the University of Chieti-Pescara looking at questions of non built up urban space: Chieti_Lab (2014-15), Verso Pescara 2027 (2016-17), BikeFlu (2017-18), LIMEN (2018-19).

“Technological deviance” referable to the ability to incorporate the complexities of natural elements into the functional and living dynamics of the urban space to activate in a city new competences, abilities and degrees of adaptation to current or future emergencies (Vittoria, 1987).

The second type of evidence comes from the need to model the liminals incorporating the complexities of their volumetric and temporal space. It is necessary to make synchronically/diachronically interpretable, measurable and adaptable all those variable and constant entities (e.g. users, times, uses, goals, information and distance) and components (e.g. surface, mass and cavities) which have coevolutive relations in liminal spaces.

An inner dimension (presence of residual volume) is not always recognisable in these spaces, nor an intermediate internal-external dimension (contamination between individual and collective good) and there is no clear external dimension (weak polarity/directionality, compresence of public and private elements).

These conditions require an investigation of the possible degrees of meso-environmental interface, acting on several levels (ambient, unit, sub-unit) a-scalar/interscalar continuously reconfigurable.

The third area of evidence, the heterogeneity of urban *limen*, let us look at three that contain recurrent technological-environmental questions (Fig. 1b).

Patchwork limen, residual fragmentary “patches” in which the identities of squares are shattered but which continue to be polarities in the networks of a city’s material and immaterial flows.

Here we can reconfigure regulatory/enabling relations using interfaces developed spatially: to guarantee accessibility, inclusivity and interactivity among the flows of material, energy and global information if they are prepared for bottom up colonisation, with additional, light and integrative reversible technologies (Losasso, 2016).

Crossing limen are borders extending longitudinally that have lost the directionality of city streets, but not the density and congestion of crossing flows. They can become linear regulatory/enabling interfaces to re-establish dynamic relations between collective and private dimensions.

Using infrastructural and intermediary technologies to reconnect the productive and creative forms needed for local socio-economic development brings resources and value to the territory and landscape (Schiaffonati, 2016).

Fringe limen are heterogeneous frameworks, the result of deindustrialisation or widespread urban expansion, where we find, without dialogue, active or decommissioned residential/industrial buildings, infrastructure and residual and/or marginal natural or agricultural areas.

They can become regulatory/enabling systems to regenerate human, natural and cultural capital using environmental technologies to join the soils, and enhance safety and territorial resilience, green/blue infrastructures, improving energy performance and urban farming (Tucci, 2017).

Technological research areas for urban liminals

The challenges of a city's liminal spaces highlight an evolution toward a technological-environmental view of design of human habitats. It is possible already to identify the main areas of study and technological development in which this vision can determine innovative outcomes for the designing process, but also for the reformulation of the training of future designers. In response to soliciting conventions and documents (*European Landscape Convention*, *Manifeste du Tiers-paysage*, *Resilience Alliance Prospectus*, *Manifesto per l'Architettura e la Città del Futuro*) in which non built up space has been brought to the centre of the project by research on cognitive-methodological innovations. There has been research on innovations in the processes to evaluate urban quality, through protocols and voluntary tools (Neighbourhood Sustainability Assessment Tools, *UN&ARUP Resilience Vision*, *Settlement Health Map Vision*). There has also been interdisciplinary research to innovate participative planning/design process and the definition of shared solutions, found in work agendas that confront sustainable relations between societies, cultures, inclusions and health (*UN Agenda 2030*, *PPS Project for Public Spaces*).

References

Forman, R.T.T., Godron, M. (1986), *Landscape Ecology*, John Wiley, New York.

Friedman, A. (2014), *Planning Small and Mid-Sized Towns, Designing and Retrofitting for Sustainability*, Taylor & Francis, London.

Gangemi, V. (1985), *Architettura e tecnologia appropriata*, Franco Angeli, Milano.

Guazzo, G. (2003), "I molti modi del pensiero progettuale", in Bertoldini, M. and Zanelli, A. (eds), *Tecnica, progetto e scienze umane*, Clup, Milano, pp. 25-54.

Hénaf, M. (2008), *La ville qui vient*, Èditions de l'Herne, Paris.

Losasso, M. (2016), "Contesti storici e progettazione contemporanea: l'innovazione tecnologica fra memoria e modificazione", *Techne*, n. 12, Firenze University Press, Firenze, pp. 6-10.

Marchesini, R. (2002) *Bioetica e Biotecnologie. Questioni morali nell'era biotech*, Apeiron, Bologna.

Orange, H. (2016), *Reanimating Industrial Spaces: Conduction Memory Work in Post-Indsustrial Society*, Routledge, New York.

Schiaffonati, F. (2016), "Il territorio delle infrastrutture", *Techne*, n. 11, Firenze University Press, Firenze, pp. 12-21.

Secchi, B. (2013), *La città dei ricchi e la città dei poveri*, Laterza, Bari.

Tucci, F. (2013), "Progettazione Ambientale, tra emergenza e scarsità di risorse: alcune riflessioni di metodo / Environmental Design with regard to emergency and scarce resources: a few method reflections", *Techne*, n. 5, Firenze University Press, Firenze, pp. 44-52.

Tucci, F. (2017), "Introduzione. Per un Manifesto della Green Economy verso l'Architettura e la Città del futuro | Introduction. For a Manifesto of the Green Economy towards the Architecture and Cities of the Future", in: Antonini, E., Tucci, F. (eds) (2017), *Architettura, Città e Territorio verso la Green Economy. La costruzione di un Manifesto della Green Economy per l'Architettura e la Città del Futuro | Architecture, City and Territory Towards A Green Economy. Building a Manifesto of the Green Economy for the Architecture and the City of the Future*, Edizioni Ambiente, Milano, pp. 25-75.

Vittoria, E. (1987), "Le tecnologie devianti per la progettazione ambientale", in Gangemi, V., Ranzo, P. (eds), *Il governo del progetto*, Ed. Parma, Bologna, pp. 62-71.

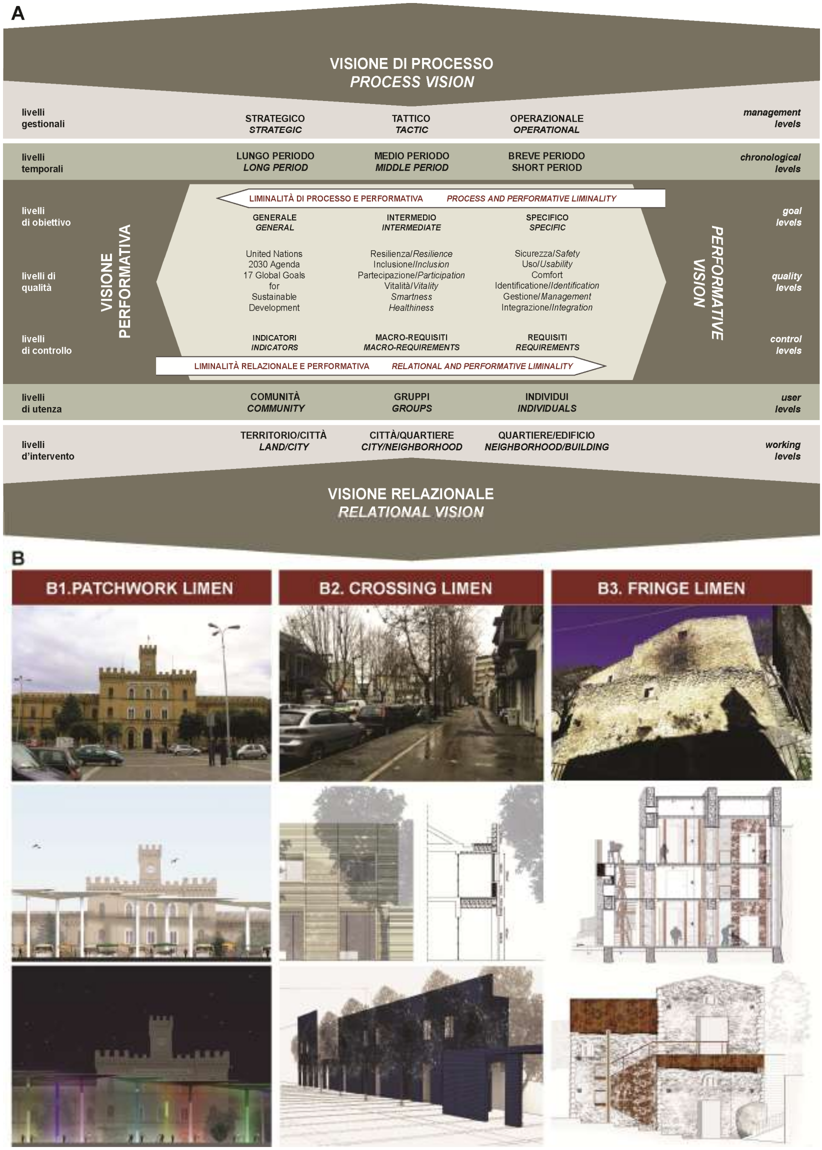


Fig. 1 - A. Methodological-cognitive framework for a technological-environmental design of urban liminals; B. Recurrent typologies of urban liminals and regulatory-enabling interfacing systems. (B1. polar interfaces; B2. exoskeleton interfaces; B3. endoskeleton interfaces).

3.12 Valorisation Design: From Plot to Vector of Architecture

Elisabetta Ginelli, Gianluca Pozzi**

Abstract

Contemporary needs call forth a paradigm change requiring design to take on a strategic evolutive value, which is oriented towards the notion of "sense of choices" over time. According to a specific declination of the concept of choice anticipation, design gains a decisively predictive character, not so much of the phenomenon as a physical condition, but of change too; that is, it has to assimilate the anticipation of potential transformation, to obtain a project resultant adapting and reacting to the inevitable transformation phenomenon. The aim is to lead the building's immobility towards a dynamic spatial valorising dimension, based on a "variable functional approach" and favoured by an open, multiple technological system with a high level of mutability.

Keywords: Flexibility, Predictive design, Adaptive/active resilience, Reversibility, Valorisation

Introduction

By definition, the design stage precedes the architectural work. Historically, component objects have been chosen with respect to the cultural, localisation and exigency context, and every material was functional in relation to the intrinsic properties monitored through the user's experience.

They held the built-in value of implicit sustainability deep within themselves. At present, we might say that architectural "objects" (divided into techniques and components) almost live a life of their own, independent and self-sufficient with respect to design systems (Heyes, John, 2014).

This paradox issues from the separation between design – and its resultant – and the time variable. In fact, two antithetical positions can be outlined.

On the one hand, exclusive objectives such as energy efficiency are unidirectionally pursued, through the relationship building/plant or by fragmenting design (Losasso, 2017) down to its last component, which seeks extreme per-

---

* Elisabetta Ginelli is a Full Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, elisabetta.ginelli@polimi.it.

* Gianluca Pozzi is a PHD candidate at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, gianluca.pozzi@polimi.it.

formances (including performance-based design processes and logics). On the other hand, design is simplistically considered a landmark, i.e. an iconic act signalling a presence, thus diverging from any social, economic and political aspects (Settis, 2017) and favouring territorial or regional marketing to the disadvantage of an organic (global) sustainability. We do witness a fractioning of knowledges, which turns design into a one-directional action discouraging the global concept of continuing improvement over time and the value's potential regeneration character. This is what happens when we lose the connection between theory and practice, which eliminates the challenge posed by the meaning of "doing architecture" (Sichenze, 2011).

Within such scenario, the discussion about design is taking over the concept of resilience. We intend hereby to include this quality by considering resilience design as a strategy, which assumes both uncertainty and change as fundamental elements (Perriccioli, Ginelli, 2018). This entails bold choices in terms of building and management, which are defined by predictive design absorbing transformation more as an intrinsic characteristic, and less as simple anticipation of potential phenomena. Hence the idea of an adaptive/active resilience, i.e. capable to provide adequate responses to change, not so much through immediate physical reactions as through our own systemic nature reacting to transformation.

Design thus becomes a means of valorisation, turning from a condition of pre-established plot to one of transformational vector wherein resilience and adaptation get imprinted on the system, which is the pivotal forum for investments of time and resources.

Design of contemporary needs

Just as Euripides once said, "expecting the unexpected", or being able to face uncertainty, represents today's cultural attitude.

The focus on this aspect translates into the realisation that making some particular decisions instead of some others may support the improvement of a condition which requires a strategy. Being unaware of the limitless strategic potential of architectural design to adapt it to our contemporaneity means risking design annihilation. In 1983, Dioguardi observed that the complexity of knowledge does not find its expression merely in relation to a "scientific moment" in the increase of information regarding a stable system; on the contrary, it has to distinguish itself on the basis of a "structural moment", directing research towards dynamic systems (Dioguardi, 1983).

The complexity of the decision-making process is emphasised by the design requirement to consistently combine heterogeneous disciplinary peculiarities, as well as to make prudent choices.

A multirationality can thus be detected – although sometimes obsolete – expressing behaviours and expectations which differ from cultural framework, organising methods, objectives, contents.

Therefore, the designer has to adopt a dynamic and even organising approach (Morabito, 2004), able to catch the transition from "what is design" to "how to design". According to Morin, this transition is the designer's most crucial problem, who finds himself caught into a paradoxical situation, since he would need a method «enabling him to design the plurality of points of view and to access the metapoint of view on all the different points of views» (Morin, 1980, p. 179).

The aforementioned approach is implicit in the expression "technological design of architecture", founded on the notion of design as constant research; of its executive power, which is considered the expression of actions incorporating the feasibility dimension; of management; and, currently, of the architectural work's functional transformability, for the purposes of a dynamic and programmatic reuse in terms of time, place and system. Adding the idea of functional transformability results in considering design not only as a transformation of the context to time t_0 (and maybe even a little further), but mainly also as a transformation of design itself in time $t_{0+x+y...z}$, in order to increase the resilience of the same context. We are dealing with a "design for time", that is, a design of intrinsic and continuous transformation.

Design for time

It is well known that change intimately belongs to design as

> «in the current sense, it is a forward projection into the future, through action strategy, of a symbol-idea, original and unique in its being the image of a significant structure and at the same time the process of that structure's transformations, until it manifests itself in the form of a real object» (Ciribini, 1984, p. 50).

Contemporaneity, which is even more intimately connected to complexity (Bocchi, Ceruti, 2007), relates to the concept of time within a broader meaning of historical moment, assimilating the idea that time exists only as a consequence of the events taking place over its course. In this respect, change and transformation arise from the awareness of "being" (Heidegger, 1998) and the understanding of every single instant. Following this logic, design needs to include transformational programming to obtain a mixture of variable functions.

Therefore, Ciribini's definition applies to the concept of time according to Heidegger's view, consciously knowing that design comprises creation and management as well as its own transformation over time. The statement that «[design] acquires the specific connotations of a "creation programme"» (Del Nord, 1988) is proved sound, with increasing information and coded communication aimed at continuous transformation, i.e. valorisation over time.

The transformation stage takes the form of an additional step in the building process, patently subject to decision anticipation.

Design openly assumes its "forward-projecting" character, that is, the ability to conceive architectural works in line with circular economy logic, flexible with respect to the different scales, in every moment of its physical lifecycle. In this way, design upgrades from simple plot to vector of architecture.

Design of anticipation

Koolhas says that:

> «flexibility is not the exhaustive anticipation of every possible transformation. Many are unpredictable […]. Flexibility is creating a wide-margin capacity (degree of freedom) allowing for different and opposite uses and transformations» (Koolhaas, Mau, 1995).

Contemporary research fits definitely well into the transformability context, emphasising the term "reactive" as the architectural work's intrinsic ability to welcome change, seen as an opportunity for improvement in order to enhance value and performances. Mehaffy and Salingaros are two perfect examples, according to whom «authentic modernity consists in accepting new growth models which include evolutive and adaptive morphogenesis processes» (Mehaffy, Salingaros, 2015).

Similarly, the term "reversible" increasingly draws the interest of designers and entrepreneurs (Mialet, 2017) as well as the attention of research programmes like 2017 *Construire Réversible* by Canal Architecture. These examples show just how flexibility is regaining its central position with regards to design choices, taking back to design's early stage those decisions which could provide buildings with a kind of facilitated – and thus economically advantageous – flexibility. To this end, every single design choice has to strive after that goal, starting from a structural and plant-engineering base; from the envelope and the access and route system, to the building's thickness.

If there is a word able to sum up the characteristics of anticipation design for flexibility it should be "metamorphosis", which contains the ideas of reversibility, mutability, evolutionary potential and reshaping capacity. The metamorphosis can be achieved only when multifunctionality turns into unavoidable design paradigm.

Flexibility, adaptability, multifunctionality. Examples and case studies of reversibility and resilience

Many important cases in history support house flexibility, very often connected with satisfying the mandatory needs linked to the lack of resources or personalisation necessities.

On the other hand, as the above-mentioned case studies show, flexibility should correspond to an elastic state condition of the system, which can be subject to transformations in time t_{0+x}. This results in the architectural system's reactive ability to change according to the impulses engaging with it, whether internal or external. On the contrary, adaptability applies especially to those buildings with variable functional destinations – generally within the services sector – where specific technical solutions allow for a form of flexibility which, despite being limited to the user's type, guarantees a long-lasting operational usability. In the sense hereby pursued, adaptability is physically equivalent to a state condition able to address the alteration of time t_0 and come back to the initial state, or to face an expected or unexpected situation assuring the very same outcomes for the system. Adaptability is related to substantial factors and can be assimilated to the response to a sudden event, generally an emergency.

Multifunctionality has recently spread as a new condition involving both flexibility and adaptability, transforming them into reversibility and convertibility. This latter results from a design able to programme buildings reacting to multiple functions, simultaneously and/or temporally. Multifunctionality can enhance the architectural work's life and usability, also in terms of sustainability, resilience and circular economy. Design quality increasingly emerges from the project's ability to host several functions at the same time or over the years, through building techniques and creation methods – for new or upgraded constructions – to facilitate disassembly and reassembly, reuse and recycle, just like dry stratification technology and tightening assembly.

As demonstrated by the following cases, multifunctionality can generate a building intrinsic potential. The analysed case studies mean to exemplify two trend lines: the former can be attributed to the reversibility concept, interpreted as use transformability over time; the latter, which will be described in the last case, represents adaptive/active resilience in the aforementioned sense, and considering that, at present, "resilient" should be strongly associated to the idea of intelligent building and SMART[1].

Examples of reversible use design over time

Reversible parking structure Saint Roch, Montpellier (FR), Archikubik 2016. The new multistorey car park of approximately 24,000 square metres is located in the town centre, acting as structural link between traffic-free zones and Saint Roch's train station. This building clearly reflects the concept of participative private space and goes beyond the initial programme, turning into a relational structure with an active role in relation to its surrounding environment.

---

1 Directive (EU) 2018/844 of the European Parliament and of the Council of 30th May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency.

This project, potentially bound to change and develop, will host office premises, accommodations and other emerging uses.

ILOT B2, Lyon (FR), Siz' Ix 2019 (prospect). The project offers 2,846 square metres for office premises, 680 square metres for shops, a day care, a student residence of 2,109 square metres, 23 social accommodations and 71 houses. It is based on the principle that architecture should ensure the product's potential reconversion: indeed, spatial organisation releases it from the bond with its original function, so that it acquires the "transformability" capacity making it sustainable and adaptable to new environments, thanks to ad hoc type-technological choices.

Résidence Intergénerationelle, Paris (FR), Atelier d'Architecture Laurent Niget 2012. Upgrading from a 3,500 square metres service building to accommodations for young and older people, including common and public spaces (plus a market). This is a suitable example of the *mixité fonctionnel* (multifunctionality) concept and of how the spaces themselves could be assigned to different functions according to particular needs.

Tour Le Palatino, Paris (FR), Eric Chabeur Architect 2015. Upgrading from over 16,000 square metres service building to free collective residence and student accommodations through structural changes and distribution systems. It enabled the construction of 543 modular and interchangeable houses, plus multifunctional common areas. Solutions related to energy and environment and management sustainability have been particularly stressed.

Metamorphosis, Milan (IT), EMPAM RE[2] 2018. Upgrade from an approximately 15,000 square metres service building to a mixture of functions, including student residence, senior accommodations, temporary residences, collective and public services, community centres, health centres and rehabilitation services.

Example of adaptive/active resilience design

Progetto Smart Living cHOMgenius[3], Politecnico & partners with Lombardy Region (IT) 2018-2020. Design for the construction of smart housing buildings using containers.

This study provides for the implementation of sea containers as supporting constructs, at the best of their structural characteristics, where any strains and possible deformations concentrate in the (checkable and reparable) junctions.

---

2 Feasibility studies have been developed within the activities of the Design and Construction for Architecture workshop from the master's degree in Architecture, Built Environment and Interiors of AUIC school of Politecnico di Milano university, academic year 2017/2018. Regular Professors: Elisabetta Ginelli (ICAR/12) and Luca Formis (ICAR/09) in collaboration with owner, con Gianluca Pozzi, Giuditta Lazzati, Giulia Vignati.

3 Winning project of SMART LIVING competition of Lombardy Region. Partner: BFC (leader), Whiteam, Politecnico di Milano. Scientific manager for Politecnico di Milano: Elisabetta Ginelli.

The buildings will comply with the highest energy saving standards, until they will go offgrid. The whole technological system has been dry processed (including the foundations on posts) and is reversible, transformable, reusable and recyclable.

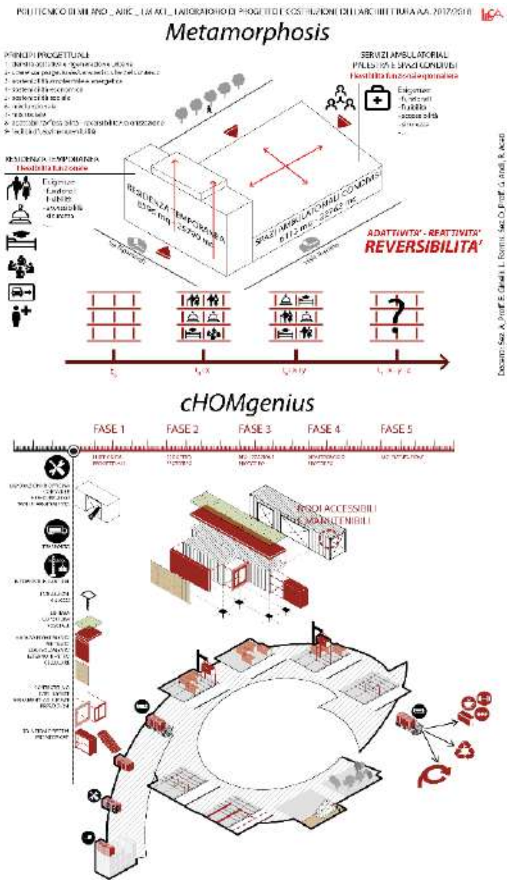


Fig. 1 - Schematic synthesis of the methodological framework of the educational projects Metamorphosis and of the project cHOMgenius.

Design repossessing

This essay falls under the context of design technological culture, which characterises methods, instruments, objectives and outcomes of design training, of design and the constructed architectural work.

The architectural product is considered a resource offering the best performances in relation to usability and management over time of its own spaces and concrete technical elements; nonetheless, it needs to face feasibility and economic and financial management according to production criteria and objectives consistent with the achievement of a balanced relationship with environment issue (Ciribini 1984).

Therefore, technological culture is perceived as an intellectual instrument of design, and technology is interpreted in the sense of rationalising architectural imagination in the form of a new value for the art of building in a given present (Vittoria, 2006). This results in design principles giving direction to projects. Typo-technological flexibility becomes a vehicle for sustainability in its broadest meaning (environmental, economic, institutional, social, technical), paving the way for multifunctionality and adaptive/active resilience (Ginelli, 2018). Design thus recovers its role of provider of a strategic – but especially political, forward-looking and "foreboding" – notion requiring bold and ineluctable solutions, able to trigger even profound changes in the current construction approaches and to envision building structures (Ginelli, Pozzi, 2018)).

References

Bocchi, G., Ceruti, M. (2007), *La sfida della complessità*, Mondadori, Milano.

Ciribini, G. (1984), *Tecnologia e Progetto. Argomenti di cultura tecnologica della progettazione*, Celid, Torino.

Del Nord, R. (1988), "Presentazione", in Lauria, A., *L'architettura dei dettagli*, Alinea, Firenze.

Dioguardi, G. (1983), *Nuovi modelli organizzativi dell'impresa*, ETASlibri, Milano.

Ginelli, E. (2018), "Progetto flessibilità evolutività", in Daglio, L., *La sperimentazione tecno-tipologica nel progetto della residenza collettiva*, Mimesis, Milano.

Ginelli, E., Pozzi, G. (2018), *Dal progetto in emergenza al progetto per l'emergenza. Il Tempo delle sinergie tra flessibilità e multifunzionalità*, in Architettura & Tempo, ICAR65, Genova.

Heyes, R, John, P.S. (2014), "Imparare dai modelli del passato", *Domus*, n. 984.

Koolhaas, R., Mau, B. (1995), *S, M, L, XL: small, medium, large, extra-large*, Office for Metropolitan Architecture, Jennifer Sigler, Rotterdam.

Losasso, M. (2017), "Between theories and practices: Culture, technology, design", *Techne*, n. 13, Firenze University Press, Firenze.

Mehaffy, M., Salingaros, S.A. (2015), *Verso un'architettura resiliente*, n. 809, Firenze, www.covile.it.

Mialet, F. (2017), "Bâtiment réversibles", *AMC*, n. 262, Sept.

Morabito, G. (2004), *Scienza e arte per progettare l'innovazione in architettura*, Utet, Torino.

Morin, E. (1980), *La Méthode*, t.1., Points, Paris.

Perriccioli, M., Ginelli, E. (2018), "La sperimentazione tecno-tipologica nel progetto della residenza collettiva", in Lucarelli, M.T., Mussinelli, E., Daglio, L. (eds), *Progettare Resiliente*, Maggioli, Santarcangelo di Romagna.

Settis, S. (2017), *Architettura e democrazia. Paesaggio, città, diritti civili*, Einaudi, Torino.

Sichenze, A. (2011), *Architettura vs Nichilismo*, Mimesis, Milano.

Vittoria, E. (2006), "Prefazione", in Cupelloni, L., *Antichi cantieri moderni. Concezione, sapere tecnico, costruzione da Iktìnos a Bruelleschi*, Gangemi Editore, Roma.

3.13 DISCIPLINARY CONTAMINATION. *"RECHERCHE PATIENTE"* IN DESIGN TECHNOLOGICAL CULTURE

Serena Baiani [*]

Abstract

Gregotti argues that the main interest of architectural research must be the project, that is able to compare itself with other cultures and to acquire their useful and necessary resources within the specificity of its discipline. The new challenge starts from the hypothesis that it is possible to combine speculative investigation with design activity, as a tool for possible change, moving from the analytical-exploratory phase of research to the constructional-intentional phase, capable of foreshadowing the transformations: it is fundamental to map the change that contemporary societies are bringing to the creative professions - determining a new synthesis between knowledge, disjointed, fractioned - also to imagine what will be the "future toolbox".

Keywords: Research, Design, Creativity

> «It is noteworthy that the progress of objective knowledge needs creative imagination. […] Imagination elaborates new forms or figures, invents/creates systems from elements captured here and there or isolated from the systems of which they were part, which confirms, in the sphere of thought, the *bricoleur* character of every creative evolution» (Morin, 1989).

The system of relations between complementary knowledge, although different, allows us to identify interdisciplinary approach as innovative, highly creative, capable of responding to real needs, orienting design more specifically towards research and experimentation of an architecture that embraces human life environment and represents set of changes and alterations made on the earth's surface, in view of human needs, except for pure desert (Morris 1881), highlighting the ethical, political, economic and social responsibility of the designer (Papanek, 1973).

At the end of the 1990s, Maldonado expressed the significant challenge of overcoming the gap between design and research in a perspective of innovation in the approach to transformation in which the practice of contamination of skills was central, through the creative ability to perceive unusual and different

[*] Serena Baiani is an Associate Professor at the Department of Planning Design Technology of Architecture, Sapienza University of Rome, Italy, serena.baiani@uniroma1.it.

connections and ideas[1]. The new evidence starts from the hypothesis that it is possible to combine speculative investigation with design activity, as a tool for change, moving from analytical-exploratory phase of research to constructional intentional phase, capable of foreshadowing transformations: interest is in analysing and mapping changes that post-industrial societies bring to creative professions, and to imagine future toolbox (Green Hat Thinking[2]).

The project [of artefacts, buildings, urban arrangements] is included in research activities, becoming critical synthesis that allows elaborating physical models, possible visions, real images.

Munari, artist, designer, eclectic and visionary, fostered by empirical experience and teacher activities, in a lecture at IUAV (1992) on the method adopted to design "Fantasy", affirms the importance of the creative approach, capable of interconnecting transversal and multidisciplinary interests «to produce something feasible and working»[3]. Creative imagination, trainer of objective knowledge progress, is therefore necessary in the research activity (Morin, 1989) and lateral thinking application (de Bono, 2001), in order to outline a "concrete utopia"[4] that tends to minimise the utopian component and to maximise the technique (Maldonado, 1970) through a critical analysis of the present. Creativity belongs to whom is able to lean forward, prefigures future and imagines one of the infinite possible configurations of reality: researcher, designer, maker of artefacts. Creativity is a set of qualities or adaptive[5] behaviours of the designer, who changes in a changing world (Manzini, Susani, 1995), is formed and transformed continuously; it requires a ready and elastic intelligence, a mind free from preconceptions, ready to learn what is needed in every occasion and to change one's opinions when a more just one is presented (Munari, 1977).

---

1 «If the great challenge of 2000 will be the environmental reconversion of industrial equipment, processes and products, the current gap between design and research is the first obstacle to overcome. In this new context, industrial design will be able to play, alongside all the other design disciplines, a role of primary importance». Maldonado, T. (1990), *Disegno Industriale: un riesame*, Feltrinelli, Milano.

2 De Bono, E. (1985). *Six Thinking Hats*, Little, Brown, & C., NY.

3 Munari defines the concepts of fantasy, imagination and invention through provisional definitions. Fantasy allows us to think of something that previously did not exist (even things that could not be achieved in practice) without any limit: by establishing links with already known elements, fantasy operates in memory by making new connections. Invention produces something that was not there before without posing aesthetic problems and dealing with the functional aspect. Creativity uses fantasy and invention to produce something that is achievable and functional. Imagination, on the other hand, is the faculty that allows us to imagine what imagination, creativity and invention produce. Munari, 1977, 121-122. *On the subject Rubini*, 1980; Garroni sub.v. "Creatività" in *Enciclopedia Einaudi*, 1978; Legrenzi, 2005 and Sterling, 2008.

4 For a critical discussion of Bloch's Concrete Utopia Theory, "Verso una prassiologia della progettazione" in Maldonado, 1970.

5 Celaschi, F. (2008), "Il design mediatore tra saperi", in Germak, C., *L'uomo al centro del progetto*, Allemandi, Torino.

This is not, therefore, a research activity aimed at defining instruments that propose a partial and deterministic approach to the project, but a predisposition of a theoretical apparatus and cognitive tools aimed at substantiating it. In this sense, it is necessary to work by orienting choices towards an innovation of instruments - material and immaterial, tangible and intangible - because as in the manufacturing process also in science the change of instruments is «an extravagance that must be reserved for the occasion that requires it. The meaning of crises lies in the indication that opportunity to change instruments has arrived»[6].

The contemporary research on a new synthesis between knowledge, disjointed, divided into disciplines, proposes to put together what is separated (Oechslin, 2013) with an interdisciplinary approach that, while maintaining peculiarities, uses complementary aspects to discover basic unity in specialised knowledge, which appears fragmented and continuously divided.

The objective is, therefore, to recompose «those knowledges which, bound together, would allow the knowledge of knowledge» (Morin, 1989) as a multidimensional phenomenon: the "map of knowledge", drawn up by Los Alamos National Laboratory[7], shows an evocative web in which, around a centre, constituted by the most diverse humanities, gravitate hard sciences, graphically interconnected.

Replacing the clash between specialisations with an encounter, highlighting present and future interdisciplinary links, while sharing specific skills, in understandable and rigorous terms, leads to reveal how each field of research participates in third culture[8].

> «The bridge between disciplines exists, but it is necessary to strengthen it through the setting up of a real creative-constructive dialogue between many activities and skills [...] to strengthen informed exchanges on frontiers of advanced research, as well as to share certain psychological traits, may be affective, certainly altruistic, able to lead to communicate to others their knowledge and experience» (Lingiardi, Vassallo, 2011).

The aim is to be able to transmit what we know and do, making it clear to those who are not familiar with it: far from aiming at generalist or know it all knowledge, this condition originates unexpected creativity and connections between aspects of culture, previously unknown or ignored.

---

6 Kuhn T. (1962), *La struttura delle rivoluzioni scientifiche*, Einaudi, Torino.

7 Cf. Bollen et alii (2009), "Clickstream Data Yields High Resolution Maps of Science", *PLoS ONE*, 4.

8 On the definitions of Third Culture, Lingiardi and Vassallo, 2011. First references in Snow, C.P. (1959), "The two cultures and the scientific revolution", in Snow, C.P. (1964), *The two cultures and a second look. An expanded version of the two cultures and the scientific revolution*, Cambridge University Press, Cambridge. In the '80s Lepenies, W. (1987), *Le tre culture. Sociologia tra letteratura e scienza*, Il Mulino, Bologna and then Serres, M. (1991), *Le tiers instruit*, Gallimard, Parigi. In the '90s Brockman, J. (1995), *The third culture*, Simon and Schuster, NY.

Creativity and connections originate from flexible, socially usable, intellectually perspectives that operate on the basis of multiplicity of approaches, images, languages, practices, thoughts and tools (Lingiardi, Vassallo, 2011). *Knowing does not mean remembering, but knowing exactly where to look for* (Gramellini, 2010).

The interdisciplinary approach, which allows to move on the boundaries and to incorporate them, is based on a system of knowledge of design processes and techniques, knowledge of arts and related sciences, filtered through a social consciousness derived from the awareness of present problems[9], through the application of creative thinking (de Bono, 1992) that allows to face the challenges posed by the new condition of contemporaneity, developing new tools, flexible and updated. Knowledge and creativity emerge, therefore, as strategic levers for the definition of the project field, integrated and multidisciplinary, constituting an added value in the research on new technologies - functional to practical problems resolution, to the optimisation of procedures, to the choice of operational strategies - in order to create innovation and develop common experiences of intelligent design. Moreover, to overcome the idea, strongly rooted, that

> «to the extent that identity derives from physical substance, history, context, reality, we can not imagine that something contemporary (in fact by us) can help to constitute it» (Koolhaas, 2006 [10]).

The technological culture of design interweaves art and technique, culture and science, theory and practice, implementing that "thinking differently" from which innovation is born.

In this process of genetic codification, debate on the two cultures - with polarisation in technical-scientific and humanistic knowledge, characterised by a certain communicative resilience between them- matured in a pluralistic conception that proposes a third, more horizontal, culture, in which even training system is rethought in a less sectorial way and not only theoretical and contemplative, but pragmatic and political, characterised by transversality, interdisciplinarity and the attempt to overcome the dichotomy between hard and soft sciences[11].

---

[9] "Architecture is a moment of synthesis fertilised by everything behind architecture: history, society, the real world of people (...), geography and anthropology, climate, culture (...) and even science and art" (Piano, 2010).

[10] Cf. "Città Generica" in Koolhaas, R. (2006), *Junkspace*, Quodlibet, Macerata.

[11] Maldonado described the research of transversality throughout his personal intellectual journey «my concern (I would almost say my obsession) was to be able to contribute to a total vision of culture. Of course, seen with hindsight, such a project was then too ambitious, but it certainly anticipated, to a certain extent, my everliving interest in what you called transdisciplinary. And that I would prefer to call, adopting an expression that has just begun to circulate, third culture. And that is the attempt to overcome (or at least make less drastic) the famous dichotomy between hard and soft sciences». Maldonado, 2010, pp. 8-9. Also Flusser, V. (2003), *Filosofia del design*, Mondadori, Milano.

> «If teaching can have a purpose, this is to inculcate a sense of responsibility and capacity for introspection. Education must lead us from free opinions to responsible judgment. It must lead us from chance and arbitrariness to rational clarity and intellectual order» (Mies, 2008).

Therefore, Schools[12] should have as a priority the task of giving values, objectives and meaning to the designer, that will be called to play a role in a society expression of a multiethnic culture, in constant transformation and hosting phenomena so complex that they become increasingly uncontrollable.

In 1938 Mies in his inaugural speech, at the opening of courses at the Chicago Armour Institute, stated of teaching that:

> «the first aim should be to equip the student with the knowledge and ability to deal with practical life. The second aim should be to develop the student's personality and thus enable him to make appropriate use of that knowledge and ability. Therefore, teaching has to do not only with practical purposes but also with values. Practical aims are closely linked to the peculiar structure of our time. Our values, on the other hand, have their roots in the spiritual nature of man. Practical ends are only a measure of our material progress. The values in which we believe reveal the level of our culture».

A relational approach with other knowledge, allows the culture of project to observe different contexts and cultures to draw methods, tools and interpretative models to integrate, within the processes of innovative solutions, with technical-economic, productive, ergonomic-cognitive, relational constraints.

Schools' orientation should aim at training *creators of architectural phenomenon*, which takes shape through the harmonious fusion of techniques, an unreachable result if the architect does not know the tools, limits and possibilities of each branch of technology and is not able to coordinate and guide the work of specialists, each of whom must exceed in fertility of intuition and clarity of concepts (Nervi, 2008)[13].

The architect is not, in fact, a specialist. The vastness and variety of knowledge that project practice includes, the rapid evolution and progressive complexity, in no way allow sufficient knowledge and control. "Connecting, designing" is the domain, since architect works with specialists. The ability to link, use bridges between knowledge, create beyond their respective borders, beyond the precariousness of inventions, requires specific learning and stimulating conditions (Siza, 2008), developed within the *Atelier de la recherche patiente*, which imposes a continuous activity of "observational-discovery-inventional-creation" of the project.

---

12 About education, it is interesting to re-read the many reflections on teaching architecture published in *Casabella* in 2008 and the most recent on technological design by Schiaffonati, 2011 and in Bellini, 2018.

13 Interesting is Mies' telegram to Pevsner «Visualization of space must be supported by structural knowledge. Design without structural knowledge will result in dilettantism. For this reason we make construction a prerequisite to architectural planning» (*The Architectural Review*, 642, 1950) in "The Training of Architects: Interim Survey".

> «If I had to teach you architecture? Rather an awkward question...
> Architecture is space, width, depth, height, volume and circulation. Architecture is a conception of the mind. You have to conceive it in your head with your eyes closed. Only in this way can you see your project. Paper is only the tool for putting the idea in order and transmitting it to the client or the builder. […] I would insist that nobility, purity, intellectual understanding, plastic beauty and the eternal quality of proportions represent the joys that architecture can offer and that everyone could understand. I would strive to inculcate in my students an acute need for control, for impartiality in judging, for knowing "how" and "why"... and I would encourage them to cultivate these attitudes until their last day. However, I would like them to be based on a series of objective facts. But facts are fluid and changeable, especially in our day; therefore, I would teach them to distrust the formulas and I would like to convince them that everything is relative» (Le Corbusier, 1938).

In an interesting "public reflection", Gregotti argues that:

> «for those who want to become architects the essential field of research must be the project, whose form is the place of synthesis between theory and practice [...], which must give a historically and methodologically detailed answer, capable of a comparison with other cultures and able to acquire specificity of their discipline their useful and necessary wealth» (Gregotti, 2014).

The project is, therefore, an intuition of a possible future and a construction of reasonable images - and possible in the present - to which strategies and consequent actions on physical space can be referred, making them communicable and questionable. The design action, therefore, represents not only possible forms of places modification, but also the highlighting of the fields of possibilities, inasmuch as it explores the context of action and creates action conditions.

The project, characterised by the theoretical audacity of innovation, is a place of research and experimentation, between projective action and feedback; a multidimensional and synergistic environment between different technical knowledge; an information system coded to provide instructions for implementation; a generator of space and its functions, social and environmental values, as a response to a need. The design is the most solid link between man and reality and history, and the ability to design, like the ability to do, both belong to the operational universe of man (Maldonado, 1970). The project, as an act of throwing something forward, «presupposes the existence of something from which the action springs. It is [...] something that has had a historical journey, that has a past, and not a monad suspended in a transhistoric space»; it is a multidimensional and synergistic place between different technical knowledge, a generator of space and its functions, of social and environmental values; it is always «at the same time, to perspective and retrospect [...]; it is to advance hypotheses, to conjecture optimal solutions»[14] in which the experimental approach is holds together science, art, technology (Munari, 1970).

---

[14] Maldonado, T. (2001), "Progettare oggi", in *Le risorse del progetto. L'esperienza di Pierluigi Spadolini professore architetto*, TAeD, Firenze, p. 26.

> «All this bearing in mind that the technical and scientific development is, for the objectives of architecture, a means and not an end [...] and that creativity is the result of the complex and profound need to give future answers based on the ground of history, a creativity based on the conviction that to be fathers it is necessary to become aware of being children, with all their diversity and their historical environments» (Gregotti, 2014).

The project has a dimension of uniqueness, as its result, and of temporariness, with a historically determined validity; it is not a mere creative act, it is not a unitary act, it is not a segment that can be isolated in terms of decision making and content from the entire building; it is not detached from the generating context; it is based on the practice of contamination, mutation and hybridisation, but also syntactic disarticulation, disassembly and reassembly, with the aim of doing less with less, through imagination, the ability that man has to combine his knowledge with the sensitivity to things, the environment, the human context. The different disciplinary contributions converge on the non-neutrality of the design exercise, i.e. the action of foreshadowing is not determined only by technical issues, but also by economic, cultural and social factors, understood in their broadest sense. Maldonado points out that:

> «designing the form means coordinating, integrating and articulating all those factors that, in one way or another, participate in the constitutive process of the product form. [...] It alludes as much to the factors relative to the use, fruition and individual or social consumption of the product (functional, symbolic or cultural factors) as to those relative to its production (technical-economic, technical-constructive, technical-systemic, technical-productive and technical-distributive factors)» (Maldonado, 1977).

The technological culture of design outlines the system

> «of knowledge concerning the analysis and prediction of the impact that technology, seen as a global expression of a spiritual and material culture, has today and will have tomorrow on the life of man (individual and society) in relation to the physical and biological environment in which he is placed» (Ciribini, 1984).

The complex nature of making alludes, to the designer's ability, at whatever level he works, to acquire technical knowledge and competence as "responsibility, first and foremost, for precise interpretations and descriptions, capable of giving rise to relevant hypothese"[15] also from an ethical point of view. «No theory and no craft, but then how is the artistic practice of architecture built?».

The centrality of the project responds to the cultural role (Giannelli, 1979) assigned to it by a community, determining its nature as a "place" for comparison and participation of the subjects who set the objective of quality [of transformation], as a place of "concertation" of the options aimed at the efficiency and effectiveness of action.

---

15 Bianchetti, C. (2013). "Un diverso campo concettuale", in Bianchetti, C., Balducci, A., *Competenza e rappresentanza*, Donzelli, Roma, p. 6.

From this point of view, the project goes beyond the meaning of “vehicle” of technical information, creating a specific way of interrogating, describing, conceptualising, prefiguring and reorganising reality: the description of the physical space is not a simple observation, but has an intentional and selective character, since it contains more or less explicitly hypotheses of transformation. The natural propensity of the designer, aimed at integrating the technical-productive moment with the design one on the level of aesthetic experimentation, moves on the different and interrelated levels of perception, which re-evaluates the relationship of the senses in the experience of things; of meanings, since it grasps the importance of the cultural and conceptual dimension of the relationship with technology; of the language with which it foreshadows new scenarios. The appropriate approach, therefore, does not propose univocal solutions, it compares alternatives and intervention options; it proposes the interpretation of the design activity, not only as the deterministic foreshadowing of a future state, but as a process, a dynamic and adaptive system, in which the solution is never the only one possible, but at most the best possible at that moment and in that context, within a relationship of interaction between disciplines. Now, if multidisciplinarity can be guaranteed by a team of specialists and interdisciplinarity by a dialogue between specialists, meta-disciplinarity arises from a glance originated by a broad view of the world: of its premises, its ways of being, its ends**.**

> «And now, my friend, please keep your eyes open. Are your eyes open? Have you been educated to keep your eyes open? Do you know how to keep your eyes open? Do you keep your eyes open continuously and usefully? What do you look at when you go for a walk?» (Le Corbusier, 1938).

References

Bellini, O.E., Ciaramella, A. et alii (2018), *La Progettazione tecnologica e gli scenari della ricerca*, Maggioli, Santarcangelo di Romagna.

Ciribini, G. (1984), *Tecnologia e progetto*, Celid, Torino.

De Bono, E. (1992), *Serious Creativity. Using the Power of Lateral Thinking to Create New Ideas*, McQuaig, Iowa.

De Bono, E. (2001), *Creatività e pensiero laterale: manuale di pratica della fantasia*, Rizzoli.

Garroni, E. (2010), *Creatività*, Quodlibet, Macerata.

Giannelli, E. (1979), *La dimensione interdisciplinare del progetto di architettura*, Medicea, Firenze.

Gregotti, V. (2014), “Non c’è architettura senza filosofia”, *Corriere della Sera*, 24 March, 33.

Le Corbusier (1938), “If I had to teach architecture? Rather an awkward question...”, *Focus*, 1 [LC (2008), *Casabella*, 766, 6-7].

Legrenzi, P. (2005), *Creatività e innovazione*, Il Mulino, Bologna.

Lingiardi, V., Vassallo, N. (2011), *Terza Cultura. Idee per un futuro sostenibile*, Il Saggiatore, Milano.

Maldonado, T. (1970), *La speranza progettuale*, Einaudi, Torino.

Maldonado, T. (1977), sub. v. “Disegno Industriale”, *Enciclopedia del Novecento*, Treccani, Roma.

Manzini, E., Susani, M. (1995), *The solid side: il lato solido di un mondo che cambia*, V+K, Naarden.

Mies van der Rohe, L. (2008), “Sull’insegnamento dell’architettura”, *Casabella*, 767, 3-5.

Morin, E. (1989), *La conoscenza della conoscenza,* Feltrinelli, Milano

Munari, B. (1977), *Fantasia*, Laterza, Bari.

Nervi, P.L. (2008), “L’insegnamento dell’architettura”, *Casabella*, 768, 3.
Oechslin, W. (2013), “Manus et intellectus”, *Domus*, 972, 12-15.
Papanek, V. (1973), *Progettare per il mondo reale*, Mondadori, Milano.
Piano, R. (2010). *La responsabilità dell’architetto*, Passigli, Firenze.
Rubini, V. (1980), *La creatività*, Giunti, Firenze.
Schiaffonati, F. (2011), “La finalità della progettazione nella formazione dell’architetto e dell’ingegnere”, *Techne*, n. 2, Firenze University Press, Firenze, pp. 52-59.
Siza, A. (2008), “Sulla pedagogia”, *Casabella*, 770, pp. 3-5.
Sterling, B. (2008), *La forma del futuro*, Apogeo, Milano.

3.14 THE TECHNOLOGICAL DESIGN AS COGNITIVE PROCESS. THEORIES, MODELS, INVENTIONS

Marilisa Cellurale, Carola Clemente**

Abstract

This contribution reflects the contemporary terms of the dialectic between the design culture and augmented technical tools. The environmental unit is specified as a model of informed interactions: the organization of the professional and research activities undergo a considerable reflection on the cognitive and operative process, and on the reordering of the skills needed to govern this transformation. We wonder what abilities will have to be acquired or reinforced by the discipline of technological design, in order to support the role of interpreter of physical space. The issue is part of the broader definition of design as synthetic and intentional action of architecture, in and of itself an exercise of prediction and prefiguration, a metaphorical act of producing the built environment.

Keywords: Building Information Modelling, Behavioural Modelling, Environmental Unit, Simulation, Prefiguration

The context

Reconstructing the context means calling upon the short history of how the technological discipline of the design has served and guided production, of how it has influenced and undergone the exactness of consolidated disciplines; it still shows the elasticity and indeterminacy of an intuition. The intent is to systematize a reflection on the multiplicity of resources and intangible factors coming to the fore in research and in professional practice, and which the disciplines of Architecture, in particular the Technology of Architecture, are called upon to grapple with.

This is the open field connected to description and simulation of physical phenomena, to production and reproduction of models close to reality. These are such descriptors as data, information of a «system considered in its behav-

* Marilisa Cellurale is Ph.D at the Department of Planning, Design, and Technology of Architecture, Sapienza University of Rome, Italy, marilisa.cellurale@uniroma1.it

* Carola Clemente is an Associate Professor at the Department of Architecture and Design, Sapienza University of Rome, Italy, carola.clemente@uniroma1.it

iour»[1] (Ciribini, 1984), within its domain, meant in the mathematical sense, and as a field related to interactions. Backwards, information encodes a system's capacity of behaviour, and the correlation of data provides a reading of it that is anything but neutral. In the domain of the built environment, human behaviour is easily recognized as the exceptional complexity of the variables to be modelled and predicted. The (limited) action of occupants on the body of buildings and on the systems (exerting far more considerable control over plant), defines their energy and weakens the predictive effectiveness of the albeit accurate virtual models of the built object. The decisive intervention of the engineering disciplines has in the first place made a fundamental contribution in assessing the issue, whose scientific outcomes are widespread. In the second place, the vast number of research efforts has executed the experimental aspects connected to the issue and contributed towards recognizing the augmented working tools and the gathering and data mining techniques, and towards the algorithmic coding of behaviours and of recorded interactions[2]. It is the task of the Technology of Architecture to decouple this line of research from a mechanistic vision and to bring the issue of the relationship operating between people and environment back to its natural course: the ecological dimension of the design.

The research

It is a characteristic typical of the Technology of Architecture to approach the project as a prefigurative activity; a debatable condition in which it can exercise, with no discomfort whatsoever, cultural foundations and the *new ancient roots* connected to experimentation and production (Nardi, 1986). And yet, in current practice, it appears necessary to exclude doubt from destiny of settlement systems. The energy aspects of construction in all its articulations of scale (Rossetti, 2012), down to the atomic extremes, are well known; through considerable applicative effort, techniques for modelling and simulating the behaviour of the building/plant system have been acquired, and intervention scenarios have been monetized and bought for the purpose of guiding operators in caring for the heritage[3]. Lastly, a regulatory literature has been dutifully formulated, that legitimizes, as the only possible alternative, the environmental, social and economic sustainability of the outcomes of the construction process.

---

1 Ciribini, G. (1984). pp. 78-79. The reference is to cybernetics, defined as a "theory of mechanisms," but is considered here as applicable to every system for the processing of data not ascribable to a random dynamic, as a physical interpretation of built man/environment system.

2 The reference is made to the research programme of the International Energy Agency -IEA (2014) Annex 66: *Definition and simulation of occupant behavior in buildings*, available at www.annex66.org. (accessed 30 April 2020).

3 Reference is to be made to the EPBD Directive, the "*Directive 2010/31/Eu of the European Parliament and of The Council of 19 May 2010 on the Energy performance of buildings*".

The environment « is an open system; it houses us and our activities. It is the site of changeable relationships» (Di Battista, 2006) but the terms of this definition appear opaque; at most they are registered as average and reproducing no vital circumstance, of use for a post occupation assessment. Technological knowledge has consolidated on the physics of those changeable relationships even more than on the physics of the built object, and its glossary shows the current nature of a very strong[4], robust, agile, and sensitive designing thought. On these first references we may organize the terms of a search in progress, conducted in a broader field of revising the bedrock paradigms of the design prefiguration of spaces serving people, in which the need for space/user interaction is stronger. All the experimentations being done on the smart requalification of buildings for the tertiary sector belong to this line of research; in them, the thrust of improvement and of technological, energy, and ecosystem efficiency is resulting in the trialling of increasingly advanced forms of user-oriented environmental control, and the experience of Ambient Assisted Living (AAL) applied to new forms of smart or simply informed living: living that is interconnected and assisted for fragile users.

Three themes

The research cuts across three themes which, ordered in this way, lend themselves to two types of reading: the first, from the material condition of architecture to the intangible processes of cognition of physical space; and a second one, from the domain of knowledge referring to a specific performance system, to the composition of a knowledge and of an environmental intelligence that relates man and artifice.

Learning spaces

Architectures for education represent a particularly interesting case on which to carry out the range of reasoning and of technical applications that have just been introduced. The exceptionality resides in the coexistence of low technological complexity and of intense relational activity between the educated, the educator, and the educating body of architecture, and in the humanistic effort that the designer is called upon to carry out in order to qualify or to requalify the learning spaces.

The first theme – remodelling and qualifying the complex of school buildings – implies a design exercise not only and not so much aimed at restoring the conditions of safety and of collective decency, which is also a need present

[4] A vision that redeems the Technology of Architecture from the “weakness” of its statute, referred to a number of times even in recent debates (Raiteri, 2017), and revisits the *matter-force* and *thought-weakness* pairs in Ciribini, *op. cit.*

where institutions have acted almost exclusively in response to emergencies, but also at relating the innovation of the didactic model to the requalification of the building system's technological and spatial performance.

The question today is to comprehend whether existing buildings are able to support the transformation of the didactic liturgy, the technological metabolism, the general rearrangement of the city that leaves behind, for good, a season of static and compartmented building/function correspondence. The urban economy is held to the same effort as the man-made community: minimizing consumption, and maximizing adaptive ability, times, and procedures for use that are discrete and linked to specific skills.

Indoor environmental quality

One may think of an environmental physiology assessing inhabited space as living matter, of which human matter is one case in point. In the complex of occurrences taking place in buildings, we see the vital and transformative nucleus of construction: in this sense, the current methods of assessing the quality of interior environments – effective but limited to verifying a determined spatial configuration or a performance profile identified in advance – do not appear comprehensive. The measurement of the concentration of pollutants overlaps with assessments of well being in terms of noise, light, and heat/humidity, and of how use conforms to ergonomic parameters: a selective characterization, effective exclusively in the perspective of verifying adherence to a defined performance profile. Other studies (Wei et al., 2015) stress how the certification protocols of buildings attribute slight weight – about 7.5% - to interior air quality indicators. These two considerations, and the density of scientific productions in recent years, appear sufficient to support the central importance of this second theme, which is to say how, in quantum models, rather than of elements, space is composed of relationships in which the observer is immersed. Therefore, the parameters that regard occupants acting upon and, in the construction, in search of a balance with the perceived environment, describe not only the devices' energy use, but above all environment in its transitory reality.

Cognitive sciences in the architectural design

Through cognitive processes, «an organism acquires information on the environment, and processes it at the level of knowledge as a function of its own behaviour»[5]. The cognitive sciences, after having diversified, multiplying the responses on the mechanisms of the human mind, are overcome and converge on the theme of the awareness of environmental phenomena. The discovery of the function of mirror neurons (Gallese, Goldman, 1998) has imposed a radical reconsideration of cognitive processes, balanced upon a neurophysiological ba-

5 "Processi cognitivi" in *Enciclopedia Treccani*, available at: http://www.treccani.it/enciclopedia/processi-cognitivi/ (accessed 30 April 2020).

sis. Relational intelligence, *empathy* (Mallgrave, 2013), is returned to the body, and the relationship itself is embodied as an architecture of the behaviours involving the nervous system, the body, and the environment, mutually.

Three techniques

This section refers to recent modelling and assessment techniques as elements of an instrumental framework that is still bounded, but of which potential intersections, decisive for governing complex phenomena, are identified.

Building Information Modeling

The International Organization for Standardization (ISO) defines the Building Construction Information Model methodology as the «shared digital representation of physical and functional characteristics of any built object […] which forms a reliable basis for decisions»[6]; therefore «the BIM may be defined as a modelling methodology and a series of processes that are associated for the purpose of producing, communicating, and analysing the *models of buildings*» (Eastman, 2016). In the BIM environment, the product is defined as a datum of complete, material, and productive reality, and not as its synthetic representation. A building's technical and functional information is organized in a given moment of the life cycle. In the case of the modelling of existing buildings, the distance between the architectural body and the model originates from the simplifications taken on to bridge the system's fragmentations and gaps in knowledge; a systematic quantitative increase of diagnostic activity would be decisive for the model's effectiveness.

Behavioral Modeling

More complex is the resolution of the uncertainties due to a second class of reductions, which regards instructing the instruments with regard to environmental phenomena. Mention has already been made of the centre of interest of this research: the interactions between body of the occupants and body of the architecture. It is a matter of constructing an interpretative scientific position, capable of critically characterizing the models deduced from the records in terms of the occupants' position in space, and of action upon the plant control systems. In the current state, research has achieved the considerable result of outlining humanized functions of behaviour to be implemented in the dynamic simulation software[7]. However, in the definitions reached thus far, the non-

[6] Art. 2.2 Standard, ISO 29481-1: 2010 (E), *Building Information Modelling -Information Delivery Manual - Part 1: Methodology and Format* (2010), revised by ISO 29481-1:2016.

[7] Consider the work of the Lawrence Berkeley National Laboratory, where an occupation simulator, calibrated to the spaces intended for offices, was developed. The simulator may be freely consulted at http://occupancysimulator.lbl.gov/.

observable links between motivation and action, to be recognized as having the predictive force of simulation, are still ambiguous.

Cost-Optimal Evaluation

The Cost-Optimal methodology, defined by regulation EN 15459:2007[8], is explicitly referred to in the EPBD Directive as an instrument to evaluate the energy performance achieved by a construction intervention; a case of the Cost-Effectiveness evaluation, it differs for the not strictly numerical qualitative assessment of the «optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building»[9]. The comparability and the degree of usability of the information represent the condition of the very sustainability of the regulatory mechanism and of the instrument's effectiveness. In other words, the more shared the interpretative passages of the evaluation methodology are, and the more the methodology is applied at a statistically relevant scale, then the more the definition of *optimal* loses its discretionary and subjective outlines. The report drawn up by Ecofys[10] in 2015 highlights the need to work on a more shared framework for interpreting the Directive. In this setting, the suggestion of a mathematical formulation of the Cost that may be ascribed to an intervention scenario introducing the benefit and the gain implicit in the financial statements appears sustainable; the results of the assessments would be considerably different (Becchio, 2015).

Activity Behaviour Space

The relational fabric that gives substance to doing architecture was already in the writings of G. Ciribini, and of P. Spadolini. A brief yet meaningful coding of this is found in the glossary of UNI 10838:1999, which defines the environmental unit as a «Grouping of activities of the user, derived from a given intended use of the building organism, spatially and temporally compatible with one another». What has been expressed thus far demonstrates the need to redefine the *attributes* of the plan, in the meaning expressed by the UNI standard[11].

---

8 BS EN 15459:2007 *Energy performance of buildings. Economic evaluation procedure for energy systems in buildings*.

9 Cf. Introduction of Directive 2010/31/EU.

10 Ecofys (2015). *Assessment of cost optimal calculations in the context of the EPBD (ENER/C3/2013-414). Final report.* Available at: https://ec.europa.eu/energy/sites/ener/files/documents/Assessment%20of%20cost%20optimal%20calculations%20in%20the%20context%20of%20the%20EPBD_Final.pdf.

11 Cf. Norma UNI 10838:1999. *Edilizia - Terminologia riferita all'utenza, alle prestazioni, al processo edilizio e alla qualità edilizia*, point 2.3 «Attribute: Trait that is non measurable, or preferably unmeasured, of a requirement upon which a judgment has been expressed solely in qualitative terms of belonging to a category or to a number of alternative categories».

Starting from the EPBD Directive, which appeals to the formulation of a comparable framework through the benchmarking of *Reference Buildings*, the intent here is to introduce a new conceptual and experimental subject: the *Reference Environmental Unit*. Here we shall go no further than to define it as a model informed by the physical and physiological characteristics of the environment, understood as a field of human artefact interactions, capable, through dynamic simulations, of yielding transition scenarios.

Therefore, on the one hand, the input that takes account of the occupants' actions specifies the traditional output data regarding the actual total energy use of the building plant system. On the other, the authors are experimenting with the possibility of implementing information regarding the users' actual physical and spatial behaviour. The physical space of the Environmental Unit is innervated by such technical supports as occupancy sensors, and the recording of temperature and of air and action quality[12].

What seems to be a technical virtuosity opens an interesting design scenario, that must necessarily include the theoretical and operating consequence of the Technology of Architecture.

Design as a cognitive synthesis – Conclusions

The simulation of a space activated by the relationships among the users that animate it yields a complex prefiguration of a future state. The modelling of this active and intentional state is an activity of judgment: the cultural attributes of the architectural disciplines find a place of experimentation in selection and synthesis,

> «the modelling shifts from the architectural object towards the pre-optimization of use and behavioural modelling stimulated and fostered by suitable design solutions interrelated with them» (Del Nord, 2016).

What to select of the environment, and how to inform the technical instrument, reflects a scientific-disciplinary attitude increasingly interconnected in technological design research and oriented towards forecasting the sustainability and effectiveness of the building which can no longer be separated from the response in terms of utility and efficiency of the delivered service.

The informed recomposition of the physical space of architecture and of the relationships characterizing it makes it possible to *stress* the building's physical model upon behavioural patterns innovative with respect to the stimuli's modification over time. It thus makes it possible to obtain an activated prefiguration and a cognitive synthesis of design, also in the case of intervention on the built object: not the building system as a container of utility, but the effectiveness/efficiency of the service offered to the user in terms of economic and so-

[12] Devices of this kind have been installed in a middle school, and the recording and monitoring of the corresponding parameters is in progress.

cial long term oriented sustainability, and flexibility of plan and of use, capable of optimizing the building resource and the smart building/urban setting relationships. The technological design therefore takes on the more robust meaning of an instrument governing the uncertainty of the design variables (Campioli, 2017), in the fullness of the discipline's bedrock statutes.

References

Becchio, C., Corgnati, S. P., Orlietti, L., Spigliantini, G. (2015), "Proposal for a modified cost-optimal approach by introducing benefits evaluation", *Energy Procedia*, 82, pp. 445-451.

Campioli, A. (2017), "Il carattere della cultura tecnologica e la responsabilità del progetto". *Techne*, n. 13, Firenze University Press, Firenze, pp. 27-32.

Ciribini, G. (1984), *Tecnologia e progetto.* Celid, Torino.

Del Nord, R. (2016), "Potenzialità dell'area tecnologica in tema di «ricerca progettuale»", in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto.* Franco Angeli, Milano, pp. 121-126.

Di Battista, V. (2006), *Ambiente costruito: un secondo paradigma*. Alinea Editrice, Firenze.

Eastman, C. (2016), *Il BIM: Guida completa al Building Information Modeling per committenti, architetti, ingegneri, gestori immobiliari e imprese*. Hoepli, Milano.

Forlani, M.C., Raiteri, R. (2017), "Crisi e continuità disciplinare tra ricerca e formazione: un dialogo", in Perriccioli, M. (ed), *Pensiero tecnico e cultura del progetto*, Franco Angeli, Milano, pp. 79-87.

Gallese, V., Goldman, A. (1998), Mirror neurons and the simulation theory of mind-reading. *Trends in cognitive sciences*, 2(12), pp. 493-501.

Mallgrave, H. F. (2013), *Architecture and embodiment: the implications of the new sciences and humanities for design*. Routledge, London.

Nardi, G. (1986), *Le nuove radici antiche.* Franco Angeli, Milano.

Rossetti, M. (2012), "Declinazioni di spessore in tecnologia" in Marini, S., De Matteis, F. (eds) *Nello spessore*. Nuova Cultura, Roma, pp. 187-197.

Wei, W., Ramalho, O., Mandin, C. (2015), "Indoor air quality requirements in green building certifications", *Building and Environment*, 92, pp. 10-19.

3.15 NEW COGNITIVE MODELS IN THE PRE-DESIGN PHASE OF COMPLEX ENVELOPE SYSTEMS

Paola Gallo, Rosa Romano**

Abstract

The paper is focused on the description of innovative research that are aimed to define new cognitive, experiential and design-based models connected with new forms of collective intelligence and capable of responding to the main challenges of the future. In particular, it will analyse the issue of the envelope systems production, in order to define innovative models capable of responding to continuously changing scenarios in the frame of environmental sustainability and energy efficiency of the built environment, through the ability to use simulation tools capable of predicting, anticipating and optimising the results of the design phase.

Keywords: Energy simulations, Design thinking, Sensitive Analysis, Envelope systems, Environmental sustainability

Introduction

The identity features linked to the innovation of forms of knowledge and the cognitive theoretical foundations of design require new vision capacities that is an effort to build the future.

It will be necessary to work not only to find answers to concrete problems, but above all, to define and expand the problem itself. A vision for everything now deserves commitment: one that tells of a future in which the environmental issue, in its broadest sense, is central.

In the next years we will be called on to create a deep crisis in a research tradition entirely located within a culture based on concepts of growth and development and to guide technology towards generating effective solutions that are capable of resolving problems. These innovative building technologies should be energy efficient, and environmentally compatible as early as the preliminary phase of the project (Campioli, 2016).

---

* Paola Gallo is an Associate Professor at the Department of Architecture, Florence University, Italy, paola.gallo@unifi.it.

* Rosa Romano is a Research Fellow at the Department of Architecture, Florence University, Italy, rosa.romano@unifi.it.

In this scenario, the future research challenges and themes in the technology area must necessarily refer to the pillars identified from Horizon 2020, linked to the topics proposed by the European Construction Technology Platform and the International Council for Building (CIB). The challenges must be related to neuralgic and transdisciplinary aspects (concerning quality, creativity, sustainability, competitiveness) and connected to the priority issues of operational research in the architectural technology area (such as housing, innovation, the environment, development).

With respect to the critical nature of the current situation, challenges that focus on the proliferation of information technologies and the now appropriate applications of sustainable practices pop up. The process of renewing the construction sector implies the adoption of strategies to transition from the construction industry to the built environment industry, based on digital economies and extended to the urban and infrastructural scale. The design of construction products processes, favoured by information processing systems with advanced efficiency, becomes the real goal to strive for, to achieve real future proofing sustainability results. As a consequence, the modelling shifts from the architectural object towards preoptimisation of behaviour and use models, stimulated and encouraged by suitable interrelated design solutions. (Del Nord, 2016).

In this period, we are witnessing the advent and affirmation of new production models connoted by Industry 4.0.

Within the scope of these futuristic scenarios, the possibility of connecting to the Internet all the objects that populate the environment we live in, the availability of production systems and technologies with a high level of automation, and the spread of digitisation within design and production processes, will bring about unprecedented development opportunities for the manufacturing industry (Campioli, 2017).

New parametric design and environmental simulation tools

The energy efficient buildings simulations, like that of complex envelopes, increasingly requires the use of parametric analysis tools. These are configured as virtual workspaces, where interactions between interdisciplinary knowledge occur with the aim of assessing, from the metadesign phase, the performances of the object, be it a material, a complex technological system, a building or even an urban context of broad dimensions.

All this why today, the science of sustainability opens up new technological areas in design and requires us to look beyond and not simply at the useful life of products, their direct users and the local context. Therefore, digital technologies lead us to rethink the design process in terms of the creative aspects, the management of information and knowledge, production and implementation (Astbury, 2016).

The ongoing digitisation of the design process actually makes it ever easier to analyse the performances of a building right from the preliminary phase of the design and increasingly often in the presence of specific expertise; this analytical ability is even more interesting when it involves technological solutions from the environment compartment. In this sense the simulation tools allow us to simultaneously assess the geometric-formal characteristics of the architectural work and the energy-environmental performances, together with issues linked to its cost and the building management, from the implementation phase to the use phase. This analysis and assessment process is even more appropriate if transferred to the scale of defining adaptive envelope systems linked to industrial innovation.

In fact, in the last decade, in the building design area, Building Information Modeling (BIM) tools have inexorably changed the procedures for defining operating models of architectural practice. These are indeed new methodological approaches to creative space, and not just simple operating tools comparable to the vector-based ones used in the past.

The term BIM in fact identifies an integrated process involving different applications capable of interacting with each other and sharing the same informative logic and structure (Ridolfi, 2018).

The need to adapt the operating structure of these complex tools to the operating situation of the construction sector, and above all to the design phase and therefore the validation and analysis of building systems and the technological solutions, has led in the last decade to the development of new BIM functionalities. These can be identified as the Performative BIM, concerning the exploratory and simulation activities typical of the idea-based phases traditionally ascribed to the figure of the architect (Marsh, 2016).

The performative model is no longer a mere geometric entity but it represents a complex system made up of families, types and elements that allow us to spread the updating of various attributes to all components of the design in a dynamic and interactive way and to modify an entire building by changing even just one of the parameters that define it (Attia, Gratiaa, De Herdea, Hensenb, 2012). This gives rise to Building Performance Simulation (BPS) and Building Performance Optimisation (BPO) tools within the context of research pertaining to Performance Based Design (PBD).

Alongside the rapid evolution of indicators and legislation on the buildings energy efficiency new computer models for evaluating the design were developed: the Building Energy Modelling/Models (BEM), which were quickly disseminated in the construction sector and evolved rapidly within a decade. They have the capacity to assess the behaviours of the built environment from the static to the dynamic situation.

These tools are capable of developing models in which descriptive data related to geometric aspects is associated with data characterising the thermophysical aspect of the technological solutions adopted.

With the introduction of BIMs, the BEMs transform into interoperable tools often integrated into the interfaces of more complex modelling products. These are plugins and addons dedicated to specific aspects of the energy and environmental simulation, demonstrating that no software is capable of resolving all aspects of the energy simulation (Ridolfi, 2018).

The complexity of BIMs and BEMs means there is a need to develop specialist knowledge, above all when BPS and BPO tools are used, as the indicators concerning the energy performance of the technological system or the indoor and outdoor comfort parameters of the building are numerous and often require detailed assessments. The calculation and simulated display of the heat and humidity characteristics of the construction elements, the forecasting and simulation of the environmental parameters (such as ventilation, sunshine, shade, the diffusion of natural light in rooms), new material production techniques, 3D printing, as far as robotic architecture, are changing the forms that we design (and can built) (Neuckermans, 2017).

Energy simulation in the concept design phase of complex envelope

The preliminary phase of designing the environmental component of complex envelope systems is characterised by the need to assess different alternatives capable of satisfying the client's requirements in terms of ensuring maximum energy efficiency and, at the same time, guaranteeing the economic sustainability of the project. Therefore, this degree of creative approximation requires the designer to quickly and accurately assess the performance scenarios with respect to which the project will be developed, also and above all within the scope of the definition of detailed technological solutions that guarantee achievement of the nearly Zero Energy Building (nZEB) standards.

The new operating paradigm, necessarily linked to the designer's forecasting capacity as early as the concept design phase of envelope systems, suggests a high degree of interdisciplinary knowledge aimed at the use of assessment tools. These tools are able to work in a dynamic regime that can help to define the project performance requirements necessary to achieve the energy efficiency objective and reduce environmental impact connected to its meaning of sustainability. In this sense the use of BPS is essential even in this first phase aimed in particular at analysing the energy flows passing through the architectural envelope (e.g.: solar radiation, thermal resistance capacity of the materials, air flows, etc.) (Charron et al., 2006; Hayter et al., 2001). The designer can use this software to analyse morphological and material choices in scientific detail, directing the design of the envelope's technological system towards its creation through prefabrication in highly innovative production environments, also characterised by the use of advanced tools connoted by the production processes typical of the fourth industrial revolution, the socalled Industry 4.0.

Thanks to datadriven strategies and the possibility of interconnecting design and production in a single work flow, customisation of the form can, in fact, be linked to a responsive interpretation with respect to local characteristics and regional variations (Figliola, 2017). Therefore, within the scope to design adaptive envelope systems, it is essential to develop a performance analysis by constructing a virtual model that allows us to assess its behaviour in relation to the materials (traditional or innovative) and the integrated technological subsystems (active and passive actuators, systems for the accumulation and production of energy, etc.) up to the need to optimize the performances based on the external climatic conditions and indoor comfort. For these reasons, the virtual model is tested in terms of contribution (positive or negative) to the energy requirements (for heating; cooling, electricity, etc.) of the built environment, also and above all in relation to the climate area in which it will be used. This evaluation phase, conducted with increasingly sophisticated BPS and BPO tools and imagining the system integrated with elements that, in terms of characteristics and form, are similar to the "test cells" used in the prototying phase, allows us to optimise the geometric, material and formal choices for the façade system. Software such as Grasshopper[1] for instance, even in this phase allows us to cross the energy-environmental analyses with the geometric-formal, as well as economic and performance-based ones. In this way all players in the process are able to assess, from the preliminary phase, the project variables that can be implemented at technological detail scale with the aim of optimizing the performances in a broad sense. Finally, it is important to remember that the simulation phase must always be accompanied by a testing phase carried out in a real environment which enables (through monitoring campaigns conducted at set time intervals and protocol applications and test procedures recognized internationally) the assessment of specific thermophysical parameters such as thermal transmittance and thermal capacity of the materials used. The thermophysical characterisation of a system by means of a "test cell" and the dynamic analysis of the output data obtained from monitoring the energy simulations under a dynamic regime allow us to obtain accurate and realistic models representative of the physical system investigated, providing a significant contribution to overcoming the limits met in the case of a simplified analysis. They also allow us to develop empirical models that can be applied to the monitoring data obtained from test campaigns on entire buildings and under conditions of use, in order to quantify the energy savings that can be achieved through the application of the devised technological component.

---

1 This is a modelling investigation and theoretical experimentation tool, that can organise projects into parametric systems, based on the logic of the relationships between the parties, offering the possibility of altering the overall configuration of the system by acting on the variables set as the basis of the design process (Tedeschi, 2010). Developed in 2007 by David Rutten and Robert McNeel & Associates, Grasshopper, was largely disseminated as a plug in to Rhino software in the context of virtual modelling linked to the architecture and design sectors.

Conclusions

It is clear how even the sector of the design of complex envelope systems is required to evolve from collective intelligence into connective intelligence made up of physical and virtual networks in which researchers and/or designers become the bearers of knowledge linked to operational and decision-making processes, involving horizontal skills (Raiteri, 2014).

The analysis of this type of adaptive technological solutions requires the use of multiple BPS tools that often produce interoperable outputs in the context of BIM environments. Therefore, it is essential that designers learn to define simulation strategies from the perspective of the design objectives more than the use of single analysis tools (Loonen et al., 2016).

The fates of Technological and Environmental Design and those of the so-called anticipation disciplines seem to cross, not only because convergent regarding some theoretic positions on postmodernity, but also because they are solicited by the needs of the real world and by some important looming reforms (Fanzini et al., 2017).

References

Astbury, J. (2016), "Digital creativity. How does technology affect the creative process?", *The Architectural Review*, available at: http://guides.architectural revew.com/Guide.aspx? storyCode=2229 (accessed 14 September 2017).

Attia, S., Gratiaa, E., De Herdea, A., Hensenb, J.L.M. (2012), "Simulation-based decision support tool for early stages of zero-energy building design", *Energy and Buildings*, n. 49, pp. 2-15.

Campioli, A. (2016), "Tecnologia dell'architettura: un aggiornamento identitario", in Perriccioli, M. (ed), *Pensiero Tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano.

Campioli, A. (2017), "Il carattere della cultura tecnologica e la responsabilità del progetto", *Techne* n. 13, Firenze University Press, Firenze, pp. 27-32.

Charron, R., Athienitis, A., Beausoleil-Morrison, I. (2006), "A Tools for the design of zero energy solar homes", *ASHRAE*, in: *Annual meeting*, vol. 112(2), Chicago, pp. 285–295.

Del Nord, R. (2016), "Potenzialità dell'area tecnologica in tema di "ricerca progettuale", in Perriccioli, M. (ed), *Pensiero Tecnico e cultura del progetto. Riflessioni sulla ricerca tecnologica in architettura*, Franco Angeli, Milano 2016.

Fanzini, D., Rotaru, I., Bergamini, I. (2017), "Teoria e prassi nella progettazione ambientale: scienze post normali e visioning process design per la sostenibilità", *Techne*, n. 13, Firenze University Press, Firenze, pp. 151-158.

Figliola, A. (2017), "Post-industrial robotics: esplorazione di architetture informate nell'era post-digitale", *Techne*, n. 13, Firenze University Press, Firenze, pp. 256-266.

Hayter, S., Torcellini, P., Hayter, R., Judkoff, R. (2001), "The energy design process for designing and constructing high-performance buildings", *Clima 2000/Napoli 2001 World Congress*.

Loonen, R., Favoino, F., Hensen, J., Overend, M. (2016), "Review of current status, requirements and opportunities for building performance simulation, of adaptive facades", *Journal of Building Performance Simulation*, vol. 10, n. 2, pp. 205–223.

Marsh, A. (2016), "Performative design", available at: http://drajmarsh.com/wiki/performative-design (accessed 2 May 2016).

Neuckermans, H. (2017), “La progettazione architettonica nell’era della tecnologia”, *Techne*, n. 13, Firenze University Press, Firenze, pp. 33-37.
Raiteri, R. (2014), *Progettare progettisti. Un paradigma della formazione contemporanea*, Quodlibet, Macerata.
Ridolfi, G. (2018), “BIM e Simulazione ambientale nelle fasi iniziali del progetto”, in Ceccherini Nelli, L.(ed), *Soluzioni innovative di risparmio energetico*, DiDA Press, Firenze, pp. 49- 54.
Tedeschi, A. (2010), *Architettura parametrica. Introduzione a Grasshopper*, Le Penseur, Brienza.

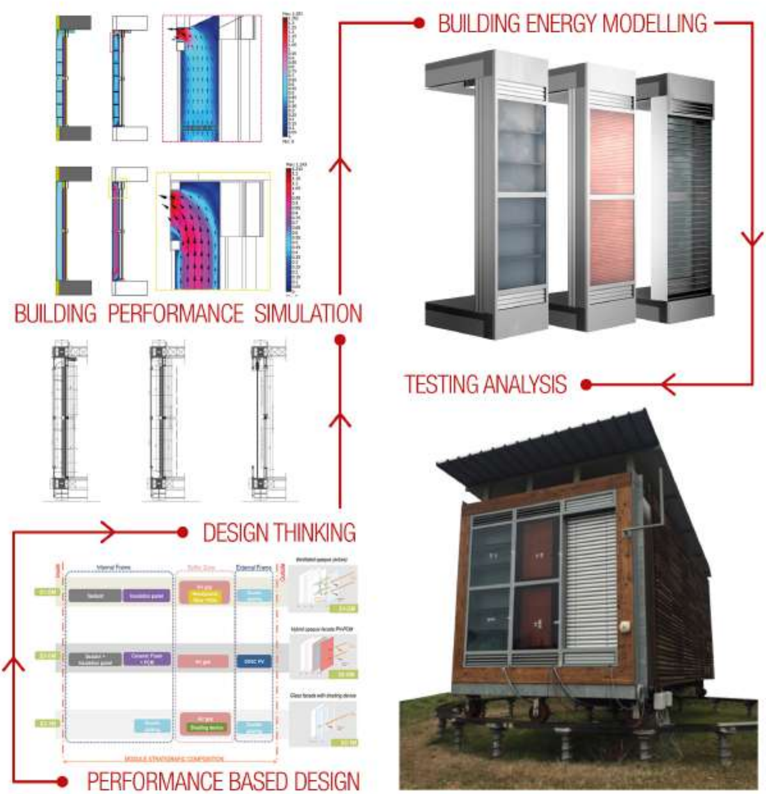


Fig. 1 - From metadesign to verification with BPS and BPO tools of the energy performance of adaptive envelope systems: the SELFIE facade system

3.16 Building performance simulation, BIM and Parametric design: potentiality for the design process

Valeria Cecafosso[*]

Abstract

The techno-morphological building characteristics as well as the building materials influence the building's microclimate and contribute to determine its energy performance. Safeguarding the environment is a paradigm to be pursued without further delay otherwise the very survival of the planet could be at risk. The research on energy efficiency and environmental quality, has introduced innovative technological tools such as: building performance simulation, building information modelling and parametric design. The road to follow in this field of research is still long but the path traced promises interesting results. The aim of the paper is to focus on the main keys that anticipate the possible future development methods.

Keywords: Building performance simulation, BIM, Parametric Design

Introduction

Architecture must respond to the constructive, functional and social living needs, seeking the most suitable intervention systems to protect the environmental context and the balance between man and the environment (Dierna, 1995). In the technological design culture, the centrality of preserving the environment, its sustainability for future generations, the solidity and reliability of building performance, and the durability of the building transformations have now been acquired. This means pursuing well defined performance targets, aiming to obtain effectiveness in the results control and users' satisfaction, knowing that, regarding the performance results and climate-environmental changes action, it is not indifferent if decisions are taken at the beginning or at the end of the planning process.

The technomorphological building characteristics influence their behaviour by modifying their performance, just as fundamental is the choice of materials and components that should be able to adapt to different contexts and to the change of daily and seasonal conditions.

[*] Valeria Cecafosso is Research Fellow at the Department of Planning, Design and Architecture Technology, Sapienza University, Rome, Italy, valeria.cecafosso@uniroma1.it.

There is by now the full awareness that there is no single answer to determine the optimal buildings performance but that the solution will always be different in relation to a complex series of factors that refer to a design made highly adaptable by the case to case approach. «There are no two identical buildings and what could work well in certain situations cannot be transferred *tout court* in other contexts» (Hemsath, Bandhosseini, 2017).

The research and experience accumulated in the last few years in terms of energy efficiency and environmental quality has allowed us to develop innovative technological tools and methods, decisive for design. To optimize the building performance and for the environmental quality control it is possible to use, through parametric computational design, simulations to test and/or integrate multiple technologies, evaluating alternative solutions in order to choose the most suitable ones in relation to the environmental context.

New tools and opportunity for the design process: Building Performance Simulation

Simulations are used to create future scenarios based on models that allow the analysis of environmental factors. Models are an abstraction of the real building that considers the influential factors on performance to a high level of detail and analyse performance indicators with a modest measurement cost. Simulations describe the system under examination, representing the characteristics of the phenomenon under study and explicitly show the connections between the parts and the whole.

They, therefore, imitate the operation of a real process or system by simplifying its components, properties and functions through a virtual model capable of giving a useful representation of the real building. Ultimately, it is a technology of considerable potential that can predict the building performance aspects, such as air quality, air masses flow or natural lighting, and to evaluate the different design options.

The most common method to integrate building performance simulations requires the export of the geometric model (entire building, partial building or model of a building component) into a dedicated software to generate the specific analysis required, with parameter setup input necessary for the calculations of energy use simulation, daylighting or solar radiation, etc.

The results of these simulations are generally used for project development through a convergent iterative process. This process does not include the integration of building modelling environment with the simulation one, and requires a further exportation/simulation for each option, increasing the time required to complete the analysis. By integrating the parametric and BPS design capabilities, it is possible to quickly test multiple design options, creating a more cohesive design process (Aksamija, 2018).

Crucial design decisions have a more significant impact on the buildings performance if they are conceived in the initial phase of a project, such as mass construction, orientation, volume, solar shading, natural lighting strategies, etc. The tools to support the development of the project that allow the performance evaluation in the conceptual design phase, help to improve the process itself, allowing a more effective and efficient control on the final outcome of the building performances.

Advances in building performance simulations have allowed designers to better understand how environmental factors affect building performance, as the impact of various design decisions can be simulated and quantified during the design process (Aksamija, 2018).

This introduces the concept of performance design in which energy performance becomes the design driving factor (Oxman, 2008). In recent years, several software programmes have been developed that are suitable for this purpose but often they only cover some aspects of the problem. In fact, most current design software applications cannot integrate performance-based simulation results into the design model.

New tools and opportunity for the design process: Building Information Modelling

The digital model of the physical and functional building characteristics can be achieved with the BIM (Building Information Modelling) that allows an integrated process of different applications able to generate graphic and numerical elaborations from a single system, allowing the realization of a shared environment containing information concerning all the operational phases of the construction and the entire building life cycle.

The BIM keeps the archive of graphic and schedule information, allowing the collection and enhancement of the latter and allows also the digital representation of the physical and functional characteristics of an object and is designed to manage seven dimensions of the project: the first three for the geometric description; the others for the analysis of the duration of the work; the analysis of the costs of the building; the use, management and maintenance phase; and finally, the assessment of sustainability.

This methodology is changing the way in which buildings are designed. In fact, it is an integrated and interoperable design system that facilitates and ensures greater communicability to the project itself, allowing designers, customers and companies to have a single element on which all information can flow. It also allows to use innovative design methods by associating a series of processes in order to analyse buildings models referring to virtual reality.

The relationships existing between all the project elements allow to coordinate the operations and to manage the changes.

In relation to the production process, the BIM optimizes the entire supply chain by limiting the frequent coordination errors in contract and reducing the construction time through a more fluid and coherent process. Even from the point of view of building maintenance, the advantages are considerable because all the information needed to manage the entire life cycle of the building is easily available. A fundamental principle of BIM is based on the creation of parameterized dependencies between individual objects consisting of geometric definitions, data and rules. Furthermore, with the BIM, expanded by components and materials, the physical behaviour of the building and its costs can be assessed. In support of this approach type there are software like Revit of Autodesk and Archicad of Grafisoft. The environmental and energy analysis tools that interface with Revit are Insight 360 and Green Building Studio, Sefaira, Radiance, OpenStudio, EnergyPlus, eQuest, DesignBuilder, IES VE and many others. Insight 360 is a cloud-based analysis software that integrates into Revit workflow. In 2014 this tool was launched as EnergyPlus Cloud and in 2015 Insight 360 was presented (Roth, 2016) that is able to perform whole building energy analysis, solar radiation analysis and lighting analysis. Analysis results can be compared with the ASHRAE 90.1 and Architecture 2030 benchmarks. Sefaira, a web design tool developed in 2009 and combined with Revit since 2014, is another plugin that provides building performance simulations related to natural and artificial light, solar radiation and energy use. For the calculation the cloud is used to run different models through multiple simulation engines in order to have a faster process. Analysis results are displayed in real time on a performance dashboard.

New tools and opportunity for the design process: Parametric design

Parametric modelling applied to architectural design has developed over the last decade. A parametric model is a computer representation of design objects with geometric entities that consist of variable attributes and fixed attributes. Variable attributes are called parameters while fixed attributes are called constraints. Every geometric configuration that derives from parametric variations is called an instance. Instances represent a unique set of transformations based on parametric inputs, generating design variations and different configurations (Turrin et al., 2011). The ability to produce many instances that lead to unique configurations of the same geometric component is the main advantage of parametric modelling. Architectural objects are defined through specification of their relationships rather than their geometric qualities. This feature is characterized by previously unknown potentialities such as automatic changes update of a part or the generation source models options (versioning) that allow the study of options in an extensive and economic way (Ridolfi, 2018).

Parametric design methods assist designers to generate and evaluate constructive elements geometries by manipulating their parameters. Parametric modelling has the potential to overcome current design limits process and to facilitate detection and comparison of performance solutions.

In architecture, computation in design utilizing the parametric-associative model technique and algorithm provides designers a design innovation method through the notions of variation and design exploration (Gerber, Ibanez, 2014). Parametric design software applications have become more prevalent in design simulations as these applications can be used to quickly test ideas and to compare and analyse the performance of multiple design alternatives (Anderson, 2014). The most common parametric design tools are Grasshopper (McNeel's Rhinoceros), Dynamo (Autodesk's Revit) and Generative Components (Bentley MicroStation). Graphical visual programming tools offers an intuitive way to implement the associative parametric technique through a graphical algorithm editor in place of a written code syntax. They provide dynamic changes and control over inputs that influence the geometry and properties of building model components. This allows designers to study appropriate solutions to achieve the goals set by overall assessments of the environmental, energy, bioclimatic, fluid dynamics, thermophysical performances, etc., not only of a building but also and above all of parts of the city: neighborhoods (are widely applied for the design of eco-neighborhoods), urban districts (Tucci, 2018). Software platforms typically focus either on environmental analysis or parametric design but few integrate both. Open source plugins have been developed such as Ladybug, Honeybee and Butterfly in order to make this connection. Ladybug and Honeybee have their functions within Grasshopper and Dynamo software interface, that allow a dynamic joint between the flexible visual programming interface, the environmental data sets and the simulation engines. Ladybug imports the standard EnergyPlus weather files (.epw) and provides a variety of interactive 3D graphics to support decision making during project initial phases. Honeybee links the visual programming environment to validated simulation engines (EnergyPlus, Radiance and Daysim), which assess energy consumption, comfort and natural lighting of the building. Butterfly imports openFOAM algorithms for CFD (Computational Fluid Dynamics).

Conclusions

Technological innovations help decoding design concepts in a series of interdependent relationships, that place the need to understand the project in a global way and to be aware of all bonds that interact bidirectionally with the cause-effect sequences. Initial design ideas can be defined and verified in design goals context and final performance values. The parametric aspect of the architectural components thus facilitates the projects exploration and the design assumptions testing according to established validation criteria.

This allows to make more informed and more energy-efficient decisions, and more generally for project quality, by following a process that incorporates building performance modelling.

For Scheer, a strong supporter of traditional design process, with BIM we are witnessing the transition from the representation of reality to its simulation. However, the representation reflects reality in a schematic way while simulation explores an operational reality with reduced complexity, a procedure that in any case can produce new knowledge. In this there is a return to a discussion that has never been concluded on shape issues, to be considered detached from everything or connected to its expressive content. The problem therefore cannot be led back to shade as an absolute expression but as to how we come to that shape, through information or without it. It is also noted that an attitude aimed at acquiring experiments results *tout court*, attributing to them a decisive role related to the choices to be made, can lead to results that are not necessarily better than relying on a current logic. These tools should be appreciated for what they offer, they can help the design process, which in any case remains the architect's responsibility. There is a growing interest in the use of parametric modelling and BIM in particular for the design of energy efficiency. The integration of parametric modelling tools with BIM makes it possible to explore design alternatives and predict their impact on building energy performance. Several studies provide best practices on modelling procedures using parametric functionality, on the ease way of integration and on interoperability between different software applications.[1] The results of these studies show a promising development in ensuring the complete integration of parametric design with building performance simulations. This will allow designers to evaluate the effects of design choices more accurately. In addition, by integrating parametric design capabilities and building performance simulations, you can quickly test multiple options, creating a more cohesive and effective design process. Parametric modelling and building performance simulation tools (BPS) used in an integrated and systematic way can be strategic to activate a validation process of the selected alternatives based on measurable comparisons of each building performance profiles and to allow key decisions in advance (Eastman, 2008).

The objective to be achieved is to use design strategies that maximize the capacity of bioclimatic response and the specificity of the role of architecture.

---

[1] Notably studies are: a) Suyoto, W., Indraprastha, A., Purbo, H. (2015), "Parametric approach as a tool for decision-making in planning and design process. Case study: Office tower in Kebayoran Lama". *Procedia Soc. Behav*. Sci., 184, 328-337; b) Zboinska, M.A. "Enriching creativity in digital architectural design: A hybrid digital design toolset as a catalyst for design emergence in early-stage explorations of complex forms". *Proceedings of the 20th International Conference on Computer-Aided Architectural Design Research in Asia: Emerging Experiences in the Past, Present and Future of Digital Architecture* (CAADRIA 2015), Daegu, Korea, 20-23 May 2015, pp. 819-828; c) Konis, K.; Gamas, A.; Kensek, K. (2016) "Passive performance and building form: An optimization framework for early-stage design support". *Sol. Energy*, 125, 161-179.

References

Aksamija, A. (2018), "Integration of parametric design methods and building performance simulations for high-performance buildings: methods and tools", *Perkins+Will research journal* / vol 10.01.

Dierna, S. (1995), "Innovazione tecnologica e cultura dell'ambiente", in La Creta, R., Truppi, C., *L'Architetto tra tecnologia e progetto*, Franco Angeli, Milano.

Eastman, C., Teicholz, P., Sacks, R., Liston, K. (2011), *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractor*s, John Wiley and Sons, Hoboken.

Gerber, D.J., Ibanez, M., *Paradigms in Computing: Making, Machines, and Models for Design Agency in Architecture*, eVolo.

Hemsath, T., Bandhosseini, K.A. (2017), *Energy Modeling in Architectural Design*, Taylor & Francis Ltd.

Ridolfi, G. (2018), "BIM e simulazione ambientale nelle fasi iniziali del progetto" in Ceccherini Nelli, L. et alii, *Soluzioni innovative per edifici Nearly Zero Energy. Esperienze di progettazione ambientale*, DiDA Press, Università degli Studi di Firenze.

Roth, A., (2016). "Autodesk Upgrades Insight360 with EnergyPlus Annual Energy Simulations", US Department of Energy's Office of Energy Efficiency and Renewable Energy, available at: https://www.energy.gov/eere/buildings/articles/autodesk-upgrades-insight360-energyplus-annual-energy-simulations.

Scheer, R. D. (2014), *The Death of Drawing, Architecture in the age of simulation*, Routhledge.

Tucci, F. (2018), *Costruire e Abitare Green. Approcci, Strategie, Sperimentazioni per una Progettazione Tecnolgica Ambientale | Green Building and Dwelling. Approaches, Strategies, Experimentation for an Environmental Technological Design*, Altralinea, Firenze.

Turrin, M., von Buelow, P., Stouffs, R., (2011). "Design Explorations of Performance Driven Geometry in Architectural Design using Parametric Modeling and Genetic Algorithms", *Advanced Engineering Informatics*, vol. 25, n. 4, pp. 656-67.

3.17 SHAPING THE CITY OF TOMORROW THROUGH "NETWORK URBANISM"

Irina Rotaru[*]

Abstract

Technology and the large availability of data have dramatically changed values, expectations, approaches and jobs as well as the ways of understanding, interacting, living and working of individuals and communities. This engendered confusion and disruptions, but also unprecedented opportunities. This contribution is inspired by several European projects and by the transformations in the activity of private and public entities. Starting from the concept of network urbanism and taking Civitas PROSPERITY as main case study, the possibilities to connect changes and challenges are explored for the development of resilient urban solutions. The intent is to use empiric knowledge to underlie a new vision of the systemic project proposed by technological culture and offer insights on the ways of producing effective projects for the city of tomorrow.

Keywords: Network urbanism, Project anticipation, Value innovation, Disruptive changes, Civitas prosperity

Context

The present reality is defined by large migrations, demographic variations and the diversification of the family structure and models.

To these are added the massive digitalisation (Kaeser, 2018), the huge amount of raw data, the large availability of disconnected ideas and tools, the environmental threats, the growing uncertainty, the crisis of public administration and the increase of tangible and intangible exchanges and flows.

All these generated significant mutations regarding the essential needs and expectations of people, most of them concerning their life environment, namely dwellings and cities. The inequalities and discrepancies increased, the most evident ones being related to housing and health (Biau, 2018).

Therefore, the research on the life environment, more specifically on the shaping and management of cities, seems of major relevance.

Work precariousness encouraged the development of the sharing economy with representatives as AirBnB, Uber, BlaBla Car etc., while the new systems

---

[*] Irina Rotaru is President of Cities on the Move, coordinator of the Innovation WP Civitas PROSPERITY, ynarina@yahoo.co.uk.

of values are favouring individualism (Biau, 2018). The sociologist Louis Wirth anticipated this evolution, when he stated that:

> «Density involves diversification and specialisation, the coincidence of close physical contact and distant social relations, glaring contrasts, a complex pattern of segregation, the predominance of formal social control, and accentuated friction, among other phenomena» (Wirth, 1938).

The heterogeneity induced by the massive migrations' favours change as it «tends to break down rigid social structures and to produce increased mobility, instability and insecurity» (Wirth, 1938) and a kind of alienation.

There is an ongoing shift from competition to collaboration, from hierarchical system to networks, from closed secret to open transparency, from intellectual property to open source, from clear roles to mixed functions (Tao, Vallejo, 2014). Obviously, this not only upgraded expectations, but also imposed new conditions of project action, in terms of management, roles, skills and content. Thus, new approaches, methods and ways of doing things are necessary in order to survive in an ever faster changing complex environment and sustainably meet the actual challenges. People are forced to reconsider their behaviours and reinvent their activities and ultimately their world and life.

Actual manifestations of the idea of network

Apparently, there are a lot of opportunities here, but also notable threats. At present, one of the most promising forms of organisation and action seems to be the network that tends to replace hierarchy. In France for example one can notice a strong culture of networks. There is a series of networks of public (e.g. the network of French mayors), parapublic (like the network of urban agencies) and private (like the network of real estate agents) institutions. Some of them extend even beyond the French territories, like for instance the cooperation and cultural action network[1], meant to connect the French cultural entities in various countries. Also, the associations are usually organised in federations. However, the connections between the various levels or networks are weak or inexistent.

This fact significantly reduces their effectiveness, preventing a real virtuous organisational system. It is true that good connections between peers help a lot, but if they are not complemented by a link with the other levels and the objectives do not go much beyond the defeat of the rights of a certain profession, they cannot manifest at their full potential. The reorganisation of the public sector implies also building networks.

At the European level, programmes like Urbact, Urban Innovative Actions (UIA) or Interreg have at their core the idea of network, supporting the creation

---

[1] https://www.diplomatie.gouv.fr/fr/le-ministere-et-son-reseau/missions-et-organisation-62169/le-reseau-de-cooperation-et-d-action-culturelle/.

of networks of cities with similar problems. This proved to have very good results allowing the extension and development of good practices. Martin Varnier (2015) writes about the rising of the *capitalisme réticulaire* represented by the network enterprises that operate around the world. In essence a very positive thing, this evolution might have tremendous impact on cities, annihilating their identity and richness. A consequence of globalisation, the franchise system was very promising at the beginning but now is risking to degenerate in private oligopoly at the costs of local economy and uniqueness. Uber[2] and AirBnB are also networks very good in quintessence but that lately proved to be important disruption factors. AirBnB's excessive popularity increased the rental prices for long term tenants and tends to progressively transform the very special experience of living like a local into a standard one (Hinsliff, 2018). As a proof of the general awareness regarding the possible negative effects of the new developments, the main challenges included in the Horizon 2020 Work Programme 2018-2020 have been built around the necessity of sustainably addressing the numerous potential disruptive changes.

The innovation need and the network urbanism

When asking for a change, there is an implicit reference to innovation as according to current understanding innovation is a new idea, more effective device or process[3]. Innovation can be viewed as the application of better solutions that meet new requirements, needs that have not been articulated, or existing market needs (Maranville, 1992). This is accomplished through more effective products, processes, services, technologies or ideas.

Having in mind the large amount of information and energies, the first impulse is to privilege quality instead of quantity and to analyse what already exists and reposition everything in a more proficient configuration facilitating common understanding. In practice, the present stake is to create the suitable mechanisms allowing the best use of tangible and intangible resources in the actual conditions of instability and unprecedented complexity (Rotaru, 2014). This has very much to do with the idea of connectivity particularly actual at present and led to the investigation and update of the network urbanism, concept first coined by Gabriel Dupuy in 1991.

Through this he refers to the network-oriented thinking in cities' design and management resulting in a virtuous overlapping of various networks (Dupuy, 2008).

More recently, Martin Varnier (2015) refers to the network as a reticular approach of the territory, including urban infrastructure links but also connec-

---

[2] http://sump-network.eu/fileadmin/user_upload/Innovation_Brief_UBER_22_08_2017_web-2.pdf.

[3] http://www.merriam-webster.com/dictionary/innovation.

tions between people. Hence, there are tangible and intangible links, fact also suggested by the statement *«les territoires demeurent des constructions sociales signifiantes»* (territories remain significant social constructions) of the above-mentioned author. Belinda Tao and Jose Luis Vallejo (2014) are defining the network-design thinking as an alternative to the traditional way of designing cities from a bird's eye view, and a single designer's perspective. It blends critical theory with hands-on practice, progressive thinking with social engagement, and research with reflection in action.

Today the network becomes an element of stability, of balance, preventing alienation and may be also regarded as a common ground. It is at the core of the systemic approach needed presently, but in a certain sense also becomes a possibility of control. It distinguishes as a flexible form of organisation, key to ensure adaptation and resilience. According to the theory of Martin Varnier (2015), the increased mobility is also facilitating the network approach as people are no longer identified with a single place but with a series of sites that they add along their lives connecting them in the endeavour of shaping their becoming. The creation of sustainable networks with limited risk of perverse effects demands to look for individuality in generality, while avoiding implicit generalisation and extremes. A speaking example of blind generalisation in the building sector is provided in France where all new dwellings have to be designed for persons with reduced mobility.

This proves often quite uncomfortable for the large majority of people not in this situation confronted with the bad partitioning of their apartments. The multilayered contemporary reality is demanding a more holistic approach to designing cities, that could be based on the principles of network urbanism. In order to creatively address this increased complexity and innovate one needs to push own boundaries and overcome the limits of a single profession, thus diversifying the means of action and theories used. Today big waste results because of professional isolation, individualism and lack or deficiencies of connectivity. In order to change this, a shift in the project and doing culture is needed, not necessarily favouring more but better. The network organisation of the public sector opens the way towards decentralisation allowing the enhancement of specific values and encouraging cooperation. New types of actors can become part of this endeavour enriching its content and increasing its potential impact while paving the way towards more effective, inclusive and resilient design and management processes. Furthermore, the combination of various knowledge, practices and experiences leads to new competences. However, what is needed in order to achieve an advanced level of connectivity is the cooperation between the various levels of governance, between those making the rules and those supposed to apply them, complemented by a virtuous relation between theory and practice, feeding one another.

Insights from Civitas PROSPERITY project

Started on September 1st, 2016, *Civitas PROSPERITY* was developed in the framework of Horizon 2020 with the aim to generate a culture shift in government agencies and local authorities to support Sustainable Urban Mobility Plans (SUMPs). The project focuses on promoting and supporting a broad adoption of effective SUMPs especially in countries, regions and cities where the take up is currently low. It is supposed to provide mechanisms and tools for national bodies and regional agencies to assume a leading role in the development of SUMPs, and build professional capacity through peer-to-peer exchanges and other dedicated activities. *Civitas PROSPERITY* has been chosen as main case study for this analysis because it is a successful experience of identifying, testing, developing and promoting innovative ideas for the city of tomorrow and reliable inside information is available. In this particular case the focus is on the urban mobility systems considered as decisive for the image, life and evolution of any settlement. However, the most relevant are the approach and the methodology adopted, that are viewed as a good illustration of the present idea of network urbanism. *Civitas PROSPERITY* created a network of cities including champion and follower ones. Best performing cities were acknowledged as champion cities and invited to share their experience on the occasion of the national promotion, training and coaching events, serving as reference and inspiration for the follower ones. Additionally, a special topic, SUMP ambassadors, was launched including people who were successful in their urban mobility initiatives and willing to share their experience and possibly act as advisors. This enables the dissemination of the endeavours of the ones that supported the preparation, promotion and implementation of the best SUMPs. (http://sump-network.eu/ambassadors). Furthermore, the project facilitates regular exchanges not only between the various cities, but also between peers at national or regional level in charge with urban mobility issues. Dedicated sessions were organised for the latter on the occasion of the project meetings. National SUMP taskforces were created as transverse national structures connecting the various levels in the field. Through these, *Civitas PROSPERITY* succeeded to regularly bring together the policy makers and professionals working with those policies. This enabled changes of attitudes and behaviours, losing the gap between the needs and demands of the local level, and higher administrative institutions that should prepare the ground and provide programmes to encourage cities design and implement SUMPs. The various initiatives developed in the framework of this project were linked. This part of relational thinking and network approach worked very well and it was enhanced by a certain degree of liberty leaving space for innovations that came evident with the advancement of the project. Some of the connections were not planned since the beginning, but developed later on during the project, for example the process of selection of the host cities for the different events in Romania.

There, it was launched a call asking the various candidates not only to demonstrate their organisational capacities, but also provide a solid motivation, reflect on their gains from this experience and propose some relevant subjects, measures and sites for the practical exercises and study visit. This helped choose a city really understanding the potential of such a role and willing to progress in the urban mobility field.

Some other not initially planned elements were also the use of the innovation briefs (developed in the framework of the project) for stirring debate in the taskforce meetings and the input from the different brainstorming activities to the taskforces seen as an access gate to the political power. What did not work so well was the collaboration with the other projects funded in the same time and having similar targets (so-called sister projects). This was very much wanted by the project steering group in order to increase the impact of each activity and produce a really sustainable shift in the way of understanding, planning and managing cities. It was also highly encouraged (even asked for at a certain point) by the European Commission (EC).

The problems at this level proved that the collaboration culture is not always mature enough. Besides, this idea came at a later stage so there were no dedicated resources and work had to be done mostly on a voluntary basis. The excessively strict framework imposed by the EC also complicated cooperation as more additional work was asked besides what was promised, without backing this up with dedicated funding. This has taken much of the available energies of the different project teams at the cost of the interprojects' synergies. Moreover, a kind of negative competition seemed to rise among the various similar projects much supported by the EC attitude. To this added the important differences in the approach and methodology of the projects.

If *PROSPERITY* was thought from the beginning very open and flexible to collaboration, pursuing to connect the already existing information and initiative for a better use.

Conclusions

The exploration of the concept of network urbanism in the present context allowed its revival widening its scope so that to better address the actual challenges. The analysis of several experiences proved that the simple idea of network is not sufficient for the development of genuine mechanisms and new ways of thinking and acting, while the different nature of contexts impedes the definition of univocal reference models. Therefore, blind application of the so-called best practices is to be avoided in favour of a greater attention to the characteristics of the context.

Moreover, a certain degree of flexibility is generally beneficial, enhancing the potential of innovation, while a deeper analysis also considering the weak signals not only the strong ones as argued by the project anticipation theory is essential. The multilayered contemporary reality is demanding a more holistic approach to designing cities, that could be based on the principles of adaptability and on the synergic use of resources implied by network urbanism.

In order to guarantee adequate levels of governance that integrate, in a virtuous relationship, theory and practice, rules and their translation into concrete actions on the territory, an advanced level of connectivity is needed.

The main opposition to the network project derives not only from economic operators anchored to traditional business models, but also from the professional world, whose domains and specialisation fields are still defended in the name of a presumed, increasingly improbable form of trade union protection.

Civitas PROSPERITY was an opportunity to experiment how network urbanism works at a practical level online and offline. It also showed how connections between theory and practice and learning processes can be created through applied research and capacity building as affirmed by the technological culture of the project. One of the virtues of the project is that it was well anchored in reality, paying a lot of attention to the context and parallel development. It not only considered the networks to be created, but also the already existing ones becoming disruption factors like Uber and offered insight on how to effectively cope with them. This experience demonstrated the relevance of inter levels networks complementing the ones between peers.

Beyond the immaturity of the cooperation culture, what most affected the project implementation was the high instability of the policy-oriented decision-making context, both at national and at European levels. This was the situation for the first two project years. One more is left and efforts are being made to improve this.

References

Biau, V. (2018), Communication on the occasion of the 22nd Summer University of Urbanism, Besancon, France, August 2018.

European Commission (2017), *Horizon 2020 Work Programme 2018-2020.*

Hinsliff, G. (2018), "Airbnb and the so-called sharing economy is hollowing out our cities", *The Guardian,* available at https://www.theguardian.com/commentisfree/2018/aug/31/airbnb-sharing-economy-cities-barcelona-inequality-locals (accessed 1 September 2018).

Maranville, S (1992), "Entrepreneurship in the Business Curriculum", *Journal of Education for Business*, vol. 68, n. 1, pp. 27-31.

Rotaru, I. (2014), *Wealth Between Heritage, Culture and Innovation: Collaborative Forms of Urban Governance as a Solution for the Creative Valorisation of the European Cities,* Polimi Milano.

Tao, B., Vallejo, J.L. (2014), *Networked Urbanism. Design Thinking Initiatives for a Better Urban Life*, Harvard University, Graduate School of Design.

Vanier, M. (2015), *Demain, les territoires. Capitalisme réticulaire et espace politique,* Éditions Hermann, Paris.

Wirth, L. (1938), "Urbanism as a way of life", *American Journal of Sociology*, vol. 44, n. 1 The University of Chicago Press, pp. 1-24.

3.18 RESPONSIBILITY AND THE THREE ROLES OF TECHNOLOGY TOWARD THE "COLLABORATIVE CITY" DESIGN

Rossella Maspoli[*]

Abstract

Social innovation in terms of urban welfare, building collaborative and circular economies, inclusive urban regeneration of degraded areas, requires us to try out processes, technologies and hybrid forms of knowledge management. In this respect, the design culture of architectural technology faces new transdisciplinary scenarios, which are delineated into three roles that qualify for design. The first role involves guiding prosumer-citizens with regard to their own living; the second concerns interactions with agents of active citizenship in the design of public spaces or "third spaces" of sharing; the third role regards expertise in public coordination and management of common goods in relation to associations and of innovationism.

Keywords: Design culture, Social innovation, Collaborative cities, Common goods

The models of social innovation

The concept of "active citizenship" opens the door to dialogue between cultures and to operational cooperation with the public and is essential to setting social innovation in motion, in terms of co-design and cogovernance centred around collective goods and services (Murray et al., 2010).

NESTA[1] has defined the aim of social innovation as being "explicitly for the social and public good", inspired by the desire to meet social needs, which can be neglected by traditional forms of private market provision and which are often poorly served by the state. The aim is to bridge the gap between state-provided services and the demands of a dynamic, nomadic society undergoing a process of transformation (Murray et al. 2010).

The social innovation is to be understood as a complex process which is subject to a high degree of risk, one which requires partnerships between various subjects.

---

[*] Rossella Maspoli is an Associate Professor at the Department of Architecture and Design, Politecnico di Torino, Italy, rossella.maspoli@polito.it.

[1] A UK-based philanthropic global foundation for innovation (https://www.nesta.org.uk/).

It can change the system within which it develops, on condition that it is successful, is characterised by durability and has a broad impact (Westley et al., 2010). Ezio Manzini describes it as

> «change in the socio-technical system, the nature of which and the results it produces *also* have a social value, in the twofold sense of solution to social problems and (re)generation of common/shared physical and social assets» (Manzini, 2018).

The focus is on the essential correlations between socio-economic regeneration and spatial components, in order to build places of collective use and performative places that are models for the diffusion of innovation.

The three roles of technology in design

The perspectives of social, technological and economic innovation are congruent with the reuse of abandoned spaces and with participatory processes that encourage cultural and creative activities and the new circular economy, which constitute catalysts for the redevelopment.

With a view to fairer and more resilient cities, the culture of architectural technology may play multiple important roles in enabling project, in terms of co-designing methods – as an evolution of a needs-performance-based approach – and of organisational tools, adequate for the management of the entire participatory process.

The scenarios within which technology can operate, in this regard, can be summarised in terms of three design-facilitating roles:

- guiding citizens at the beginning of the participatory process;
- interacting with agents of active citizenship with a view to process management;
- coordinating "innovationism" and the formation of networks of local information and support centres, with a view to achieving continuity and repeatability in terms of results.

The citizen accompaniment

The first role concerns fostering active citizenship to become more aware of their role, from a lifestyle which reduces costs for the community to co-production which achieves tangible results.

The accompaniment process involves using analysis techniques that capture the causes of the need for innovation – such as changes in the economic model, reducing public expenditure and shortcomings in policies – in addition to instruments that render explicit the aspirations that "ignite" the widespread creativity.

A role is that of the *architect activist*. This figure identifies a mode of acting virtually in opposition which accords a central importance to the usability of public space, opening up to the transfer of experiences. The "design activist" can be defined as «a person who is a free agent; a non-aligned social broker and catalyst» (Fuad-Luke, 2015). The approach is one of *bursting in* on a given setting with a team that is initially characterised by a low degree of formalisation.

The *activist* – architect, designer, performer, facilitator – in an increasingly multimedia scenario is essential in helping to change the perception of space and to pave the way to experimenting with changes to social life. Activists introduce strategies aimed at codesign and cofuture, approaches which seek to bring about a collaborative convergence between bottom up approaches – set in motion by social movements, grass roots associations, communities and citizens' groups – and top down approaches – headed by public sector institutions and big business.

The key concept is that «design is seeding», the design is progressive, consensual and adaptable to unforeseen conditions and opportunities. It thus becomes necessary to orchestrate synergies in such a way as to minimise misunderstandings and damage as the project process progresses (Fuad-Luke, 2015).

An essential focus is on correlations between the roles of *expert design(ers)* and *diffuse design(ers)* (Manzini, 2015) as well as between *authorised designers* and *non-authorised designers*, and on fostering mutual learning. According to their skills and commitment, participating citizens-prosumers may be allotted specific roles that bring social responsibility into play.

The prosumer-citizen

A prospect of development of the "prosumerism" may be based on the energy self-sufficiency and environmental control (European Commission, 2016), which requires design and implementation consultancy services as well as management of the transition towards distributed generation.

In western society, the trend of the so-called "neoluxury" model (Mattia, 2017) is also towards improving mental and physical well being and housing quality in the sustainable and experiential sense, shifting the cultural values towards freedom of choice and construction of identity.

Starting from these perspectives of cultural sharing, in the pilot projects "Climate Street", in Utrechtsestraat, Amsterdam (2012) and in Iso Roobertinkatu, Helsinki (2017)[2], the transition from codesign-oriented communication to shared implementation and impact assessment is essential. In "Climate Street", the processes led by the municipal administrations adopt interactive digital platforms for communication and round tables for participation organised into workshops, to exchange points of view of the parties, with the gradual strengthening of commitment to cooperate in the interdisciplinary technical round ta-

[2] https://amsterdamsmartcity.com/projects/climate-street, http://ilmastokatu.fi/.

bles, leading to the development of projects to prototype and test in real world conditions. During the subsequent stages the municipality organised open design competitions and acted both as an intermediary and contracting entity, bringing together citizens, specialists, start ups and small and medium enterprises to turn ideas into reality and foster local, sustainable entrepreneurship.

Interactions with agents of active citizenship

The second role of design technology concerns interactions and the development of actions with agents of active citizenship, in designing public spaces or third spaces of sharing and the related services of facilitation and guiding. From *civic hacking* to established forms, participation must allow for the creative dimension, by recombining resources and including people's skills.

Less active communities – with fewer cultural tools to take part – need to be stimulated and facilitated through access to dedicated social media and direct communication in the places of attendance.

In the sphere of social studies, it has been noted, indeed, that social innovation generally does not arise in the most run-down, deprived communities, but rather where greater capacities for collective action, in terms of skills and resources, are concentrated (Blanco et al., 2016).

The active citizen becomes

> «a person who does not only take part in the discussion about topics of public interest, but also develops and manages what he/she has discussed. And who does it for him/herself, for those with whom he/she collaborates and for society overall» (Manzini, 2018).

The design must produce social innovation that benefits communities that are complex and often in conflict. It requires shared competence and new professional profiles that involve process technology in socio-cultural and technical-regulatory terms. The development of innovation management methods is important for enhancing and combining often underestimated cultures and skills. The *Manifattura Milano* plan is emblematic, to make the territory an "enabling ecosystem" for digital manufacturing and new craftsmanship.

Widespread experimentation with ICT instruments and hybrid technologies – according to the "Onlife" perspective (Floridi, 2014) – is having a radical impact on participatory processes. IoT (Internet of Thing), AI (Artificial Intelligence), Cloud and Open Data technologies are mature enough to spread into local daily life, from urban *participatory mapping* applications to the use of open data and geosocial networks to activate practices for inclusion and redevelopment – with the support of crowdfunding platforms –, to the forms of real participatory planning and neighbourhood cogovernance.

The other technological dimension of innovation for social inclusion regards the ways of interaction space - service - product design in relation to the

Internet of Things and the growth of urban smartness, such as connected objects to placemaking, DIY (Do It Yourself).

Continuity between academic knowledge and that of inhabitants and city users is increasingly significant, for example in the approach to *give back* to one's own community.

The fundamental experience of CfA (*Code for America*) addresses the widening gap between communities in the effective use of technology and of design between communities, through the activism of an intersectoral network of professionals (the *Brigade Network*) who are willing to give their skills back to their local area. Interest in the concept of giving back to the community is also, in its ethical scope and in its potential of dialogue and diffusion for the growth of local innovation. A process model is similar to that of *public engagement* for state universities, one of the aims of which is to broaden visions in shared design projects and test the usability of technologies.

Furthermore, studies in the field of psychology were the first to show that two things are essential to a design process in placemaking: the sense of place identity and an emotional place attachment, hence attention to the resulting modes of social action and the consideration of the emotional components – affective, cognitive, behavioural – involved in participation (Manzo, Perkins 2006). With regard to the tools of the process, therefore, continuity, communication and quality in participation, particularly must be ensured by:

- supporting access on the part of citizens – through architect activism and social facilitation – during the different stages, both with communication platforms and in direct forms;
- establishing design teams that are dynamic yet with stable local cores, from codesign to co-construction, involving facilitators, experts, designers, residents, prosumers, experts in *giving back*, digital makers and traditional craftsmen;
- setting up service centres, as points of reference for networks of potential agents, and neighbourhood competence centres, physical places for communication and interaction between operational, training and research aspects.

Coordinating "innovationism" for the collaborative city

The third role of design technology regards management of the participation process and results. The perspective can be considered "innovationist"[3], that is a dynamic approach which combines induction into creative processes with constant attention to rationalisation of the action.

It also fosters communication between technical and creative functions, in the perspective of co-organisation.

---

[3] http://www.ladirezione.it/definizione-di-innovazionismo/.

Complex skills come into play, from project management to technical-economic evaluation and impact assessment, in terms of the use of spaces, the effectiveness of technologies and integration of the results.

In this direction, the activities of foundations and social inclusion agencies are geared towards stimulating and guiding new projects for social inclusion. Yet they still face difficulties in moving on from start up acceleration or public support programmes to developing capacity to anticipate and guide the broader demand, that stems from local participatory realities[4].

Similarly, in European and national plans – such as PON Metro, Progetto Periferie, Urban, Urbact, UIA, and so on – the approach is often insufficient to spark widespread processes of reuse and instrumental resources or to activate sustainable forms of self-organisation of neighbourhood services. Effects on the local area risk being occasional and temporary, without impacting transformations.

With regard to spatial factors, placemaking for the shared enhancement of spaces for public use can be appropriate for triggering social processes of change and starting innovation workshops in order to encourage independent centres of production that can generate a local impact, with the construction of collaborative, circular economies for local development.

The creation of a multidisciplinary network of designers and facilitators involved in the process of decision making and public strategic consultations[5] is important for the testing of social innovation, sustainability and development of infrastructures, public space and shared assets at the micro scale.

In terms of the collaborative city, simple approaches to *design thinking* and *rethinking space* prove effective for strategies that include the viewpoints of community groups who put into practice different skills and capacities. The *design thinking* – originally proposed by David Kelley at Stanford University – has spread from market to social innovation, proposing participative and dynamic forms, in which the main phases to be considered are "inspiration, ideation and implementation". This approach is human centred and easily adaptable, includes the testing and admits the error. The collaborative and exploratory strategy combines problem setting, abductive reasoning and imagination, in order to create innovative solutions. In perspective of *rethinking space*, it can be applied to produce dynamic spaces, both physically and metaphorically, in which to experiment new ways of thinking and working collaboratively.

The application for the common good and spatial regeneration – experienced in Denmark, France, Australia and the UK (See, 2013) – requires a pro-

---

4 Nel caso di Torino, la crescita di agenzie – SocialFare, Incet, Nesta, Torino Social Impact - che profilano esperienze di accelerazione sociale e di investimenti ad impatto sociale, di fablab e di *digital makers hub* rappresenta un modello di riferimento europeo che si traduce faticosamente in metodologie e operazioni incidenti sulla qualità dell'abitare nelle aree periferiche.

5 Il caso del "*Laboratorio para la Ciudad*" a Città del Messico, fra i primi esperimenti di origine non informale e pubblica latino-americani (www.labcd.mx).

cess methodology articulated in toolkit for operating project, communication strategies, feasibility analysis, financial sustainability model, implementation plan, learning plan, impact assessment.

Design strategies to meet the needs of citizens have been implemented by Helsinki (2005), using codesign to address situations of the built environment and open to the gradual incorporation of the approach into all of the municipal departments, for community innovation centres, school services, health care and public transport. *Helsinki Lab* (2015) consolidates the strategy by bringing together a community of developers to ensure that future planning is user-oriented, creates cooperation partnerships in order to extend the application of design and digitally, and encourages the creation of new kinds of local economic activities.

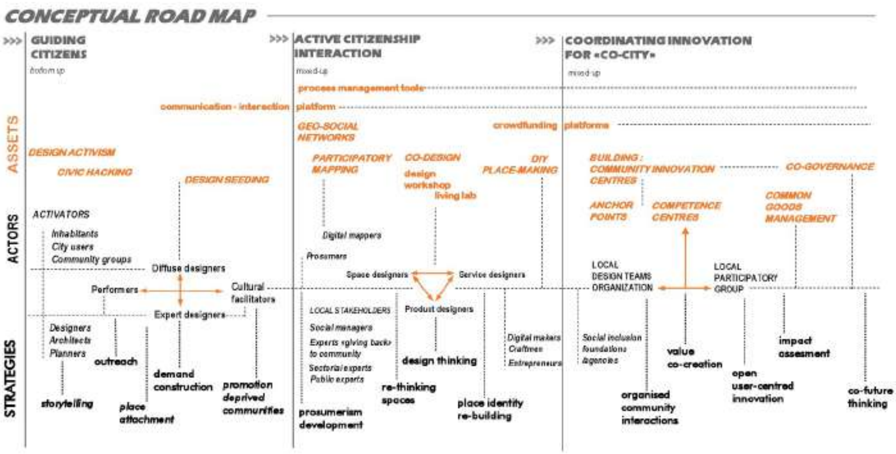


Fig. 1 - The Conceptual Road Map, regarding the three roles of architectural technology in the social innovation project and process, highlights the main activities to be developed (Assets), the types of actors involved (Actors) and the innovation strategies of reference (Strategies).

Conclusions. The transition towards the "co-city"

Social innovation processes require tools of collaborative governance centred around the design and shared management of common goods in the regeneration of spaces aimed at innovation, with significant social and economic impacts.

In the transition towards the *co-city* – in which the city itself is the common good – the technology tools supporting the process mostly still need to be tested. The challenge underway regards how to develop the tangible and intangible factors of the new cultural and economic production of a local area, according to the paradigm of “value cocreation”. New community design centres can be the essential result of codesign and placemaking processes, to support planning, social inclusion and promotion of new micro-enterprises of the creative industry, into the open and circular economy.

These interventions of urban acupuncture – as Jaime Lerner defined them – precise and symbolic, strategic and activating, must be iterated from the small scale to scenarios of innovation, shared and extended to the whole territory.

References

Blanco, I., Cruz Gallach, H., Martínez Moreno, R., Parés, M. (2016), *El papel de la innovación social frente a la crisis*, Ciudad y Territorio, vol. XLVIII, n. 188.

Brown, T. (2009), *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, Harper Business, New York.

EESC (2016), *Prosumer Energy and Prosumer Power Cooperatives: Opportunities and challenges in the EU countries*, European Commission, Bruxelles.

Floridi, L. (2014), *The Onlife Manifesto. Being Human in a Hyperconnected Era*, Springer, Heidelberg.

Fuad-Luke, A. (2015), *Design activism’s teleological freedoms to transform our habitus*, In Fuad-Luke, Hirscher, Moebus (eds) *Agents of Alternatives: Re-designing Our Realities*, AoA, Berlin.

Mattia, G. (2017), *Il neo-lusso. Marketing e consumi di qualità in tempi di crisi*, Franco Angeli, Milano.

Manzini, E. (2015), *Design when Everybody Designs. An Introduction to Design for Social Innovation*, The MIT Press, Cambridge.

Manzini, E. (2018), *Politiche del quotidiano. Progetti di vita che cambiano il mondo*, Edizioni di Comunità, Ivrea.

Manzo, L.C., Perkins, D.D. (2006), “Finding Common Ground: The Importance of Place Attachment to Community Participation and Planning”, *Journal of Planning Literature*, vol. 20, n. 4.

Murray, R., Caulier-Grice, J., Mulgan, G. (2010), *The open book of social innovation*, Young Foundation-NESTA, London.

SEE (2013), *Design for Public Good*, Design Council, London.

Westley, F., Antadze, N. (2010), “Making a Difference: Strategies for Scaling Social Innovation for Greater Impact”, *The Innovation Journal: The Public Sector Innovation Journal*, n. 15.

3.19 DIGITAL TECHNOLOGIES AND PRODUCTION OF INHABITED SPACE IN THE ATHROPOCENE

Marina Rigillo[*]

Abstract

The rise of ITC technologies identifies an epochal innovation, which does not yet find a shared cultural positioning, due to the dimensions and the speed of the change. The value of innovation is not only qualifies for its technological content, but also for its impact on the inhabited space (housing, building, city) and on lifestyles, so that it is increasingly urgent to make such cultural change correspondent with new design approaches, integrating consolidated project methodologies with completely new ICT processes and tools. The paper aims to describe the change underway through a review of research and events, with the purpose of identifying the supporting elements and to hinge them within the technological culture of architecture.

Keywords: Digital Technologies, Inhabited Space, Life Styles, Knowledge Transfer, Anthropocene

Background

The rise of digital technologies has led to the overwhelming transformation of contemporary society, permeating the quality of production processes, the characteristics of goods and services, and (above all) the nature of the relationship between people and objects, and of the objects between themselves, now required to develop a continuous and ever more intense interaction. The Third Industrial Revolution, forecasted by Rifkin in 2011, has actually been overlooked and overcome by the advent of the Fourth, which has established an "epochal" paradigm shift, historic for the size, speed and scope of transformation and for its consequent impacts on the social system (Schwab, 2016, pp.8). It is not inappropriate to use the term "epochal", since the combination of Information Technology (IT) and Operational Technology (OT) - which typically characterizes the value of these innovations - has created a new, unimaginable scenario where biotic and abiotic systems combine in a single cognitive world (Schwab, 2016). Such scenario is characterized by the presence of enormous opportunities for growth and development, and by identical, equally tre-

[*] Marina Rigillo is an Associate Professor at the the Department of Architecture, University of Naples Federico II, Italy, marina.rigillo@gmail.com.

mendous, risks of devastation, so that - not improperly - Google researchers have created the term “Augmented Humanity” to describe the potential of the advances produced in the man-machine relationships.[1] It is precisely the extent of innovation that solicits scholars and intellectuals’ efforts so that our technological future, and evidently our present too, has to be framed within clear rules, ethically acceptable, and consistent with the need of managing social, political and cultural aspects of the revolution underway. In line with the rise of ICT tools in every production sectors, the scientific community has begun to wonder on both the nature of transformation and the needs and drives of human beings in the digital age, not only with the purpose of reducing the risks associated with such exceptional acceleration, but even to explore the historical and philosophical dimensions connected to it.[2] Regarding the latter, in his last book *Homo Pluralis*, Luca De Biase, emphasizes the idea of narrative as a conceptual device to prefigure (and evaluate) potential scenarios made by the coevolution between ITC development, humanistic culture and scientific tradition:

> «Given that the research on these topics can no longer be purely technical and related to engineering, new disciplines are established [...] (disciplines) that define new fields of experimentation [...] disciplines such as digital humanities, post human philosophy, the logic of complexity and of self-organizations [...] Therefore a sort of narrative experiment emerges: imagining a vision, learning to tell its consequences, interpreting current facts in the context of that narrative, and see if everything can stand in front of the progressive unfolding of the story» (De Biase, 2016, p. 57).

The storytelling of our, near future is the field of action of outstanding research centres such as the Institute for the Future of Palo Alto, the MIT Center for Collective Intelligence, or the European Association of Digital Humanities, fully engaged in exploring the ongoing directions of the relationship between society and science, as well as the progress in collaborative thinking and collaborative design, as new frontiers in governing the new decisional processes, that are necessarily plural, and interconnected. In the same way, contemporary art is ever more rising as a narrative device to provide forecasts of the global society. Since the 60s, the alliance between artists and engineers gave the way to research lines oriented at exploring the man/ machine relationship[3], ac-

---

1 See the Empathetic Computing advances, especially referring to the relationships man-machine chain; machine to machine; machine-to-human (VINT, 2014).

2 See Pierre Levy on the notion of IEML, Information Economy MetaLanguage (https://pierrelevyblog.com/), Luciano Floridi on the philosophy of Information (http://www.philosophyofinformation.net/), the Deep Ecology definition and the Environmental Philosophy on www.deepecology.org/platform.htm.

3 In 1966 the exhibition *9 Evenings*, produced by the EAT group (Experiments in Art and Technology, founded by Billy Klüver and Robert Rauschenberg), as well as the “legendary” expositions titled *The Machine as seen at the End of the Mechanical Age* (MOMA, NY) and *Cybernetic Serendipity* (ICA, London, UK), both in 1968, collect suggestions coming from cybernetics, art and humanities (Gere, 2004).

knowledging the ability of the artistic medium to generate original points of view to prefigure unimaginable conditions:

> «By the year 2000, technology will undoubtedly have made such avances that our environment will be as different from that of today as our present differs from ancient Egypt. What role will art play in this change?» (Hultén, 1968, p. 11).

After 50 years, art continues to question the new boundaries of the new electronic habitats (physical as well as anthropological and psychic)[4]. The focus of the reflection is mainly oriented to climate change, as well as to the exacerbation of social and economic differences. In an age where the capacities of Augmented Humanity do not find yet principles of ethical refounding, the projections on our future offer images of a planet at risk, in which human beings, and other living species, interact with the abiotic world through the widespread real time and responsive technologies, where both the monitoring and control of living conditions are integral parts of the human/ environment relationship. A world in which the human being loses his ontological centrality to assimilate as "Info-org" into the relational flows of an "Infosphere" of which he is an essential part, but no longer the *first dominus* (Floridi, 2014)[5], just as the built environment expands beyond its canonical boundaries to include spaces of nature that in no case, and at no latitude, it is still possible to define "unspoilt".

The production of inhabited space

The concept of *Anthropocene* (Crutzen, Stoermer, 2000) culturally supports the narrative of our present and allows us to typify the man/ environment relationship in the digital age according to two main assumptions: the technical (as well as ethical) responsibility of human beings with respect to the maintenance of the planet's vital functions and, simultaneously, the value of research (and the technological advancement) as the only, possible order for a very uncertain future[6].

---

4 Significantly, in 2018, two events draw attention to the extent of the changes taking place. The exhibition *Art in the Age of Internet, 1989 to Today*, at the Institute of Contemporary Art / Boston, February 7 - May 2018, offers a dreamlike insight into digital contemporaneity by analysing the perception of personal identities and corporality; whereas, the exhibition *Después del fin del mundo* (at the *Center de Cultura Contemporània* de Barcelona, October 24 2017 - April 28 2018) focuses on the consequences of climate change such as social inequality, food production and the transformation of the inhabited space. On the other hand, cinema, with *Blade Runner 2049*, propels us into a future in which enabling technologies control an alienated (and alienating) everyday life.

5 Cf. Luciano Floridi Ted Talk at: https://www.youtube.com/watch?v=c-kJsyU8tgI.

6 Crutzen and Stoermer wrote «Without major catastrophes [...] mankind will remain a major geological force for many millennia, maybe millions of years, to come. To develop a worldwide accepted strategy leading to sustainability of ecosystems against human induced stresses will be one of the great future tasks of mankind, requiring intensive research efforts and wise

The result is a new awareness on the community of destiny (Morin, 2002) between the biotic and abiotic system, which is reflected in the demand of operations to increase sustainability and resilience of the inhabited space, whether built or natural. Contemporary habitats evolve indeed rapidly into a techno-social environment (Pierre Levy Blog) whose configuration is affected not only by the quality and quantity of the available information, but rather by the ability to process the latter in a tailor-made approach, that can meet specific and local needs[7]. The search for mathematical/cognitive models aimed at finalizing the growing number of data becomes an integral part of the architectural project, which acquires new opportunities of shaping the inhabited space thanks to the capacity of managing an increasingly important data set, that always corresponds to more complex performances. One can envisage an idea of inhabited space whose project proceeds - equally - through practices established in the discipline and the algorithms' production (equally implementing its efficiency, technological innovation and social shared practices), so that the image - and the value - of the next, smart environments derives from the combination of hyper-specialized experiments and of bottom up processes[8], of great entrepreneurial drivers and of green and circular economies.

The term smart characterizes, in this sense, the capacity to create fundamentally new living spaces (housing buildings, cities, natural landscapes), consistent with the new lifestyles and with the social implications connected to these, environments characterized by the capacity of integrating consolidated technologies with completely renewed processes and tools. Human habitats of the digital era are developed according to coevolutionary processes (determined by the interaction between technological advancement and social culture reasons) and through project experiences still difficult to decode: experiments carried out in these years (rather those of immersive architectures, in which users operate as an active and responsive subject with respect to the use and transformation of space) tell us about a world that rapidly updates cultural references and technical tools, creating a new production of digital infrastructures aimed at facilitating communication and the interconnection between subjects, objects, processes[9].

A revolution that gives great importance to the project and the technological culture that sustains it.

---

application of the knowledge thus acquired in the Noösphere, better known as knowledge of information society» (2000, p. 17).

7 «the future is not […] infrastructure and software as a service, but […] a lot of loosely connected miniservices [that] can be easily assembled like Lego blocks and on top of which you can build agile and resilient applications» (https://pierrelevyblog.com, accessed August 21 2018).

8 See "Arduino", the first - all Italian - experience of "digital handicraft".

9 Cf. the work of the Edilstampa IT Revolution in Architecture series, directed by Antonino Saggio.

On the one hand, in fact, digital innovation offers elements for rethinking the idea of space, whose identity is also affirmed through the redefinition of its codes: the dualism, between material and immaterial, the repositioning of the recognised boundaries of architecture (internal / external, artificial / natural), the concept of time (throughout the revolutionary turning from static to dynamic). On the other hand, IT and OT technologies open up new technological design perspectives, that are required to update their rules and practices, developing a deep knowledge of digital systems, of their potential and the culture that generates them. It is not just a matter of adding new technical devices to those already in use, but rather of reformulating the logical structure of the design process, of its expected performances and of the subjects involved, in a viewpoint in which the actions of sensing, processing, visualizing and feedback characterize the technical domain of the future (Arthur, 2011).

Knowledge Transfer

The outlined framework presents prominent challenges for the production of the inhabited space. The establishment of ITC technologies requires the creation of a specific knowhow, able to test effective models of collaborative thinking and codesign, for the efficiency of the objectives required for the contemporary environment. Consolidated practices of the project and of the construction process must achieve a rapid conceptual and operational adaptation to respond to the paradigm shift. The inhabited space of our present (somehow future) evolves through narratives that must take into account the characteristics of the markets, the requests of increasingly larger social groups and the need for a technical class able to interpret the bottom up demand for change, already expressed by the digital society. Much remains to be done. Italy, in particular, presents a backward construction sector for skills and investments, too constrained by the traditional structure of decision-making and of construction process, thus, unable to generate competitive positions on the global market. There is a lack of a methodological framework as well as in practical implementation to test the applications of ITC innovations in consolidated processes. Further, there is a trend in mainly developing product innovation, aiming to increase the market of high or very high user target in terms of economic accessibility; similarly, some important experiences (for example the Italian Pavilions for Expo 2010 and 2015) demonstrate how the BIM based design is still, essentially, prerogative of cultural and industrial elites, and very far from intercepting current practices. There is a cognitive debt that requires new, strategic alliances between the research and construction sector, to develop “cutting-edge” technologies - new hardware that, by their nature, are assigned to hyper-specialist skills - and bottom up software, which respond to local and specific needs to facilitate the capacities of companies with different positions on the market.

An alliance able to launch innovative practices of technology transfer, where top down modalities are integrated and substantiated by “clustered” exchange of knowhow and experience, to enhance the “embedded knowledge” that continues to characterize the actors of the construction process and the quality of building as well. An alliance aimed at creating new skills and professionals, so that the introduction of enabling technologies (or rather dedicated software) into the construction process responds to the demands of cultural and economic democracy, necessary to guarantee human responsibility in the environment transformation processes, also interpreting the needs of inhabited space, according to the new, crucial ethics of living. As the Institute For the Future studies reiterates, we will need new stories to imagine the essence of our future, living environments, social relations, markets and businesses (IFF, 2016). Research in architecture has to provide firmness and quality to these spaces.

References

Arthur, B. (2011), *La Natura della Tecnologia. Che cos'è e come evolve*, Codice Edizioni, Torino

Crutzen P., Stoermer E. (2000), The “Anthropocene”, in *Global Change Newsletter*, vol. 41 (May), pp. 17-18.

De Biase, L. (2016), *Homo Pluralis. Essere umani nell'era tecnologica*, Codice Edizioni, Torino.

EU-COM/2012/341 final (2012), “A European strategy for key enabling technologies-A bridge to growth and jobs”, 26 June.

EU-COM/2017/0479 final (2017), “Investing in a smart, innovative and sustainable Industry A renewed EU Industrial Policy Strategy”.

Floridi, L. (2014), *The Fourth Revolution. How the Infosphere is Reshaping Human Reality*, Oxford University Press.

Gere, C. (2004), “New Media Art and the Gallery in the Digital Age”, *Tate Papers*, n. 2.

Hultén P. (1968), *The Machine as seen at the end of the Mechanical Age, Introduzione al Catalogo*, MOMA Publisher.

IFF Institute For the Future (2016), *2016 Ten-Year Forecast Report*, available at: http://www.iftf.org/our-work/global-landscape/ten-year-forecast/2016-ten-year-forecast/ (accessed on August 7 2018).

Morin, E. (2002), *Il Metodo. Volume V. L'identità umana*, Cortina, Padova.

Schwab, K. (2016), “The Fourth Industrial Revolution”, World Economic Forum: https://luminariaz.files.wordpress.com/2017/11/the-fourth-industrial-revolution-2016-21.pdf (accessed 3 August 2018).

VINT (2014), “The Fourth Industrial Revolution Things to Tighten the Link Between IT and OT”, available at: https://www.fr.sogeti.com/globalassets/global/downloads/reports/vint-research-3-the-fourth-industrial-revolution (accessed 5 August 2018).

3.20 ENABLING TECHNOLOGIES FOR CONTINUOUS AND INTER-DEPENDENT DESIGN

Flaviano Celaschi, Daniele Fanzini*, Elena Maria Formia**

Abstract

Design is undergoing a great transformation due to the introduction of new technologies, new models, new organisational systems and new missions, the connotations of which are not yet completely clear. What does design mean today? Who is the design destined for? What value does the activity yield? How is design linked to the production process? What is the relationship with those who commission the project? But above all, who are the project commissioners of today? Beginning with the concept of the mutating city, or rather the city as a living organism that evolves over time in relation to the circumstances and needs of its inhabitants, this paper deals with the issue of technologies that enable continuous project production methods in response to some of the above questions.

Keywords: Mutating city, Continuous project, Codesign, Enabling technologies, Building Information Modelling

Introduction

The change in design processes follows the change in factors on which the project is based. In this sense, the rhythm by which we try to renew our toolbox of processes, methods, technologies and practices for carrying out a project is now apparent. The contemporary city, the place to live *par excellence* of the new millennium, in which the ability of humans to adapt is really put to the test, is apparently still linked to the modern idea of the industrial city.

However, simply by measuring the parameters of functionality and quality of life, the difference is clear: overconsumption of energy, rising air temperatures, the high cost of procuring water and food supplies, the increase of uncontrolled poisonous substances, the disproportionate and rapid movement of peo-

* Flaviano Celaschi is a Full Professor at the Department of Architecture, University of Bologna, Italy, flaviano.celaschi@unibo.it.

* Daniele Fanzini is an Associate Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, daniele.fanzini@polimi.it.

* Elena Formia is an Associate Professor at the Department of Architecture, University of Bologna, Italy, elena.formia@unibo.it.

ple and things, the overproduction of waste or the lack of recycling, etc., indicate a scale of emergency which cannot be tackled with the tools of the past. The costs involved in the abandonment of brownfield sites, the real or perceived increase in crime, the awareness of the flow of city users active in the territory, the cost of certain services and events, population density, the perception of the happiness and wellbeing of citizens (social networking) are of no lesser importance.In the face of these problems, certain difficulties attract our special attention as researchers. The most evident are: the design of temporality and temporal variables involved in transformation, the need to experiment in the field rather than in laboratory, the sharing of objectives with citizens, but also the processes necessary to achieve this, the education of the masses about using the territory and resources with less devastating results. Rizzo asserts that great change occurs when environmental entropy is too elevated, this brings about a move towards a different energy model and consequently to the birth of new technologies and new economic, social and political institutions (Rizzo, 1989). This interpretation is particularly interesting in reference to our living environment, the most significant changes to which – using as an example the transformations brought about by the industrialisation of goods and services production processes – have an energy matrix with negative implications: progressively increasing the amount of energy used, we have indeed increased the entropic process and degradation of our living environment with evident consequences for today. As highlighted by Rizzo (1989), the use of energy-consuming technologies does not necessarily cause an increase in productivity, if anything it may result in a reduction of labour, which nevertheless represents one of the possible ways of using the available energy. In order to re-establish a good relationship with the environment, the paradigm needs to be inverted: the true revolution «does not mean the substitution of human work with advanced technological tools, but the invention and application of technological systems which allow a greater amount of labour to be made better use of»[1]. Not only, therefore, to reduce energy consumption, but to make better use of the work which the energy is capable of providing, to protect the environment and fundamental values of our society: «How a city is designed, built, maintained and managed depends on its energy supply»[2] and the move from quantitative growth and high entropy to qualitative and low entropy growth is the solution which needs to be pursued through technology.

The city, therefore, is going through necessary and essential mutation. Thus, it is also necessary and essential to study and disseminate different approaches to the management of this transformation, which is continuous, as is the work of the designer who aspires to achieve it.

---

1 Cf. Rizzo, 1989, p. 73.

2 Cf. Rizzo, 1989, p. 74.

Design policies for the mutating city

Key factors of change, like those referred to in the introduction, cause serious problems for the city, with unimaginable consequences in the future. The dimension and cost of this fragility is impossible to know; the growth or attenuation is impossible to perceive. However, this latent element is in fact the ground zero for evaluating and quantifying the gravity of the phenomenon, to design/forecast the intended change and to demonstrate the will to invest in the transformation. As asserted by the first studies on the crises of current urban models elaborated in the Sixties, traditional top down planning approaches are no longer effective. This situation is countered by the vision of the mutating city which is continually self analysing by means of the representation and social sharing of the elements of transformation and which plans, in real time, possible solutions based on awareness and participation. A vision which is fed by the relationship of interdependence between the built environment and the mental state of the people – space-feeling-action – (Fanzini, e al., 2018) and which allows design anticipation to be used as an instrument for increasing the resilience of the ecological-social system. Design experience and the use of enabling technologies means that projects based on the following operational structure can support sustainable urban transformation:

- study of fragility factors and the impact on the area under examination;
- acquisition of sensitive data and its social sharing;
- codesign and involvement of the stakeholders and citizens in data analysis;
- Setting up communication systems which aim to define what is ethical and unethical urban behaviour, comparison with other similar urban centres (continuous competition and comparison), presentation and celebration of ethical citizens and behavioural guidelines;
- implementation of adaptable systems of governance which exploit the potential of the widespread social network (citizens as sensors) to support the central decision-making processes.

In this proposal, the mutating city becomes the paradigm to verify anticipation by design, through the presentation of scenarios and models for urban transformation. The discussion is supported by a theoretical background: the constant-latent-receding factors constitute a base element of the proactive design driven process. An approach which adapts the concept of anticipation developed by social sciences to design (Celaschi, 2016; Formia, 2017, Celaschi et al., 2018). In this sense, the urban dimension represents a platform of meeting and exchange, both because it is a natural place for the sharing of expertise and because it includes a variety of stakeholders. Some examples around the world are moving in the direction of anticipating models and scenarios of continuous, sustainable and shared change. Among these are the *Città Leggera* (Italy); Incheon Living Lab (South Korea); Sencity (USA); Rock Project (Italy); Guadalajara Digital (Mexico).

In these projects, the digital transformation mediated by the relationship with people (Industry 4.0) overtakes the functional paradigm of the smart city and becomes, thanks to the mediation of design, architecture and built environment technologies, a strategy which counters the dystopian vision of the city of the future. This reality is continually monitored and effectively represented in order to share the changes and investments necessary for the inefficient to be corrected and regenerated day-by-day.

Enabling technologies and the continuous project of the mutating city

In order to re-establish a balanced relationship with the ecosystem, as frequently cited in the introduction, Rizzo (1989), proposes a difficult if not actually improbable existential and epistemological passage towards a low entropy society, characterised by a dominance of qualitative and spiritual values over those of purely quantitative and high energy intensity. Over thirty years later, while the basic principles of this proposal are upheld, it assumes new meanings and operational implications: availing of new and powerful exosomatic instruments (as also defined by Rizzo), the epistemological and existential pathway necessary to save humankind, finds the means necessary for its realisation.

To understand how this can be made possible we must return to the mutating city concept expressed in the second paragraph, which views the city as a unique Living Lab. A living place because it is made up of various types of living (or at least active) and interacting components that, thanks to enabling technologies, is able to monitor its own status in real time and to share the results. A place which Dioguardi (2009) foresaw almost ten years ago as a structure in which real socio-technical networks of intelligent terminals are activated in the form of real "urban laboratories" (Dioguardi, 2009, p. 173).

The interaction between citizens and their own living environment by means of continuous monitoring of conditions makes them responsible and calls them to account for the real issues of that living environment, in a parametrical and geolocalised way, and to participate, also on a project level, in finding solutions to those problems. All this conditions their behaviour and facilitates the autopoietic assumption of responsibility. The implications are extensive and promising: with regards the environment, for example, this makes the union between ecobiological reflection and social anthropology issues possible, a concept which Casurano (2017) presents as the basis for a new and balanced ethic of the project. This union breaks away from the schemes we are used to, which are based on scales of differentiation, roles, contractual relationships, and are viewed mainly as a contrast of responsibilities rather than as the promotion of possible partnerships. If we look at what is happening today in the field of urban regeneration, a subject which unites all the various realities of our territory, we can see how the relations between planner, user, developer, financier are not as defined as in the past: the roles alternate and, very often, the agreements of partnership and collaboration make the difference. The impacts on the planning process are evident through cocreation, codesign, tangible collaboration tools and practices. The key factor is the moving from the "fixed" logic of the project activity, which represents partial decisions defined at a given time, to the "continuous" and interdependent concept of the project; its framework is the fluid exchange of information between animate and inanimate components of the city, between administrators and users, between citizens, through the functional and intelligent use of the information systems. Industry 4.0 (Celaschi et al., 2017) offers an interesting approach to the human-machine partnership, launching a strategic message to the operators: enabling technologies will increasingly provide possibilities for value creation, not only through specialisation, but also and above all, the appreciation of widespread creativity:

> «with this approach, intelligence can be the result not only of the cognitive and emotional capacity of individuals, but also the ability to relate to and collaborate with the various components of a system, living beings and forms of artificial intelligence» (Bagnato, 2014, p. 50).

Fig. 1 - Areas of man-machine collaboration in Industria 4.0 (source: Celaschi, 2017).

Apart from advanced sensor technologies which allow the real time connection of the physical realities of the city (traffic flow data, for example) to the intangibility of decision making, there naturally emerges the need for the harmonious and shared design practice which Ratti (2017) defines as "of mutation". In other words, technologies able to facilitate the interaction between different individuals within the complex decision-making process. In the planning sector, the diffusion of Volunteered Geographic Information, VGI, has allowed for the investigation of social dynamics and preferences of citizens, contributing to the identification of new relationships between communities and places in which communities live and to sustaining the transdisciplinary relationship between planning, design and VGI, which brought into being the new discipline of Geodesign (Mourao Moura et al., 2018).

This same experience can be replicated at other levels of the project, from the building sector to the objects which furnish public spaces, giving life to other new disciplines and new organisational models of production. Building Information Modelling (BIM) is established as a new technology able to facilitate design management as a form of collaboration in the fields of engineering and architecture. It can also be applied at all levels (from the environment to the territory, to an individual artefact) and to all projects (from new builds to restoration, to urban and environmental regeneration). This particular technology is becoming rather widespread, due also to it now being an obligatory requirement for new public procurement contracts. The applications available on the market prioritise technical planning, neglecting another important aspect, namely that which precedes the activation of a project, or the definition of the essential framework. The principal use of BIM really stems from the possibility of establishing a profitable collaborative relationship between all the individuals involved in the planning process, primarily the commissioning body, whose task it is to define, in an informed and reasoned way, the planning alternatives and choices in the design definition phase.

In the field of industrial product design, it is stated that:

> «planning can begin with two different approaches: it can take its lead from the requirements, or it can be led by an exercise in creation, visualisation and prototyping» (Rizzo, 2009, p. 129).

The ability to read the potential of a territory, to express the visions and requirements adequately (firstly in spatial terms) and to establish the rules for the management and control of the design process are the premises for the practice of the "continuous project". Within this, BIM can work "as a metaphorical change driver" (Cribini 2016), an efficient vehicle for change to guarantee collaboration, interaction of expertise, collaboration between individuals, continuity of decision processes. This is true if it is mainly used for its cognitive mediation potential, rather than pure and simple standardisation.

Enabling technologies, the continuous project of the mutating city and the impact on production organisation models

Numerous examples of the biological metaphor of the mutating city, namely of the city as a living organism, can be found in the literature. As well as the previously cited work of Ratti (2017), it is interesting also to quote Bagnato's point of view (2014, p. 51), which specifically refers the biological metaphor to the world of vegetation in order to define the future conditions of the production model in view of a possible fourth industrial revolution:

> «to be rooted in the territory, reproducing widespread productive units, not to be hierarchical, to leave each party (individuals) free to follow their own strategies, to be oriented towards problem solving using the resources of the external, economic and physical environment» (Bagnato, 2014).

These same elements can be traced in the “holonic virtual” enterprise concept (Merli et al., 1994) – which we can today express as digital – coined to describe a systemic type of production configuration which is highly flexible, reactive and adaptable. A model which has led to the concepts of “neogood” and “neomanufacturing” and which breathes new life into the building sector, giving form and meaning to the networked production model presented and designed by Gianfranco Dioguardi, who, in 1983, used the term “macro company” or “company systems” to describe the overview of actors involved in achieving the production objectives of a company. In light of these considerations, the concepts of macro company or company systems, thanks to enabling technologies, can today be transferred to the project, viewed not as a single phase in the production process, but as combined enterprise management which, thanks to information modelling, is able, while maintaining the performance logic of the measurement of results, to include various points of view, different project aims. At the SIT*d*A Conference 2018 in Reggio Calabria, Filippo Angelucci explained:

> «in some circumstances, management still expects an authorial rather than an evolutive project, without confronting the subject of the metamorphosis of space […] we have the possibility to become enablers through technology […] that is, to find connections, compatibility, to build through different levels of intervention».

Enabling technologies are capable of greatly increasing this possibility, to the point of surpassing those very organisational models which still base their effectiveness on the contraposition of responsibilities.

References

Bagnato, V. (2014), *Architettura e rovina archeologica*, Aracne, Roma.

Casurano, R. (2017), *Per un’etica del progetto*, Timìa, Roma.

Celaschi, F. (2016). *Non industrial design*, Sossella, Milano.

Celaschi, F., Montanari, R., Padula, G. (2017), “Approcci all’innovazione trainata dal design”, *MD Journal*, n. 4, pp. 74-86.

Celaschi, F., Formia, E., Iñiguez Flores, R. León Morán, R. (2018), “Design Processes and Anticipation”, in Poli R. (ed), *Handbook of Anticipation*, Springer, Cham, Switzerland, pp. 1-21.

Ciribini, A.L.C. (2016), *BIM e digitalizzazione dell’ambiente costruito*, Grafill, Palermo.

Dioguardi, G. (2009), *Organizzazione, cultura, territorio*, Franco Angeli, Milano.

Fanzini, D., Bergamini, I., Rotaru, I. (2018), “Anticipation in built environment design”, in Poli, R. (ed), *Handbook of Anticipation*, Springer, Cham, Switzerland, pp. 1-28.

Formia, E. (2017), *Storie di futuri e design*, Maggioli, Rimini.

Merli, G., Saccani, C. (1994), *L’azienda olonico-virtuale*, Il Sole24Ore, Milano.

Mourao Moura, A.C., Campagna, M. (2018), “Co-Design: digital tools for knowledge-building and decision-making in planning design”, *Disegnarecon. Journal of Architecture and Cultural Heritage*, vol. 11, n. 20, pp. 1-3.

Ratti, C. (2017), *La città di domani*, Einaudi, Torino.

Rizzo, F. (1989), *Economia del patrimonio architettonico ambientale*, Angeli, Milano.

Rizzo, F. (2009), *Strategie di co-design*, Angeli, Milano.

3.21 DESIGNING COMPLEXITY: FROM UNCERTAINTY TO KNOWLEDGE EXCHANGE

Daniele Bucci, Ottavia Starace**

Abstract

The current condition of uncertainty in "making architecture" is nothing more than a reaction to the change of contemporaneity. This paper aims at reflecting on the role of the architect who, within the design processes, should be able to read in a systemic way the territories, using dynamic approaches to contextualize and configure methodologies able to foster collective planning and a new glocal relational dimension. The objective of the research is to understand, through the analysis of a case study, how the organizations constituted by these new professional figures are changing and how these distributed networks can lead to further changes in the design practices of the people who are part of it.

Keywords: Architectural design, Complexity, Glocality, System thinking, Human network

What today is defined as conditions of uncertainty and disorder in architecture is an integral part of a problem concerning scientific knowledge and contemporary society in general. Society is the product of the continuous interaction between individuals, whose products are necessary for the production of the same or of other products (Morin, 2017). Thus, emerge two fundamental and undeniable aspects of our contemporary: the complexity and the indissoluble relationship between things and the facts of the world. These two concepts call into question not only the approach to knowledge, but redesign the professional roles, reconfiguring the boundaries and fields of application.

Therefore, on one side we can record an evident mutation in the architectural disciplines. At the same time, the challenges posed by sustainability issues are looming. And it is not the final product, whose constructive systems are the result of a reaction to the environment, to be intended as sustainable, but the whole process, from the analysis to the realisation, and to the final disposal. Then the sustainability shall be considered as one of the main requirements of the entire lifecycle of the project.

Over the years, the same project has changed in terms of role and value within the urban and territorial system. In fact, the project is no longer seen as a

* Daniele Bucci is a Systemic Designer and Freelance Researcher, dnlbcc@gmail.com.

* Ottavia Starace is a PhD student at the Laboratoire EVCAU dell'ENSA Paris-Val de Sein, France, ottaviastarace@gmail.com.

concluded *unicum* whose value and role are expressed by the signs and languages of which it is the bearer, but it increasingly becomes an indissoluble part of a broad and complex system. The architectural project alone is no longer enough to satisfy the needs of a territory, it is no longer considered a self-sufficient island, but it is also a way of getting in continuity with the territory; this means emphasizing and giving a fundamental importance to the relationship between things, thus modifying the role of the project, which becomes an island part of an archipelago (Merlini, 2013). This position finally seems to actualize and fill with meaning what academically was defined as a sense of belonging to the context. In this case, belonging to the context means to become part of a territorial system, in which connections assume greater importance than the object itself (Gausa, 1999). It is clear that if the importance is shifted on the connections rather than on the object, the project will be able, or will have to be able, to respond and feed itself directly from the spatial and temporal context in which it is during all phases of its life. This means not only rethinking design practice but, above all, rethinking the role and responsibility of the designer. It is necessary that the designer places himself as part of an archipelago, as part of a complex fabric of knowledge, in which the interweaving and knots have value as the connections and as the whole fabric, overcoming the disciplinary compartment in which the architect is the sole arbiter of the project, so that he is one of the many bearers of knowledge within the design process. This process has been underway for years in the cultural sphere of design, where design is no longer considered as a personal cognitive process, but as a shared social process (Cross, 2011). Moreover, these methodologies are bringing a vision focused on the study of the context and on the testing of appropriate solutions through prototyping and iterations in a continuous process of rebalancing the design taken from cybernetic science (Dubberly, Pangaro, 2015). This approach implies, above all, an act of true understanding of contexts and projects, in which understanding means intellectually learning together, knowing both the text and the context, the parts and the whole, the multiplicity and the one (Morin, 1999). This implies that the architect has a holistic sensibility and that he is able to work with a team of other professionals who are equal to him. The territories are complex systems so, in order to rightly understand them, they have to be addressed in a systemic way. This implies that it is essential, before the design response, to start from the detection of dynamic, reproducible, adaptable, semistructured and shared methodologies within the design practice. The territorial complexity requires us to formulate strategies rather than static programs. As explained in a comprehensive way by Edgar Morin (2017) the strategy is the art of using the information that manifest themselves in action, to integrate and formulate action patterns that are able to put together the most certainty in order to face uncertainty in the best possible way.

This also involves the development of methodologies whose concepts are never closed and concluded, in which the knowledge spheres are open and joint, in which it is essential not only the multiscale aspect but the multidimensional aspect too. In the multiscalarity and multidimensionality the singularities are always considered looking at the totality of which they are part and vice versa. The two concepts that seem to overlap in the meaning actually concern two different reference systems. Multiscalarity refers mainly to the physical and tangible dimensional character of the project, the scale.

Multidimensionality, of which multiscalarity is part, on the other hand covers all aspects of reality and always involves an individual, a social and a biological dimension where it is important the dialogical relationship between things, without whom the unit loses in plurality (Morin, 2017).

The development of methodologies able to incorporate the concept of multidimensionality within them, shifts the attention from the design response, which becomes an integral part of a process, to the processes of analysis. Therefore, to do analysis means to look for problems and potentialities present in a manifest or latent manner, approaching the context without anticipating a design response and constructing a set of questions coherent with emerging potentialities (von Hippel, von Krogh, 2015). The designer, or rather the group of designers (no longer just architects or urban planners), are thus able to provide answers that are more responsive to the potentialities, the problems and the resources of a territory, in such a way that the design action is actually part of that archipelago of signs and actions of which the territory is composed and that are in close relationship with each other.

This type of approach and this urgent need for a change in the design paradigm, from which arises the need to reassess the analysis and design of strategies within the architectural production, imply a large investment in terms of time and energy and a long and laborious process. At the same time, however, they lead to design strategies capable of responding to the real needs of the territory and its inhabitants, using them not only as a part of the process but also as a resource for the context. Therefore, multidimensionality is not a characteristic that belongs only to the project, but also to the approach to the profession. In fact, the designer is no longer just the architect, but the system in which it works (work team) and acts (territory), or the system in which the exchanges of skills and knowledge occur. This involves a necessary shift in the design actions, from centralized and traditionally top down to distributed, shared and bottom up. These project actions will necessarily be composed of long term strategies designed by planners and professionals with an overview in the long run (top down), and tactics directly adopted by the people living in the territory as direct answers to the problems of daily life and the small scale (bottom up).

These two approaches must constantly communicate, integrating and enriching each other. For this reason, neither of the two can be exhaustive if applied individually.

Design practices and the nature of the organizations that practice them changes, from centralized and pyramidal they become more or less formalized distributed networks (Barabasi, 2009) that revolve around the concept of boundaryless organization, that are not organizations undefined or limited by predefined structures, but able to reconfigure themselves according to need, where there is total accessibility if values, culture and practices are shared. The designer must therefore combine critical, social and psychological skills and must be able to establish a participatory and active involvement of the population, no longer intended as a user, but as a generative and fundamental element of the system.

He will also be called to share the skills and techniques in transparency, to allow a transparent understanding of the design process (Serafini, 2011). A concrete example to describe these new phenomena is represented by *CivicWise*, a network based in various European territories and in some Latin American countries.

Through this network, professionals and researchers in the field of civic design have the opportunity to get to know each other, exchange good practices and case studies. The people who are part of *CivicWise* have the possibility to get in touch in both physical and digital environment through an infrastructure built by a set of communication tools. The most used in the digital environment is *Slack*, which allows you to create themed rooms to discuss:

- internal global projects, useful for autopoiesis (Maturana, Varela, 1980) of the network;
- global thematic projects, are specific projects that can be shared globally by people who do not share a physical territory, most of the time they are large research areas and are not directly linked to a territorial context, such as *Mapping Lab* or *Civic Factories*[3];
- local projects, useful in building connections between people who share the same territories;
- civic design courses, which are held annually, are a very important moment of regeneration and openness in the network. All the people participating in the courses become part of the network having the opportunity to meet the other members of CivicWise. Through these courses are transferred values and basic information that represent the network itself, at the end of the path those who will feel more alike will remain inside while those who do not share certain work methods and behaviours will be free to abandon it.

To the digital context it is important to add other physical ones aimed at the growth of the experience, knowledge and skills of the individual. Currently the most important are:

- the *Incontro Civico* (*Encuentro Civico in Spain*), a national meeting point that consists of an informal gathering to update the nodes of the network,

[3] Civic Factories are part of a project that aims to build a network between people that manage regenerated spaces that act as hubs of social innovation in territories in which they arise. As of 2018, there are four Civic Factories: in Valencia, in the Canary Islands, in Modena and Paris.

talk about the projects in progress, introduce new people and new realities, do team building activities and discuss growth strategies in the national network;

- the *Glocal Camp*, international gathering of the entire CivicWise network that chooses a city to meet, providing support to the territorial organization group to accelerate local projects. During this event, which lasts between one and two weeks, it is possible to work on network governance so that the structure of the system adjusts the strategies to the tactics adopted in the previous months at the glocal level, remaining flexible and adaptive.

This brief description of the territories, both digital and physical, in which *CivicWise* works, makes it clear how the design of the organization and the functions that derive from it can strongly influence the ways in which the designer is required to work today. Moreover, in continuity with the intuitions of Carlo Doglio and in particular with his approach to design as an action that relates human facts, their expression in material forms and spaces, that puts the relationship between social and physic city at the centre of attention (Doglio, 1963), the designer has the power to actualize the approach considering his action field not only the city, but the entire territory both in its physical form and in its digital form.

References

Barabási, A. L. (2009), *Linked: how everything is connected to everything else and what it means for business, science, and everyday life*, Plume print, New York.

Cross, N. (2011), *Design Thinking: Understanding How Designers Think and Work*, Bloomsbury Academic, Oxford.

Doglio, C. (1963), "Il piano della vita", *Comunità*, n. 109, pp. 67-77.

Dubberly, H. and Pangaro, P. (2015), How cybernetics connects computing, counterculture, and design, available at: http://www.dubberly.com/articles/cybernetics-and-counterculture.html (accessed 3 May 2018).

Gausa, M. (1999), *The metapolis dictionary of advanced architecture*, Actar, Barcelona, 2003.

Maturana, H.R.,Varela, F.J. (1980), *Autopoiesis and cognition: the realization of the living*, D. Reidel, Dordrecht.

Merlini, L. (2013), "L'île d'utopies et les archipels du projet", Des Utopies réalisables, Y-Type éditions, Genève, pp. 147-154.

Morin, E. (2017), *La sfida della complessità*, Le Lettere, Firenze.

Morin, E. (1999), *Les sept savoirs nécessaires à l'éducation du futur, Organisation des Nations Unies pour l'éducation, la science et la culture*, Paris.

Serafini, S. (2011), *Liberazione partecipata dello spazio dall'iperreale. L'Italia come esperimento biourbanistico*, available at: https://www.researchgate.net/publication/214824166 (accessed 7 July 2018).

Von Hippel, E., Von Krogh, G. (2015), "Crossroads-Identifying Viable 'Need Solution Pairs': Problem Solving Without Problem Formulation", *Organization Science*, vol. 27, issue 1 (December 30), Paper n. 5071-13, pp. 207-221, MIT Sloan Research.

3.22 TOWARDS AN EPISTEMOLOGY OF PRACTICE: RESEARCH AND DESIGN ACTIVISM

Renata Valente[*]

Abstract

The condition of misunderstanding between the roles of design culture and the society containing them indicates the need to refound practice and its methods. This can be done through transdisciplinary scientific redefinitions with integrated and complex project approaches. The education of the various levels of the commission to the complexity of the transformative processes, has a strategic function towards a conscious participation. These changes require reflection about an epistemology of practice based on theoretical speculation that accepts and cultivates uncertainties and doubts. The indicated directions are the research applied to the profession and the socially committed proactivity. Academia must support them with dedicated teaching programmes and public engagement.

Keywords: Roles, Uncertainty, Public interest, Perkins+Will, Kieran Timberlake

Introduction

Catastrophic events such as the collapsing of structures and infrastructures show the urgency to reflect on the state of the design culture and the construction management. In the Italian civil society, there is a widespread unawareness (in citizens as well as in administrators who have to manage infrastructures and collective services) of the technological culture related to the buildings they live in and use, as well as of the ecosystem dynamics of the settled territories and their relative hazards. Reflecting on the designer's active role in contemporary society is more necessary than ever. The reason is the disconnection between the knowledge of academic culture on the advancement of the building process criteria and the real national operating conditions, with further local differences, before major works or everyday constructions. It is very appropriate the definition of architecture by the past president of the Venice Biennale, Paolo Baratta, as the most political of the arts with an informative but also pedagogical-political function.

[*] Renata Valente is an Associate Professor at the Department of Engineering, University of Campania Luigi Vanvitelli, Italy, renata.valente@unicampania.it.

Roles and Trans-disciplinarity

The contemporary situation shows a widespread unawareness of the designer's skills, confusion of roles, frequent encroachment of actions by professionals that are not prepared for the required tasks. It is necessary to recover credibility by defending with determination the cultural developments of the discipline, while social and political evolution leads to collaborative needs between different parties, requiring new skills and a tendency to complex and lateral thinking. This transdisciplinarity, typical of architectural culture especially in environmental design, calls for a composite character of the designer, bearer of humanistic and technical specifics with diplomatic and mediation qualities.

> «we architects can make ourselves indispensable within a system which will never be deprived of specialists, but is going to need more and more places of synchronization and coordination between the parties, attempting to strongly reaffirm the social and ethical role which the architect has always had in the history of the construction of places» (Faroldi, 2017).

The urgency is to absorb and transmit updated paradigms with new tasks to undertake, addressing ethical, ecological and social issues. Among these there is the importance of an educational approach for a transversal awareness of the society strata. The administrators responsible for collective asset management, as well as the private individuals who handle their own assets or entrusted ones, are not always professionals in the field. The complexity of the transformation process of the natural and built environment must be presented to them, by explaining roles, skills and objectives. This is to provide the tools to consciously comanage habitats, even with different cultural levels. In the meantime, it is also urgent to reposition the role of the architect, because the professional crisis is not only about general economic and sector contingencies, but architects have been displaced from the traditional activities and rarely are part of the decision-making bodies (Kanaani, Kopec, 2016). Moreover, the (rare) services of architecture are destined for increasingly restricted social groups, losing the connotative ethical mandate of this profession; the project must therefore return to being proactive, pervaded with collective responsibility. There are many users who have not been reached because they do not know what the project is; it is our task to explain and propose it, also because space and its construction are political issues. This approach is expressed in Schön's theory of reflective practice (1983), for which the designer, who has been in a crisis of recognition for decades, recovers it when he vehicles messages of reliability, as well as the search for justice and social security. After all, the difficulty of recognizing one's own present role facilitates the search for new transdisciplinary transgressions, already described as a current need for a new approach. This opening of the boundaries of knowledge facilitates the speculative aspect in professional practice: consequences are the management of transcalarity, the telescopic dimension within the project and the acceptance of uncertainty, in contrast to the outdated deterministic criteria (Belanger, 2017).

Doubt and uncertainty

Contemporary philosophical culture, from Morin to Serres, is pervaded by scepticism towards deterministic methods, accepting doubt and risk rather than (false) certainties. Yet, designers hardly recover the relationship with civil society and the client, precisely because the most up-to-date operational criteria deviate from deterministic principles of certainty, now inadequate, which are however those to which the user in general refers. Thus, beyond a communicative resetting of the scenario of traditional processes, it is necessary to prepare for the consideration of new approaches and objectives to overcome ineffective structures. This widespread uncertainty, therefore, although being a symptom of transparency and qualification, adds difficulties of acceptance, requiring clients to have cultural preparation which is not uniformly spread and paradoxically absent in the most educated classes, rooted in traditional criteria.

> «This is not so much random uncertainty, the result of the large number of independent causal variables at play in processes of transformation of the built environment, as epistemic uncertainty, the result of the impossibility of creating sufficiently detailed models of reality due to incomplete knowledge» (Campioli, 2017).

Yet architecture has the duty to offer a different point of view.

> «Today, working with doubt is unavoidable. […] Instead of stable systems we must work with dynamic systems. Instead of simple and clear programmes we engage contingent and diverse programmes. Instead of precision and perfection we work with intermittent, crossbred systems, and combined methods. Suspending disbelief and adopting a global understanding is today an a priori condition, a new fundamental for creative work in science, urbanism, and architecture. Working with doubt becomes an open position for concentrated intellectual work. We are committed to working with doubt creatively and enthusiastically» (Holl, 2010, p. 13).

Project research: two examples

One of the strategies for the refounding of professional practice discussed here is project research, acceptance of the speculative dimension combined with operational practice and driving it forward. The project disorientation of the reflective professional finds comfort there, developing it in offices of different sizes in diverse ways and verifying how essential it is for an innovative action, despite being expensive, challenging and risky (Aksamija, 2016).

As a further transdisciplinarity, the practice based on artistic and scientific speculation is spreading (Hensel, Nilsson, 2016). A leading experience in project research is Perkins+Will office with one thousand five hundred employees in offices around the world. Strongly believing in the value of research, the SDI Sustainable Design Initiative on training and best practices was launched in 2004.

In 2008, the Building Technology Laboratory (Tech Lab) started investigating systems and materials, while the Digital Practice Group generated and analysed information to collect data and process them in the DEAR Design Excellence Annual Review structure. In the Innovation Incubator, employees propose ideas that can be financed with micrograntes of time and money. To share research reports, the results are published in the Perkins+Will Research Journal (a biennial peer review that since 2008 documents research associated with practice on buildings and contexts, the first example of its kind) and in the Tech Lab Annual Reports. Finally, since 2011 the non profit research organization AREA Research (Advanced Research and Expanding Application) has connected practice and academy for mutual benefit, importing into the profession information from the research process and data from practice to research (Hensel and Nilsson, 2016). The application results concern facade performance simulations, experimental modelling protocols (using WUFI analytical software), processes for choosing technical solutions, studies on materials that influence asthmatic pathologies, shared on the "Transparency database". This considerable effort is however affected by the discontinuity of budgets or projects and the study works to reduce the distance between practice and research, even with a Director of Research who identifies issues and solutions.

The case of Kieran Timberlake, on the other hand, concerns an office with ninety staff units. The holders, instructors at the University of Pennsylvania, decided in 2000 to leave the teaching of the "design studio" and start a "design research laboratory". This change has been reflected in the professional and publishing activity, in which they refer to design processes based on the management of information in virtual models to optimize systems by reducing waste and consumption, implementing the formal result. The projects Cellophane House or Loblolly House express the research on the assembly and reassembly of elements, the thermal performance of transparent and translucent curtain walls, the reduction of time and the maximization of performance. Thus, since 2008, the study has had a "rhizomatic" and pervasive research activity (ivi, 2016) that concerns each station of the study, described in the Research and Environmental Design (RED) reports. The result is the two of the six 2013 Research and Design Awards, for the study on the vegetation of green roofs and for the network of wireless sensors developed to simplify and economize the collection of microclimate data in buildings. The belief is that the designer's work today requires environmental and ethical reliability, having defined a new post-professional hybrid space, on the one hand referring to the digital economy of industrial processes and on the other hand adopting technological processes that suggest applications in different climates and cultures (ibid., 2016, p. 57).

These speculative practices propose a designer figure who dialogues with *academia* and with culture, binding himself to society and its needs, nourishing the dialogue between the parties involved.

Activism and public interest

The other strategy for the re-establishment of professional practice concerns the new direct interest in and responsibility for the ethical aspects of one's own work.

> «The profound social and economic changes facing contemporary societies define new design areas and modes of action, placing at the centre of the debate the social, ethical and political dimension of architecture» (Perriccioli, 2017).

The project becomes a widespread phenomenon for a multitude of subjects: a new generation of architects rediscovers activism and the historical figures of Team X are essential references, according to "an approach that creates an epistemological reversal" (ibid.). If the current social condition is different from the references of the past, this reversal still makes the figure of the designer central, with activist procedures that involve the contemporary and participatory work of different parties, provided that new roles are recognized. Activism can be intervention by civic authorities in a social space to protest and perhaps correct actions by civic authorities (Shelley, 2017). Not restricted to individual project disciplines, it alters the conditions for urban experience; it is not for the technique itself that it defines itself as militant, but for the effects it is able to produce for the user, with projects of public utility and general interest such as health or justice (Bell, Wakeford, 2008). By bringing architecture closer to society with its needs and by serving it, spreading architectural services, the activist project also recovers the cultural value of utopia, considering action a process that transforms the production of space and the distribution of power.

> «Designers can make a vital contribution to democratic design and the public realm through critical analysis, intellectual discourse, and knowledge production. […] Perhaps most importantly, designers can produce and valorize democratic social relations by making thoughtful contributions to the physical spaces where collective experience occur» (Bell, Wakeford, 2008, p. 91).

While designers have the skills to connect the figures and needs of recipients of social architecture interventions, these users often have no financial resources. Three solutions are generally adopted: the designers' provision of time and effort[1], donations and funding for works of public interest, the implementation of self-financed initiatives that create economic opportunities, such as sales of goods, microcredit programs, or crowdfunding. In any case, proactive attitudes are needed, looking for recipients of projects who do not suspect that they need them or have the opportunity to afford them. This can be done through a strong affirmation of one's own competences and areas of action, also by working intensively to seek alliances between activists and enlightened (or more often to be enlightened) entrepreneurs.

---

[1] For example, to develop a culture of public engagement, John Peterson launched a national campaign in 2005 with the structure "Public Architecture" that urges architectural firms to devote 1% of their working time to *pro bono* initiatives.

To this end, *academia* must recover critical and cultural value as a driving force, through training that is able to explain roles and recover spaces, transforming the design process from reactive to proactive. Instead, in Italy in particular, there is little official teaching on the topic, although it is necessary to create a strong approach to public interest, educating people to ask themselves who they want to work for and what ethical role they can play in the world (Kanaani, Kopec, 2016). Schools in the USA have done a lot in the past decades, particularly with community design groups (Valente, 2017). Today, as a consequence of the Boyer Report (Boyer, Mitgang, 1996), which advocated the need to work in schools of architecture to instil commitment in the relationship with society, the National Architectural Accrediting Board (NAAB) in the United States has chosen to evaluate the consideration of cultural diversity and social equity as a positive condition for the accreditation of educational structures (Kanaani, Kopec, 2016). But in the United States as in Italy, training programs on such aspects are not mandatory, despite the students' interest. A direction suggested by the position of the NAAB and applicable in the Italian national territory, concerns the development of what in the indicators of accreditation and evaluation protocols is indicated as Public Engagement, an aspect which is not always properly carried out. The increase in activist practices of social involvement through didactic work and research can find attention and stimulus precisely considering the evaluation obtainable at ministerial level, instrumentally urging also interlocutors who are not always sensitive to such issues of design for the public interest.

Crucial points for an activism action plan are therefore the designers' education to this approach, the establishment of an information network to share projects, problems and scenarios, the creation of a tax infrastructure which makes these operations easier and the continuous involvement of entrepreneurs and recipients of projects for the public interest.

The condition of misunderstanding between the roles of the design culture and the society containing them denounces the need to refound practice and its methods. Project activism includes each of the aspects described: aiming in a theory for transdisciplinary scientific redefinitions that outline integrated approaches; working in practice for the strategic function of educating the various levels of clients to the complexity of transformative processes, so they can consciously participate in them.

These changes require reflection on an epistemology of practice, based on theoretical speculation accepting uncertainties and doubts. The two main directions instrumentally indicated here are research applied to the profession and committed proactivity. In each of the two areas, *academia* must also support the refounding of roles with the courage to propose an assertive cultural line, which is updated in training, participatory in social dynamics, propulsive by means of advanced research, critical, visionary, fascinating, because this is the task that awaits it and that must not be abandoned.

References

Aksamija, A. (2016), *Integrating innovation in architecture: design, methods and technology for progressive practice and research*, John Wiley & Sons, West Sussex.

Bélanger, P. (2017), *Landscape as infrastructure: a base primer*, Routledge, New York, NY.

Bell, B., Wakeford, K. (eds) (2008), *Expanding architecture: design as activism*, Metropolis Books, New York.

Boyer, E.L., Mitgang, L.D. (1996), *Building Community: A New Future for Architecture Education and Practice: A Special Report*, Carnegie Foundation, Princeton, NY.

Campioli, A. (2017), "Il carattere della cultura tecnologica e la responsabilità del progetto", *Techne*, n. 13, Firenze University Press, Firenze, pp. 27-32.

Faroldi, E. (2017), "L'opera di architettura come esperienza intellettuale", *Techne*, n. 13, Firenze University Press, Firenze, pp. 14-20.

Hensel, M.U., Nilsson, F. (eds) (2016), *The changing shape of practice: integrating research and design in architecture*, Routledge, Taylor & Francis Group, New York.

Holl, S. (2010), *Urbanism Lavorare con il dubbio*, Libria, Melfi (orig. 2009, Princeton Architectural Press, NY).

Kanaani, M., Kopec, D. (eds) (2016), *The Routledge companion for architecture design and practice: established and emerging trends*, Routledge, Taylor & Francis Group, New York.

Perriccioli, M. (2017), "Innovazione Sociale E Cultura Del Progetto", *Techne*, n. 14, Firenze University Press, Firenze, pp. 25-31.

Schön, D. A. (1983), *The Reflective Practitioner: How Professionals Think in Action*, Temple Smith, London.

Shelley, C. (2017), *Design and Society: Social Issues in Technological Design*, Springer AG.

Valente, R. (2017), "American Design Activism", *Techne*, n. 14, Firenze University Press, Firenze, pp. 147-157.

3.23 Technological Regenerative Design to improve future urban scenarios

Antonella Violano[*]

Abstract

The regenerative design provides buildings in harmony with nature, with limited ecological footprint and coevolutionary generative principles. If the entire design process follows the Cradle to Cradle approach, the synergic relationship between building and surrounding environment increases. Thanks to its biotic and transformed-biotic materials, building assumes the behaviour of an organism that interacts, adapts, evolves with the context. It uses energy of the sun and earth's resources, produces oxygen and CO_2 sequestration, closes the cycle of water and waste, breathes and it is built with materials recyclable at the end of their useful life. The contribution illustrates conceptual structure and criteria of an evaluation model on which the technological design principles are based.

Keywords: Regenerative Architecture, Cradle to Cradle approach, Grown materials, Regenerative Design, Technological footprint

Introduction

Resilience reserves, from which it is possible to draw in order to feed the future scenarios of the human habitat, are intrinsically present in nature and in its generous capacity to reintroduce dialogic and sensitive human processes into its life cycle. According to the ecocentric approach, the scientific paradigm emphasizes the epistemological integrity implicit in ecology and the ecological metaphysical reality. Therefore, Architecture sees its design and construction processes discussed, based on logics such as: uncontrolled consumption of resources, unpredictable pollution and parasitic development. If the ecosocial approach had already stated that there is a dialectic connection between nature and human beings, the Cradle to Cradle (C2C) approach takes an important step towards the transition from a linear to a closed loop system. The process of growth and consumption of the linear system varies according to a defined and linearly dependent number of variables; the closed loop system is characterized by reduced negative environmental effects, compensated and controlled through the reintroducibility, as input of a subsequent process, of the factors

[*] Antonella Violano is an Associate Professor at the Department of Architecture and Industrial Design of University of Campania Luigi Vanvitelli, Italy, antonella.violano@unicampania.it.

that result to be output of the previous cycle. Whatever the process of anthropogenic growth or transformation, the type of output (read: waste) can be an input (read: nutrient, raw material, energy, etc.) for something else (Braungart, McDonough, 2002). In architecture, if the whole design process follows the C2C approach, the synergic relationship between the building and the surrounding environment increases, thanks to a renewed energy and environmental balance. Thanks to the coevolution and adaptation capacity, the environmental impacts are progressively reduced and cushioned by the resilience of its environmental surroundings, and at the end of their useful life the reintegration into the natural cycle is total and with positive utility. However, the complexity of the management of this process innovation[1], requires the help of specific project methodologies[2]. Focusing on the development of innovative solutions about materials, the C2C approach is strongly interdisciplinary and oriented to the qualification and differentiation of the matter, traceable with certifiable standards. Thanks to its materials (biotic and transformed biotic: biobased materials), the building assumes the behaviour of a real biological organism that interacts, adapts, evolves, protects and fully exploits the resources of the context.

Regenerative architecture for a symbiotic city

The study evaluates in comparison the ways of making architecture that have evolved in recent years, through the performance of building materials generally used. Starting from Traditional Architecture, which for centuries founded the design model on Vitruvian triad: *Firmitas*, *Utilitas* and *Venustas*, and then from Modern Architecture (which with the advent of the frame construction system has progressively felt the need to manage the flow of materials and energy through an increasingly lighter envelope), contemporary architecture, identified as the architecture of sustainability, represents the first significant evolutionary step. It has mainly focused on optimizing performance (mostly in terms of energy) in the operational phase alone, also making eco-oriented metadesign choices, which have had a positive impact only and partially on the environmental balance of the cradle and grave phases.

Then, scientific experimentation opened new frontiers to technological design, developing design methodologies (more than specific technological solu-

---

[1] Design is managed as a decision-making process «that based on the evidence of the technical and scientific knowledge, orients and reorients the creative input depending on the objectives and constraints of the context» (Fanzini, Bergamini, Rotaru, 2017).

[2] The "Generative Design" could represent a useful support tool that can guarantee both a traceable solidity to the technological culture of the project, and the control of the "certifiable quality" of a design and its constructional feasibility, optimizing the performance of the three relevant components: efficiency of plant systems, resilience of the envelope and intrinsically regenerative quality of materials, in an absolutely transdisciplinary and multiscalar perspective.

tions) that aim to give an added biological value to the building organism. This, already perfectly in line with the mandatory requirements of efficiency and environmental compatibility, is called upon to play the role of generator of ecosystem services for an increasingly symbiotic city[3] that

> «seeks to promote a *syntropy* urban system i.e. an ecosystem that allows the encouragement of economic and sociocultural development of cities and urban areas, but whose almost cyclical metabolism makes the best use of imported resources and minimises waste rejection» (Lufkin et al., 2016, p. 3).

We are talking about the Regenerative Architecture (Reed, 2009) that proposes buildings that, through materials and components, are in synergy with the natural biological cycle and have a limited ecological footprint.

With Regenerative Architecture we go beyond the concept of sustainable conservation of resources, intervening proactively in the restoration/improvement of ecological conditions of a habitat, including the urban one.

In the regenerative design, organic materials are not only used, but inserted in a metabolic way in the system; synthetically biomimetic materials are not only imitators of a natural process, but they implement in themselves the metamorphosis of the process that leads to another vital element of the system that, because it is closed, regenerates itself intrinsically.

The proposed evaluation model

The research underlines the added value of the regenerative approach, comparing three examples of materials, systems and components belonging to the following categories: traditional architecture; sustainable architecture; regenerative architecture, assessing them according the ratio Performance/Environmental Costs and comparing them on the basis of four categories of indicators (Tab. 1) derived from the ISO 21929-1: 2011 standard, divided into functional phases: 1. Production; 2. Construction; 3. Operational phase; 4. End of life.

The need to assess the level of quality performance arises, highlighting the difference between sustainability performance of a building and its contribution to a sustainable development.

Particularly, the former is closely linked with the intrinsic qualities emerging in the phases of the life cycle; the latter is linked with the positive self-multiplicative effects that can be produced as consequence of appropriate choices.

---

3 Symbiotic city is based on three complementary and convergent axes: 1. increasing the intrinsic efficiency of cities; 2. systematically enhancing renewable resources; 3. implementing urban symbioses. (Lufkin et al., 2016).

	Criteria	Range
PRODUZIONE	Approvvigionamento di materie prime	1. Da fonte non rinnovabile con bassa disponibilità 2. Da fonte non rinnovabile con alta disponibilità 3. Da fonte non rinnovabile con basso potenziale di rigenerazione 4. Dalla fonte rinnovabile con un alto potenziale rigenerativo 5. Dalla rifiuto di materiali rinnovabili / non rinnovabili
	Trasporto *[Distanza / Disponibilità]*	1. Massima distanza e minima disponibilità 2. Massima distanza e media disponibilità 3. Media distanza e media disponibilità 4. Minima distanza ed elevata disponibilità 5.Distanza trascurabile e massima disponibilità
	Produzione *[CPP/QRF]* *CPP = Complessità del processo di produzione* *QRF = quantità di risorse necessarie per la fornitura*	1. Alta CPP / alta QRF 2. Media CPP / alta QRF 3. Media CPP / media QRF 4. Minima CPP / media QRF 5.MinimaCPP / minima QRF
COSTRUZIONE	Trasporto in cantiere	1. Internazionale 2. Nazionale 3. Regionale 4. Locale 5. Km zero
	Costruzione e istallazione *[QRU / QRF]* *QRU = Quantità di Rifiuti utilizzata* *QRF = quantità di risorse necessarie per la fornitura*	1. Massimo QRU / alta QRF 2. Medio QRU / media QRF 3. Minimo QRU /media QRF 4. Nessun QRU / minima QRF 5. Autocostruzione
ESERCIZIO	Uso *[Reactivity]*	1. Mantenimento inalterato delle proprietà intrinseche 2. Risposta reattiva modificando le proprietà dell'ambiente circostante 3. Riduzione della domanda di energia senza produzione di energia 4. No riduzione della domanda di energia, ma produzione di energia 5. Riduzione della domanda di energia e produzione di energia
	Gestione *[Mantenimento delle prestazioni nel tempo]*	1. Alta necessità di intervento per mantenere inalterate le sue prestazioni nel tempo 2. Media necessità di intervento per mantenere inalterate le sue prestazioni nel tempo 3. Bassa necessità di intervento per mantenere inalterate le sue prestazioni nel tempo 4. Nessun bisogno di manutenzione 5. Autogestione (comportamento rigenerativo)
FINE VITA	Riciclo / Riuso	1. Nessun riutilizzo / Nessun riciclaggio 2. parziale riutilizzo / riciclo parziale 3. Nessun riutilizzo / riciclaggio 4. Riutilizzo /Nessun riciclaggio 5. Riutilizzo / riciclaggio
	Discarica	1. 100% smaltimento in discarica (con rifiuti speciali) 2. 100% smaltimento in discarica (solo rifiuti ordinari) 3. dismissione parziale in discarica 4. decomposizione biologica 5. Reinserimento in un ciclo di vita successivo (C2C)

Tab 1 - Evaluation criteria.

Indicators must consider and calculate all life cycle stages and define the main aspects (see ISO 21929-1: 2011, par. 4.3.1) that could have potential impacts on the areas of protection (i.e. use of non-renewable resources), primary (direct) impacts on natural resources and secondary (indirect) impacts on ecosystem and economic prosperity. The research work compares four examples of building components belonging to the three typologies of architecture (Fig. 1):

1. transparent envelope
2. opaque envelope: curtain walls
3. opaque envelope: Insulation materials.
4. plant systems for heating and DHW production

Transparent envelope

The technological research in the construction industry reserves an extremely large range of combinations of the glazed surfaces performances, but the real potential for the transparent skin of the building is the ability to change, adapting itself, to different external conditions. (Violano, Verde, 2013)

1. common solar control glass, with pyrolytic coating, which associates a low solar factor to a good light reflection, ensuring favourable conditions of indoor comfort;
2. homeostatic *façade* (e.g. Homeostatic Façade System by Decker Yeadon in New York), a self-regulating *façade* system, automatically adjusts to suit changing external environment, such as sunlight and temperature variations. The system comprises a ribbon, made of dielectric elastomers, inside the cavity of a double skin glass *façade*.
3. photo-bioreactor system, the new frontier of biological architecture. It is based on the photosynthesis exploitation by the proliferation of microalgae contained in a Polymethylmethacrylate (PMMA) double panel. Through the photosynthesis process, microalgae proliferate, saturating water and preventing the transfer of the direct solar radiation, transforming into a biological brises soleil.

The building performances change according to the climatic conditions, turning architecture into a truly living organism.

Opaque envelope: curtain walls

The brick is one of the most common building materials. Three kind of bricks are analysed in this research:

1. clay brick, used in buildings for centuries;
2. hemp-lime brick, a highly insulating product, rigid and light, which permits great energy saving;
3. biobrick made up of biocement “grown” from microorganism in a mould at room temperatures, through a process that imitates the construction of coral or seashells (e.g. biobrick by BioMason).

Opaque envelope: Insulation materials

Three thermal insulations are compared: Expanded Polystyrene (EPS), cork (by FSC) and fungibased materials (e.g. Ecovative). From the graph, a substantial coincidence of the performance of these materials during their operating phase immediately emerges.

All the materials achieve a low score in terms of responsiveness to react to external conditions and a positive score in terms of maintenance. The main difference is in the Cradle Phase. The EPS, derived from a complex chemical processing expansion of polymers, has low scores for its nonrenewable sources and its huge use of energy and resources manufacturing. The cork is classified as a renewable source with a high regeneration potential and it presents positive score regarding the data of recycling. The third selected product is a grown mushroom-hemp material. The LCA analysis shows a high performance in "cradle" and "grave" phase. In fact, during the supply, the transport and the manufacturing, the impact of the process is very close to zero, because the cultivation of mushrooms takes place inside the seats of processing and has a very high potential for regeneration, even the same production phase requires a minimum use of resources. At the end of life, it can be reused after a simple crumbling returning in the production cycle.

Plant systems for heating and DHW production

The research has investigated the heating system of three different categories: boiler (traditional system), solar panels (sustainable system) and algae bioreactor (Regenerative system). In order to assess the environmental sustainability of a plant system we must consider all stages of the life cycle: consumption of raw materials/energy/water, transport, production, distribution, use and end of life. For a traditional boiler using fossil energy sources (natural gas, LPG, diesel), the use phase (over a useful life of 15 years) is the most important, because it determines the consumption of nonrenewable resources and polluting emissions for a long period. The traditional boiler and the solar thermal panel were compared with the Solar leaf Façade, the first bioreactive system generating renewable energy from algal biomass and solar thermal heat. During Construction and Production phase, the three systems have not a too diversified score, because these systems are constituted by a massive technological component, which requires for the Raw Material Supply or even for construction, a similar use of resources, materials, and processes.

About the end of life, only a few studies have been conducted regarding the disposal/recycling of solar panels. Instead, the component of the bioreactive façade can be recycled and reused, and finally reinserted totally in the LCA for the Disposal phase.

The results of overall these comparisons are illustrated into the Figure 1.

Conclusions

Designing an envelope that grows algae able to capture CO_2, constructing infill wall with self-repairing materials thanks to the action of bacteria and making it thermally efficient with thermal insulation produced by the action of fungi, adds a new meaning to the term Green Building.

The improvement of the conditions of adaptability to the context determines not only the conditions for which the building needs less and less energy, but also makes it able to coevolve with the ecosystem in which it is built, without any negative impacts, but even giving a positive contribute to the environmental balance.

The architecture that lives overcomes the performances of the homeostatic process and this research highlights the added value of the regenerative approach. The results obtained on the opaque envelope (curtain walls) show that the regenerative solution is the best, because in the operating phase there is an increase in the performance/environmental cost ratio during the “cradle” phase, because the embodied energy is lower. In addition, there is added value in the construction phase, and at the end of its life it returns to nature with a positive environmental impact.

About insulation materials, we can highlight two significant results of comparison. First, in the operational phase, the three types of materials present similar performances. However, cultivated materials have a production process that almost completely eliminates the impact in the “cradle” phase and have a wide range of possibilities of recyclability at the end of life.

About the transparent envelope, analysing the graph, it’s evident that in both phases of Construction and Production, the traditional, sustainable and regenerative systems have not diversified score (average score), because these systems are made by a massive technological component, which requires for the Raw Material Supply or even for the construction, a similar use of resources, materials and processes. A different consideration, however, must be done for the homeostatic *façade*, which results to have a score even lower than the other two systems, in Manufacturing and Transport to Site subphases, because their complexity.

For plant systems, the evaluation criteria should be different. In fact, the most significant parameter is the performance with the same energy source (renewable or no renewable). The match is played mainly in the operational phase, which determines the major environmental impacts. The use of more efficient plant system has implications on the environment in terms of emissions avoided. However, the reduction of environmental costs in the cradle and the grave are necessary but require strong eco-oriented engineering, which uses recycled / recyclable, but also disassembled and reused.

We must understand that sustainability will never achieve its needs if we do not change our behaviour, culture and way to work. This is the new frontier of architecture; this is the mental and behaviour innovation that asks to the technicians: let us cultivate ecological intelligence and change our way to design!

Acknowledgement
We would like to thank M. Cannaviello, L. Melchiorre, V. Montaniero and F. Verde for their cooperation in the research.

References

Braungart, M., McDonough, W. (2002), *Cradle to Cradle: Remaking the Way We Make Things*. New York, North Point Press.

Fanzini, D., Bergamini, I., Rotaru, I. (2017), “Teoria e prassi nella progettazione ambientale: scienze post normali e visioning process design per la sostenibilità”, *Techne*, n. 13, Firenze University Press, Firenze, pp. 151-158.

Lufkin, S., Rey, E., Erkman, S. (2016), *Strategies for Symbiotic Urban Neighbourhoods: Towards Local Energy Self-Sufficiency.* Springer International Publishing, Switzerland.

Reed, B. (2009), *The Integrative Design Guide to Green Building: Redefining the Practice of Sustainability*, John Wiley&Sons Ed., New Jersey.

Violano, A., Verde, F. (2013), “A transparent choice”, in Gambardella, C. (ed), *Heritage, Architecture, LanDesign. Focus on Conservation, Regeneration, Innovation,* La scuola di Pitagora editrice, Napoli, pp. 1176-1182.

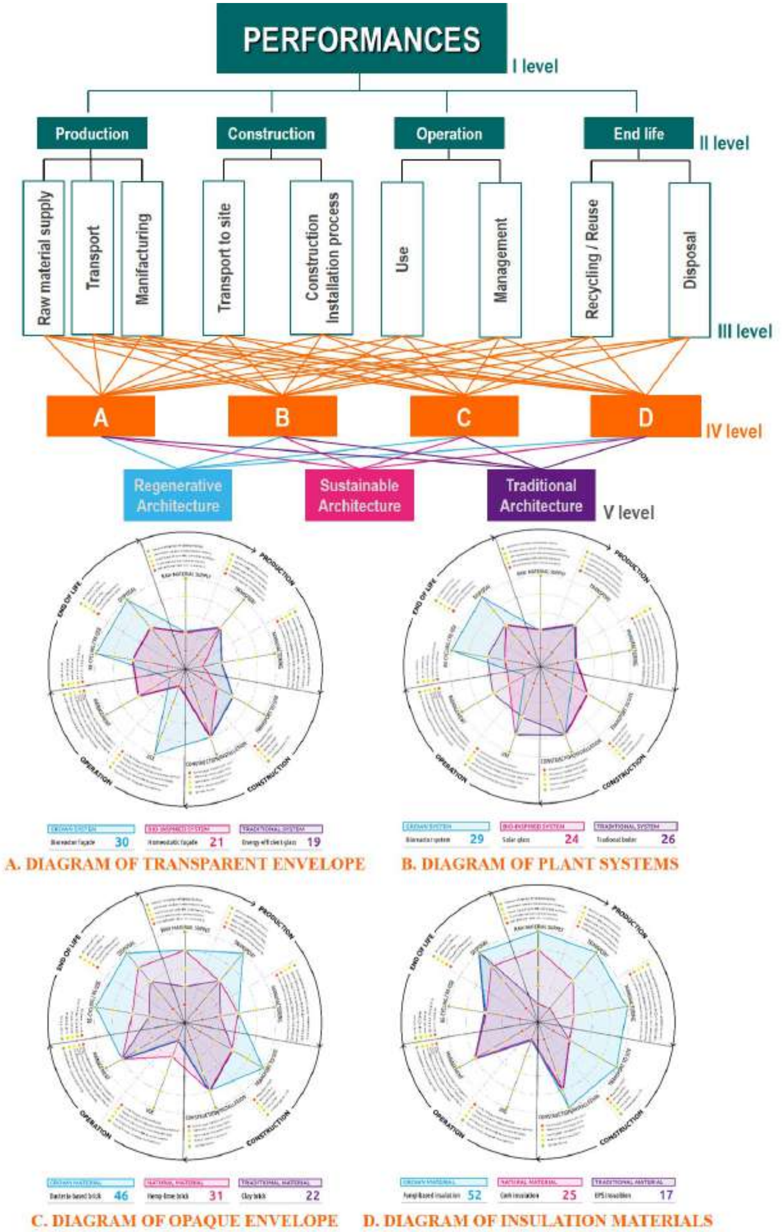


Fig. 1 - AHP hierarchy Model and diagrams of analysed components.

3.24 PRINCIPLES OF THE GREEN ECONOMY AND DESIGN STRATEGIES FOR CLIMATE ADAPTATION

Marina Block[*]

Abstract

The central role of adaptive design, in designing inclusive and resilient spaces, leads to investigate habitat modification processes in local contexts that, based on climate projections, prefigure actions of evaluation, verification and updating of data and influence the variables that affect the perception of comfort in urban space. The contribution suggests a possible Climate design strategy for the urban environment that, drawing on the principles of the Green Economy and simulating possible scenarios, provides tools and technical solutions of different nature aimed at responding to the alterations of urban space.

Keywords: Climate change, Adaptive design, Green economy, Local project, Urban district

Introduction

In response to the important environmental and climatic challenges to which our society is called upon to provide appropriate answers, the formulation of an operative methodology applied to the issue of the regeneration of peripheral and marginal urban districts through climate adaptive design approaches, aimed at adaptation and mitigation of the effects of climate change on the built environment and the improvement of environmental quality, is tactical.

The adaptive design approach in the implementation of regeneration programmes based on adaptation principles as a response to environmental and socio-economic challenges is in line with the EU development guidelines: from the objectives of Cities of Tomorrow to those of 2030 Climate and Energy Policy Framework, to the 2050 Roadmap initiative promoted by the European Climate Foundation, through the establishment of networks that relate resources, built environment and actors involved in the process and that are able to manage an increasingly complex system.

The modification of the local contexts' habitat requires to influence the variables that act on the well being of the urban space, defining adaptive responses

[*] Marina Block is a European PhD at the Department of Architecture of University of Naples Federico II, Italy, marina.block@unina.it.

to face the environmental impacts and prefiguring actions of evaluation, verification and updating of data and climate projections, in order to design inclusive and highly resilient spaces. The aims suggested by the Manifesto of the Green Economy (2017) underline the urgency of developing specific studies in different local contexts, to define regeneration strategies appropriate to the different climatic-environmental, settlement and socioeconomic features, as well as suitable tools for the control and measurement of the performances offered by the adaptation solutions. In collecting the inheritance from the normative and performance-oriented normative culture, the discipline of environmental design is measured with a «less deterministic dimension and more adherent to the complexity that characterizes the quality of living» (Lauria, 2014), and fosters the conscious and measurable introduction in the urban project for environmental input, explaining the differences on the local level, without losing sight of the systems' complexity, operating in an integrated way and also measuring objectives, constraints and resources, which the specific environmental contexts impose (Dierna, 1995). Within the Community and national legislative framework and in reference to complex decision-making processes, this integrated and systemic approach interacts with the emerging scenarios of digitization of the construction sector, which contribute to define for the urban project - in an environmental key - and for the building process, greater efficiency rationales, in which aspects of simulation, technical and performance control of environmental impacts emerge. Drawing on environmental, demographic and sociocultural data, adaptive design can identify, starting from the simulation of possible scenarios in a predictive and proactive project perspective, the most critical aspects and factors that affect the urban space and the effects that these have on people and their behaviour, providing tools and technical solutions aimed at responding to such unavoidable alterations. Through an appropriate culture of the environmental design addressed to the mitigation and adaptation in a climate change regime, also through attentive listening to social demand, technologically appropriate actions are proposed in which innovation becomes a strategic perspective and systematic tension of project action (Schiaffonati et al., 2011).

Innovative approaches for the urban project

The description of a methodology for adaptive design to support a sustainable urban project is developed through a multiscale approach that takes into account the different levels of planning - territorial, metropolitan, municipal, local - in light of the climate emergency and the aims set from the National Plan of Adaptation to Climate Change and from the strategic ones suggested by the Manifesto of the Green Economy.

The contribution of environmental design to local adaptation plans, as foreseen by the National Plan for Adaptation to Climate Change (2017), can take place at various scales and in different ways. An effective contribution can be found at the metadesign level using tools for the knowledge and transformation of the built environment, in the awareness of the phenomena affecting the urban system, intercepting socioeconomic and cultural transformations, the innovations of the regulatory framework and public policies on the environment, energy, planning (Mussinelli, 2015).

Overcoming urban studies of a mainly type-morphological nature, this approach develops on several dimensions - from the consideration of the specificity of contexts to the rational management of resources - and in a multidisciplinary approach useful for preserving the spatial dimension of design strategies, making use of innovation technology to identify positive effects on the quality of life and, therefore, on social processes.

The current European research guidelines identify in cities the contexts where the negative effects related to the climate change phenomenon will be most evident. The tendential worsening of climatic conditions and the increase in extreme weather events (rising temperatures, droughts, heat waves, more intense rainfall, rising sea levels), will hit more consistently those contexts, typical of the contemporary city, in which the conditions of liveability, endowment of services, identity, environmental performance and resources consumption, are already strongly disadvantageous.

Cities, and in particular peripheral and marginal areas, therefore require an urban project declined in terms of mitigation and adaptation, considering that

> «less efficient mitigation measures will require more significant adaptation actions: the mitigation and adaptation policies must be dealt with in concert, exploiting all possible synergies» (Mezzi, Pellizzaro, 2016).

Adapting the city to climate change also means acting, through the architectural design, exploiting the opportunities offered by the values of the contexts in which it operates considering «the territory a heritage from which to draw to produce wealth, continuing, through the production of new territorial acts, to guarantee their existence and to increase their value» (Magnaghi, 2010). The guidelines of the European Strategy for Adaptation to Climate Change COM (2013) 216, implemented in Italy by the MATTM in 2013, underline the urgency of developing specific studies in different local contexts, to define regeneration strategies appropriate to the different climatic, environmental, settlement and socioeconomic features, as well as suitable tools for the control of the performances of the adaptation solutions. In order to offer a further boost to the limited initiative that has taken place in Italy in response to the risks associated with Climate Change - only a few municipalities have in fact adopted an Adaptation Plan - in 2016 the 5th edition of the General States of the Green Economy dedicated a working table to development of a manifesto for architecture and urban planning, providing proposals and claims aimed at encouraging mitigation and adaptation policies in response to the climate challenge.

The focal points of the proposal are aimed at promoting green infrastructure and safeguarding water resources for the protection of natural capital and ecosystem services, encouraging circular models of economy and more sustainable mobility, and regenerating urban interventions that look above all to the redevelopment of the vast public heritage, in a conscious project of ecological conversion and exaltation of the quality of the cities, so that these can turn out to be more liveable and inclusive (Antonini, Tucci, 2017).

More recently, in the National Plan for Adaptation to Climate Change (2017), the socioeconomic and natural sectors were identified, within which to implement key actions on adaptation, alongside the top down approach of a large area, operations bottom up, to the urban district or neighbourhood scale, for a more detailed knowledge of the contexts on which we are going to act and a more accurate prediction about the measures to be implemented.

Environmental planning, intended as a redefinition of man's habitat, allows on the one hand to analyse the variables that act by altering the perception of well being in the urban space for defining adaptive responses to cope with the stresses of the external environment, on the other to update values of the past by integrating them in the present as resources and, therefore, «as goods that are a cultural reference of a new settlement project, contrasting both the degradation and the embalming of the environment» (Vittoria, 1985).

Climate design for the urban environment: a possible design strategy

A sustainable approach to the urban project looks at the urban district scale in the local project as the optimal dimension for the development of urban and environmental cycles, and attempts to define nature-based solutions for adaptive design interventions.

The local project themes, linked to the increase in the value of the territorial heritage for future generations and to the idea of bio-region as an institution of virtuous relationships between different focuses, identified within the entire territorial heritage, could allow the identification of the useful dimension to promote self-revaluation of identities in order to reduce the vulnerability to changes. The definition of the boundaries within which optimizing the cycle of urban metabolism and generating a multiplication of urban centralities, allows to favour the enhancement of historical identities and appropriate degrees of functional and productive complexity (Magnaghi, 2010).

This approach has already been widely accepted in international good practices, such as the adaptation plans of Hamburg, Rotterdam and Copenhagen, where environmental design emerges as a key factor in reducing vulnerability and enhancing the built environment, acting on the definition of the conforming dimension of the urban district in which implementing actions of mitigation and adaptation to Climate Change.

The further identification of homogeneous urban areas, an intermediate dimension between the urban district and urban elements, gives the possibility of considering potentially replicable interventions in areas with similar features.

The downscaling action allows a broadening of knowledge starting from the observation that the vulnerability of urban systems is influenced by the impact of climate change on the local scale on urban and natural elements, on people and economic, social and cultural resources.

The functional-spatial, technological and environmental performances, as well as the characteristics of the road layouts, of the orientation, of the morphological-type components, of the construction techniques, of the orographic conditions, of the green areas, strongly influence the system's vulnerability and require to be known and managed for foreseeing effective adaptation interventions[1]. Implementing strategies and adaptation interventions starting from the urban districts requires their coherent perimetration, taking into account natural and anthropic limits, as well as parameters relating to the homogeneity of the built up fabrics, the number of inhabitants, the covered area and the population density.

A district can in turn be divided into homogeneous urban areas, having similar features and bounded by criteria and connotative elements, such as natural and anthropical limits (landscape elements, infrastructures, main viability); density of the built (main viability, coverage ratio); prevailing functions (use of the buildings); building type (period of construction); relationship between open and built spaces (use of open spaces)[2]. Through environmental simulation software, it is possible to investigate the types of HUAs identified with respect to their climate profile and to a series of connotating indicators[3], revealing the presence of climatic vulnerabilities, which cause a depletion of natural capital, a weakening of the social capital, the erosion of the cultural capital and of the identity of the places and the general worsening of the energetic and environmental question.

---

1 This approach comes from studies and researches addressed in a wide way within the METROPOLIS – "Integrated and sustainable methodologies and technologies for the adaptation and security of urban systems" project, scientific coordinator: prof. Valeria D'Ambrosio, DiARC, University of Naples Federico II.

2 A more detailed level of detail in the definition of the conforming dimensions of urban districts and homogeneous urban areas was dealt within the PRIN 2015 – "Adaptive design and technological innovation for the resilient regeneration of urban districts in climate change regime" research, scientific coordinator: prof. Mario Losasso, DiARC, University of Naples Federico II.

3 Specifically, with reference to the results of the Degree Thesis in Urban and Environmental Planning, entitled "Principles of the Green Economy and Strategies for Local Adaptation Plans", by dr. Dario Colarusso, supevisor prof. Mario Losasso, tutor arch. Marina Block, have been investigated, through the ENVIMET software, the air temperature that affects the livability of open spaces; the surfaces albedo which, by retaining heat, cause the phenomenon of nocturnal reirradiation; the permeability of soils which, where absent, favors the increase in temperature; finally, a summary indicator, perceived thermal comfort (or PMV value).

This enables to define aims and strategic guidelines to prevent such phenomena and to identify a set of categories of mitigation and adaptation works which could be used within the field of the study and potentially replicable in the areas of the same type. Therefore, in relation to the aims of protecting natural capital, enhancing the heritage of cultural identities of places, mitigating and adapting to the causes and effects of Climate Change, of effective use and saving resources, we can identify a series of solutions, of which some nature based aimed at replicating the functions performed by natural ecosystems, which refer to categories of works distinguished according to their cost[4]. Comparing the effects at 2030 of the application of two light strategies and choosing the one that guarantees the greatest improvement, it is possible to consider the possibility of associating it with further interventions, making a deep upgrade, ensuring a clear improvement of the environmental comfort.

Conclusions

The proposed design strategy is an example of the contribution of environmental design within a local adaptation plan, starting from the definition of a district wide profile and defining, through a downscaling process, a set of adaptation and mitigation strategies for the identified vulnerabilities, distinguished by the different categories of area through the aims set by the principles of the Green Economy. In this way, adaptive design allows to overcome sectoral design guidelines through a systemic approach that looks at human comfort, environmental health, as an ecological, social, economic and cultural system, and finally at the flows of reciprocal interrelation to different scales (Forlani et al., 2016). Thereby we can activate design processes in which the territory can again be considered a place full of history, signs, values to be transformed into resources for the production of lasting wealth and to be transmitted enriched to future generations (Magnaghi, 2010), in response to the climate crisis we are facing. The identification of a conforming dimension to implement the various metadesign strategies and the development of solutions that enhance the specificity of cultural and environmental heritage, are innovative elements to support action plans of municipal or more extensive dimension, whose successful outcome cannot be separated from a phase of monitoring and evaluation of the effectiveness of the implemented actions, useful for defining good practices that can be replicated in similar contexts.

[4] With reference to the same study, interventions on surfaces have been indicated as light with particular attention to the impact of colour and shading on climate phenomena (trees, absorbing surfaces, cool floors and roofs, shielding elements), while greening for the redevelopment of public and collective spaces (rain gardens, green surfaces and roofs) have been defined as deep.

References

Antonini, E., Tucci, F. (eds) (2017), *Architettura, Città e Territorio verso la Green Economy. La costruzione di un Manifesto della Green Economy per l'Architettura e la Città del Futuro / Architecture, City and Territory towards a Green Economy. Building a Manifesto of the Green Economy for the Architecture and the City of the Future*, Edizioni Ambiente, Milano.

Dierna, S. (1995), "Tecnologie del progetto ambientale. Per una trasformazione sostenibile degli aspetti insediativi", in *Teaching in Architecture Energy and Environment World Network*, Proceedings of the Florence International Conference for Teachers of Architecture, Firenze, September 28-30, 1995.

Forlani, M.C., Mussinelli, E., Daglio, L. (2016), "Tecnologia, ambiente, progetto", in Lucarelli, M.T., Mussinelli, E., Trombetta, C. (eds), *Cluster in progress. La tecnologia dell'architettura in rete per l'innovazione*, Maggioli, Santarcangelo di Romagna.

Lauria, A. (2014), "Approccio esigenziale prestazionale e qualità dell'abitare", in Claudi de Saint Mihiel, A. (ed), *Tecnologia e progetto per la ricerca in architettura*, Clean, Napoli.

Magnaghi, A. (2010), *Il progetto locale. Verso la coscienza di luogo*, Bollati Boringhieri, Torino.

Mezzi, P., Pellizzaro, P. (2016), *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, Altreconomia, Milano.

Mussinelli, E. (2015), "Themes, scales and goals of environmental design", in Mussinelli, E. (ed), *Design, technologies and innovation in cultural heritage enhancemen*t, Maggioli, Santarcangelo di Romagna.

Schiaffonati, F., Mussinelli, E., Gambaro, M. (2011), "Tecnologia dell'architettura per la progettazione ambientale", *Techne*, n. 2, Firenze University Press, Firenze.

SGGE Stati Generali della Green Economy (2017), *La Città Futura. Manifesto della Green Economy per l'architettura e l'urbanistica*, SUSDEF Pubblicazioni, Roma.

Tucci, F., SGGE Stati Generali della Green Economy (2017), *Verso l'attuazione del Manifesto della Green Economy per l'architettura e l'urbanistica. Obiettivi, ambiti di indirizzo, strategie prioritarie*, SUSDEF Pubblicazioni, Roma.

Vittoria, E. (1985), "I casali della provincia di Napoli", *La Provincia di Napoli*, n. 1.

PERSPECTIVES. REFLECTIONS ABOUT DESIGN

*Elena Mussinelli**

The large panel of contributions documented in this volume conveys an articulated spectrum of cultural positions, research activities and experimentations, but also contributions of theoretical and methodological nature, questioning the ways of production of the project, in this phase of transformation - from the normative, procedural and instrumental point of view - of the building process, with changes affecting the different phases and scales of the project and its technical contents.

The points of view expressed are linked by a specific vision that refers to the peculiar conditions of observation of the design practice, as far as the Architectural Technology Area is concerned: with a critical eye that has always placed at the centre of the research the investigation of the operative methods of doing architecture, between project and construction, both in the perspective of the individual subject, the designer, and, above all, in that of the relationships between the multiple figures that in various ways are interested and invested in the project itself (clients, users, companies, etc.). The dynamics of innovation that have modified and continue to have a significant impact on the project activity are substantially ascribable to the impact of some central factors.

The first is related to the updating of the regulatory frameworks, also on account of the necessary harmonisation at European level, in matters such as implementation design, building and hygiene regulations, procurement procedures for public works and services, environmental and energy performance of buildings, building materials and subsystems. Provisions that often require design action to be guided by both process and new technical content.

A second factor, equally relevant, concerns the hard and soft technological innovation. On the one hand, therefore, there are new materials, components and construction techniques, with increasingly high and complex performances, not always easy to manage within a balanced time-cost-quality ratio; on the other hand, the impact of ICT, of the project digitisation tools and of the computerisation of the entire building process. These two fronts are very well researched in the second part of this publication, both for the critical issues that

---

* Elena Mussinelli is a Full Professor at the Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Italy, elena.mussinelli@polimi.it.

they bring about and for the opportunities that they open to the designer and other operators in the sector.

Not least, the evolution of demand at all levels (users, clients, businesses, public administrations) must be considered, in accordance with new and diversified objectives in terms of environmental quality, energy saving, flexibility, durability and maintainability, safety and cost containment. Such objectives, of also a structural nature, affect the techno-typological and functional characteristics of architecture, due to the different composition of housing units, with the emergence of specific users' - even very characterised (elderly, students, disabled, immigrants, etc.) - needs, and for an overall transformation of lifestyles, especially in cities.

Also, in this case, the change in demand has significant repercussions on design, for example, due to the need for a considerable horizontal extension of skills and a higher rate of specialisation and vertical deepening of knowledge.

In order to cope with this, the architect needs theoretical apparatus, methodological instruments and increasingly advanced technological devices, as well as more advanced organisational models of professional work; the commitment is certainly challenging, especially considering the characteristics of the architectural design in the Italian context, which are still largely characterised by "artisanal" work and populated by a large number of people who operate mainly individually, who are not very inclined to join together in evolved and complex corporate forms.

The topics briefly mentioned here are well known to the professionals in the sector as well as to those in the field of training; professional Orders and trade Associations, Universities and Ministries carry out periodic surveys and, for some time now, have started to discuss about possible actions to be taken, such as updating courses, internships and traineeships, for a greater interaction between the fields of education, research, profession and production. Overall, the picture undoubtedly presents critical issues, but at least it is the subject of attention and there is a certain awareness of the need for shared initiatives.

There is another front on which technological innovation determines a transformation of design action, combined with progress in neuroscience. This refers, particularly, to those areas of investigation that have recently explored how the understanding of the mechanisms, cognitive and perceptive processes of man with respect to the environment that surrounds him, can support the definition of design choices, in the perspective of architecture and urban spaces configured in close relation to the needs and conditions of the user.

Michael Arbib, Director of the USC Brain Project at the USC-University of Southern California, has identified three main areas of application of neuroscience in architecture, also considering the possible effects on the training of the designer architect.

On the one hand, the one related to the ways in which users experience the built environment from a neurological point of view (neuroscience of the architectural experience), on the other hand, the one related to "neuromorphic architecture", at the intersection between biophile design and smart buildings - constructions that begin to take on aspects of living, learning, and knowing[1].

The third area refers to the study of brain activity that develops during the design process. This is another area of reflection for which there is not yet adequate attention, with limited analysis often conducted by professionals outside the world of architecture. In the field of neuroscience there are, for example, many studies carried out and still in progress in order to understand the functioning of the brain and the modifications that occur at the cognitive level in the transition from manual writing (mainly italics) to keyboard writing or directly on screen (digital); much more scarce is the research on the transition from the traditional manuality of the sketch and technical drawing to the graphic elaboration given by hardware and software tools such as CAD, GIS, BIM, etc.[2].

Rather few studies reflect on the act of design, on its internal and external reasons, on the ways and the forms through which it is carried out, and on the same environmental conditions where the act takes place, during the various phases of the process, from the moment of conception to the work completed. With the aim of understanding how the "creative" and "technical" dimensions are developed and intertwined, also in their correlations with the complex of apparatuses that - from the graphic sign on the drawing board, through the mediation of hardware and software instruments - support the transition from the concept to the evaluation of alternatives, to the verification of feasibility conditions, until reaching a specific physical-spatial, technical, etc. solution.

It is a complex path, which rarely follows a linear and/or deductive trend, along which the designer makes choices that contextually bring into play subjective, and therefore individual, evaluations of an objective nature, linked to data, indicators and quantitative factors, such as economic ones, those related to the nature of demand or environmental performance. Almost in all cases this path is carried out through multiple interactions with other subjectivities and skills, in different places and contexts, that also intervene, to some extent, to modify the thought and the design path.

---

1 An interesting synthesis of these explorations, referring in particular to the interaction between individual and community in public space, is contained in Elnaz Ghazi's doctoral research, "Nuovi orizzonti e nuove potenzialità dello spazio pubblico. Interazione, socialità, comunicazione, tecnologie, neuroscienza", PhD in Architecture, theories and design, Sapienza University of Rome.

2 Among the most significant contributions are *The Thinking Hand* (Pallasmaa, 2009) and *How the Brain got Language* (Arbib, 2012), which investigate the hand-eye-brain-activity relationship. On the specific theme of representation: *La rappresentazione dell'architettura. Sapere e saper fare* (Gaiani, 2018). Similar investigations, referred to the action of writing and placed at the intersection between neuroscience and sociology, are developed in *Corsivo vs computer. Perché scrivere a mano* (Natta, 2016) and *Handwriting vs typewriting. Importanza della scrittura a mano nell'era dei nativi digitali* (Gilardoni, 2014).

Design thinking varies, indeed, when visiting a project site or seeing the footage taken by a drone, or standing at the drawing board and/or computer alone, or standing with thirty other people in the open space of a large design facility, rather than around a meeting table with a panel of experts, in the technical office of a municipality, on a construction site or in a building materials centre, in a teaching room, etc. If it is true, as the studies mentioned above suggest, that human-environmental interaction significantly influences perceptual and cognitive processes, it is reasonable to assume that these different contexts, with their different environmental conditions, also play a role in forming design thinking.

This is easy to understand if we think about the importance of direct observation of a place, a space, a built architecture (with the wealth of multisensory perceptions that they determine) in the formation of mental images that, through a more or less conscious and continuous exploration of memory, then inform the design act. In a recent contribution, Andrea Giachetta has highlighted how mental images can be interpreted as a synthesis of experiences, memories, sensory perceptions - visual, tactile, auditory, olfactory, etc. - of objects and spaces previously captured with the body in their physicality. The recalling, reinterpretation, revisitation, recombination, hierarchisation of these fragments of images and experiences present in the mind, is therefore the basis of the design act (Giachetta et al., 2019).

From this viewpoint, the immersive nature of architectural design is perhaps changing today: as Schiaffonati pointed out, knowledge of landscapes, urban places and architecture is increasingly mediated by the perception of indirect images (Schiaffonati, 2019), when is not by rendered simulations or reconstructions; with a perception that is all and only visual, often filtered and/or preconstituted by the gaze of others. It is not only the computer work that is changing the way we think and execute the project, but the whole universe of our cognitive references and the very modalities of learning in all fields of knowledge. The growing expansion of knowledge, which specialises and intersects at the same time, the high accessibility to data and information, the simplification of interfaces, the pervasiveness and ease of use of computer devices, support new ways of producing and using knowledge. In addition to the undeniable positive consequences, already widely documented in other contributions collected in this volume, the transition to the knowledge society also has negative impacts. Studies on the cognitive abilities of the so-called “digital natives” show, for example, a significant contraction in language skills (with a vocabulary that has decreased significantly between the end of the 1970s and the 2000s, from about 1,600 to about 500 words); and also a strong tendency towards multitasking, fast and randomised thinking in the search for information, explored in a rapid and horizontal way, with a clear prevalence of those in the form of images and very short texts; with forms and learning tools connoted by hyper-stimulation and a recreational character. For Italy, recent OECD surveys also highlight important shortcomings in terms of logical-formal and mathematical skills.

Giachetta also points out that the speeding up of all activities is radically changing the way of design: hand drawing, which requires time (and for this reason requires longer periods of reflection and exercise), has been almost completely abandoned, thanks to software that allows to prefigure the project from its initial conception, directly in three-dimensional and rendered form as far as materials and colours are concerned, and to define the techno-typical choices by applying predefined models and components.

As in the case of writing, hand gestures and posture change radically, as does the relationship between the hand, body and brain: the hand, previously engaged in complex activities that made it a real "catalyst of cognitive development", conforms its functionality to the logic of "click and play". And, as in the case of writing in the transition from italics to keyboard, the ability to know and recognise forms, to memorise them, to enrich one's mental archive of images also changes. Already in 2003 Emanuele Arielli, in his book *Pensiero e progettazione* (Thought and Design), had well highlighted how the act of drawing does not consist in the mere mechanical transposition of an idea on a physical support, but instead plays a relevant cognitive function in the process of the formation of ideas and mental images.

Fausto Novi underlined how the great efficiency and ease in the use of computer tools tends to shift the attention from the project to its representation, contracting the commitment to the study of space and matter that determine it (Giachetta et al., 2019). Even the stratification and, therefore, the memory, of the different configurations of the project in the various phases of study tends to get lost, no longer witnessed by the superimposition of the sheets of gloss, gradually overwritten by the updating of the images on the monitor.

I believe that the considerations of Novi and Giachetta - mainly oriented to a critical consideration on the learning processes in the project education - can be extended to the practice of design *tout-court*. For a design action more aware of how knowledge, experiences, images and past events built over time, are continuously reworked by thought - through the instrument of the hand and / or computer - to transform themselves into new forms, new places of experience and architecture. Undoubtedly, it is increasingly difficult to make the elements of knowledge deriving from the research. Technological innovation and the application of specialist skills interact and integrate with those deriving from the experience and the individual perception. This criticality often reflects into design and, therefore, also into architecture and places, characterised mainly by an unconscious adoption of technological, formal, functional and material choices, often completely indifferent and insensitive to the environmental context. Far from hoping for a nostalgic return to the past, thinking critically about these issues is now essential, even with more in-depth and targeted investigations on how digital culture is pervasively changing the ways of living and thinking, or else the already difficult link between thought and construction will end up becoming even more fleeting and underdetermined.

References

Arbib, M.A. (2012), *How the Brain got Language: The Mirror System Hypothesis* Oxford University Press.

Gaiani, M. (2018), “La rappresentazione dell’architettura. Sapere e saper fare”, in *MeTis. Mondi educativi. Temi, indagini, suggestioni*, vol. 8(2), pp. 13-49.

Giachetta, A., Novi, F., Raiteri, R. (2019), *La costruzione dell’idea, il pensiero della materia. Riflessioni sul progetto di architettura*, Franco Angeli, Milano.

Gilardoni, C. (2014), “*Handwriting vs tipewriting. Importanza della scrittura a mano nell’era dei nativi digitali”*, Corso di Rieducazione del Gesto Grafico 2013/2014, AED, Milano.

Natta, F. (2016), “Corsivo vs computer. Perché scrivere a mano. Percorsi cognitivi e orizzonti di ricerca”, *Studium Educationis*, n. 2, Pensa MultiMedia Editore srl, pp. 23-34.

Pallasmaa, J. (2009), *The Thinking Hand: Existential and Embodied Wisdom in Architecture*, John Wiley and Sons Ltd, Chichester.

Schiaffonati, F. (2019), *Paesaggi milanesi. Per una sociologia del paesaggio urbano*, Lupetti Edizioni di Comunità, Milano.

Book series STUDI E PROGETTI

Books

1. Andrea Tartaglia, *Project Financing e Sanità. Processi, attori e strumenti nel contesto europeo*, 2005.
2. Daniele Fanzini (ed), *Il progetto nei programmi complessi di intervento. L'esperienza del Contratto di Quartiere San Giuseppe Baia del Re di Piacenza*, 2005.
3. Fabrizio Schiaffonati, Elena Mussinelli, Roberto Bolici, Andrea Poltronieri, *Marketing Territoriale. Piano, azioni e progetti nel contesto mantovano*, 2005.
4. Matteo Gambaro, *Regie evolute del progetto. Le Società di trasformazione urbana*, 2005.
5. Silvia Lanzani, Andrea Tartaglia (eds), *Innovazione nel progetto ospedaliero. Politiche, strumenti tecnologie*, 2005.
6. Alessandra Oppio, Andrea Tartaglia (eds), *Governo del territorio e strategie di valorizzazione dei beni culturali*, 2006.
7. Fabrizio Schiaffonati, Arturo Majocchi, Elena Mussinelli (eds), *Il Piano d'area del Parco Naturale della Valle del Ticino piemontese*, 2006.
8. Matteo Gambaro, Daniele Fanzini (eds), *Progetto e identità urbana. La riqualificazione di piazza Cittadella in Piacenza*, 2006.
9. Lorenzo Mussone, Luca Marescotti (eds), *Conoscenza e monitoraggio della domanda di mobilità nelle aree metropolitane: teoria, applicazioni e tecnologia*, 2007.
10. Luca Marescotti, Lorenzo Mussone (eds), *Grandi infrastrutture per la mobilità di trasporto e sistemi metropolitani: Milano, Roma e Napoli*, 2007.
11. Giorgio Casoni, Daniele Fanzini, Raffaella Trocchianesi (eds), *Progetti per lo sviluppo del territorio. Marketing strategico dell'Oltrepò Mantovano*, 2008.
12. Elena Mussinelli, Andrea Tartaglia, Matteo Gambaro (eds), *Tecnologia e progetto urbano. L'esperienza delle STU*, 2008.
13. Elena Mussinelli (ed), *Il Piano Strategico di Novara*, 2008.
14. Fabrizio Schiaffonati, Elena Mussinelli, *Il tema dell'acqua nella progettazione ambientale*, 2008.
15. Raffaella Riva, *Il metaprogetto dell'ecomuseo*, 2008.
16. Fabrizio Schiaffonati, Elena Mussinelli, Roberto Bolici, Andrea Poltronieri (eds), *Paesaggio e beni culturali. Progetto di valorizzazione dell'Area Morenica Mantovana*, 2009.
17. Matteo Gambaro (ed), *Paesaggio e sistemi territoriali. Strategie per la valorizzazione della fascia contigua al Parco naturale della Valle del Ticino piemontese*, 2009.
18. Roberto Bolici, Andrea Poltronieri, Raffaella Riva (eds), *Paesaggio e sistemi ecomuseali. Proposte per un turismo responsabile*, 2009.
19. Fabrizio Achilli, Daniele Fanzini, Valeria Poli, Cesarina Raschiani (eds), *Popolare la città. Cento anni di case popolari a Piacenza*, 2009.
20. Giovanni Boncinelli, *Simmetria e funzione nell'architettura*, 2009.
21. Giorgio Casoni, Daniele Fanzini, *I luoghi dell'innovazione. Complessità, management e progetto*, 2011.
22. Marta Ferretti, Tamara Taiocchi, *26 Km Bergamo - San Pellegrino Terme. Strategie e progetti per la riqualificazione della ferrovia della Valle Brembana*, 2012.
23. Giorgio Bezoari, Eduardo Salinas Chávez, Nancy Benítez Vázquez (eds), *San Isidro en el Valle de los Ingenios. Trinidad. Cuba*, 2013.

24. Elena Mussinelli (ed), *La valorizzazione del patrimonio ambientale e paesaggistico. Progetto per le Corti Bonoris nel Parco del Mincio*, 2014.
25. Fabrizio Schiaffonati, *Il progetto della residenza sociale*, a cura di Raffaella Riva, 2014.
26. Fabrizio Schiaffonati (ed), *Renato Calamida, Marco Lucchini, Fabrizio Schiaffonati Architetti*, 2014.
27. Giovanni Castaldo, Adriana Granato (eds), *Un progetto per gli scali ferroviari milanesi*, 2015.
28. Elena Mussinelli (ed), *Design, technologies and innovation in cultural heritage enhancement*, 2015.
29. Fabrizio Schiaffonati, Elena Mussinelli, Arturo Majocchi, Andrea Tartaglia, Raffaella Riva, Matteo Gambaro, *Tecnologia Architettura Territorio. Studi ricerche progetti*, 2015.
30. Oscar Eugenio Bellini, *Student housing_1*, 2015.
31. Maria Teresa Lucarelli, Elena Mussinelli, Corrado Trombetta (eds), *Cluster in progress. La Tecnologia dell'architettura in rete per l'innovazione / The Architectural technology network for innovation*, 2016.
32. Paola De Joanna, *Architettura e materiali lapidei. Strategie sostenibili e processi estrattivi*, 2016.
33. Luca Mora, Roberto Bolici, *Progettare la Smart City. Dalla ricerca teorica alla dimensione pratica*, 2016.
34. Fabrizio Schiaffonati, Giovanni Castaldo, Martino Mocchi, *Il progetto di rigenerazione urbana. Proposte per lo scalo di Porta Romana a Milano*, 2017.
35. Raffaella Riva (ed), *Ecomuseums and cultural landscapes. State of the art and future prospects*, 2017.
36. Daniele Fanzini (ed), *Tecnologie e processi per il progetto del paesaggio. Reti e modelli distrettuali*, 2017.
37. Andrea Tartaglia, *Progetto e nuovo Codice dei contratti. Innovazioni nel processo edilizio*, 2018.
38. Roberto Ruggiero, *La versione di Rice. Cultura progettuale di un ingegnere umanista*, 2018.
39. Sergio Russo Ermolli (ed), *The Changing Architect. Innovazione tecnologica e modellazione informativa per l'efficienza dei processi / Technological innovation and information modeling for the efficiency of processes*, 2018.
40. Andrea Tartaglia, Davide Cerati (eds), *Il progetto di valorizzazione dei territori rurali metropolitani Proposte per il Sud-Abbiatense / Design for the enhancement of metropolitan rural territories Proposals for the Sud-Abbiatense*, 2018.
41. Oscar Eugenio Bellini, Andrea Ciaramella, Laura Daglio, Matteo Gambaro (eds), *La Progettazione tecnologica e gli scenari della ricerca*, 2018.
42. Maria Teresa Lucarelli, Elena Mussinelli, Laura Daglio (eds), *Progettare Resiliente*, 2018.
43. Massimo Lauria, Elena Mussinelli, Fabrizio Tucci (eds), *La Produzione del Progetto*, 2019.
44. Oscar Eugenio Bellini, *Student housing_2. Il progetto della residenza universitaria*, 2019.
45. Daniele Fanzini, Andrea Tartaglia, Raffaella Riva (eds), *Project challenges: sustainable development and urban resilience*, 2019.
46. Eugenio Arbizzani, Eliana Cangelli, Laura Daglio, Elisabetta Ginelli, Federica Ottone, Donatella Radogna (eds), *Progettare* in vivo *la rigenerazione urbana*, 2020.
47. Sergio Russo Ermolli, *The Digital Culture of Architecture. Note sul cambiamento cognitivo e tecnico tra continuità e rottura / Notes on cognitive and technical change between continuity and disruption*, 2020.
48. Elena Mussinelli, Andrea Tartaglia (eds), *Nodi infrastrutturuali e rigenerazione urbana. Stazioni, spazio pubblico, qualità ambientale*, 2020.

E-books

Maria Teresa Lucarelli, Elena Mussinelli, Laura Daglio, Mattia Federico Leone (eds), *Designing Resilience*, June 2019.

Maria Azzalin, Eliana Cangelli, Laura Daglio, Federica Ottone, Donatella Radogna (eds), *Il progetto tra ricerca e sperimentazione applicata. Il contributo dei giovani ricercatori*, October 2019.

E-books Open Access

Raffaella Riva (ed), *Ecomuseums and cultural landscapes. State of the art and future prospects*, December 2017.

Daniele Fanzini, Andrea Tartaglia, Raffaella Riva (eds), *Project challenges: sustainable development and urban resilience*, December 2019.

Associazione culturale Urban Curator Tecnologia Architettura Territorio (ed), *Una strategia per il sud-est di Milano. L'hub di Rogoredo. Progetti, operatori, infrastrutture e valorizzazione ambientale*, February 2020.

Elena Mussinelli, Andrea Tartaglia (eds), *Nodi infrastrutturuali e rigenerazione urbana. Stazioni, spazio pubblico, qualità ambientale*, October 2020.