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Icons of the Italian Style. The façade of Olivetti headquarters building in Milan (1954)

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Abstract. The Olivetti historic headquarters in Clerici Street (Milan), built in 1954, is considered one of the most meaningful Italian works of the period after the Second World War. Designed by the architects Gian Antonio Bernasconi and Annibale Fiocchi, and by Marcello Nizzoli, the designer of the company at that time, the building is one of the foremost achievements in the field of industrialization and prefabrication applied to the construction sector at that time in Italy. The project aims to reflect the "style" rather than the greatness of the brand. This result is obtained using innovative architectural solutions which are the expression of the principles that have always distinguished the brand: modernity, high efficiency and great precision. The building looks like a suspended volume, placed on a wide grid of reinforced concrete pillars coated with black oxidized aluminum. On the south-west front, the surface of the suspended volume consists of a curtain wall with mechanically orientable *brise-soleils* in aluminum. Since its construction, *Palazzo Olivetti* was considered as one of the greatest practical implementations of prefabrication, industrialization, mass production, optimization and use of highly specialized technologies. For this reason the building façade represents an icon of the Italian style of that period and the use of digital technologies is a significant implementation for its preservation and performance management.

Keywords: Construction History, Italian Style, Reinforced Concrete Construction, Building Customization, Curtain wall, Olivetti Built Heritage.

1 Introduction: the curtain wall and the International Style

The definition and application of curtain wall is the result of the long evolution of windows over time. In this system, the window frame, as a technological item, highly specialized thanks to industrialization, becomes itself architecture [1], and an identity element of International style overseas and *Moderno* movement in Italy. This uninterrupted outer shell appears like a fully glazed skin enclosing building volumes that embody the image of modernity and lightness. Since the period after the Second World War, the glazed envelope has been a widespread system in the United States, because it was suitable to the requirements of buildings used as "office block". The

development plan for the areas to be addressed to tertiary activities follows the minimum soil consumption; therefore, high rise buildings and accurate dimensioning of minimum internal spaces are preferred. In this perspective, in order to ensure the best use and habitability of interiors and meeting the necessities of sector activities, big rooms, diffused light and easily adaptable internal partitions are some of the main features of these new business centers.

Then designers have to project buildings whose form is not defined by a specific function, but the volume and dimensional relationships are driven by prescriptive and in force regulations at that time. The only elements to be designed are structure and exterior panels, which need to respond to different situations proposing a solution that could be universally applicable, and also a construction item to be installed in any structural steel or reinforced concrete frames, using few special components. This system respects the same dimensional modularity in plan and elevation arrangements. Highly qualified construction firms have a leading role in resolving and managing problems about dimensioning and qualitative aspects, they are responsible for the final proposals, and they often carry out the works directly [2]. In this process many different design levels are involved: the curtain wall is intended as an industrial mass product and technological solution promoted by companies operating in the building sector, as well as a constitutive element of the architectural idea in terms of formal and composition aspects proposed by designers.

In this context, the formalization of the fully glazed envelope has taken place progressively and has gradually overcome the window definition, herein intended as opening on external walls to provide adequate lighting and natural ventilation in the respect of health requirements connected to the use of internal spaces. Thanks to industrialization and to the ensuing progress, the window as technological item acquires more significance and architecture production increases its interests in highly specialized windows frames up to their maximum expression in the curtain wall, where the relationship between the opening on the external wall and window frame is definitively replaced by the coincidence between external wall and window frame.

During the definition process of the curtain wall, the dissemination of the so-called "Chicago window" has been a fundamental stage. In fact, the adoption of pillar and beam structures, whose elements are made of steel or reinforced concrete, allows the increasing of windows size together with the progress in technical processing of glass, that provides larger glazed panels. Therefore, traditional hung sash windows, horizontally divided into two parts, and replicated on the façades following the rhythm of the structural masonry elements, has been replaced by the new tripartite windows. In these elements, the central panel is bigger than the lateral ones, and it cannot be opened because mechanisms are not capable to support the weight of the pane while opening and closing; then, the lateral sashes, which are smaller and lighter, can be opened and provides for natural ventilation of the interiors. One of the first buildings showing the application of the "Chicago window" is *Reliance Building*, designed by Daniel Burnham and constructed in 1894. In this skyscraper, windows are very different from the structure, and are partitioned into four parts, whose two central quarters cannot be opened, and the other two lateral quarters provide the access to freshened air. In this building, the tripartite window is clearly visible and defines the curtain

wall together with the frame structure. This result has been possible thanks to the evolution of the architectural solutions tested in other buildings before, such as *Monadnock Block* (1890), *Manhattan Building* (1891) and *Tacoma Building* (1891), where the façades appear like a continuous sheathing made of glazed and nontransparent parts, even if the traditional hung sash windows are still used.
Mies Van Der Rohe has a leading role in the process of the formalization of the real curtain wall. Since his first drawings of steel and glass skyscrapers (1919), he has focused on outer building envelopes. These shells become the main character of architectural design at the expense of the volume, that is identified in a generic and simple prism whose only function is to "contain" and host unspecified activities referring to business and commercial sectors. Thanks to the ideological formation from Bauhaus, Mies recognizes that industrial production is a determining factor in order to ensure high quality and prevent negative standardizations and the abandonment of creativity in architectural design. The production information becomes the leading element in the definition of architecture itself, it is the result of the refining process guided by simplicity and also the product of industrial manufacturing, easily reproducible. In this respect, Mies prefers using materials, such as steel and glass, in their natural form so as to be included without forcing and inevitable technological difficulties. At the same time, the distinction between structure and building envelope, comparable to bones and skin, has become clearer; in the three skyscrapers *Promontory apartments*, *860 lake shore drive apartments* e *Commonwealth promenade apartments*, the columns have been gradually moved backward from the front line of the façade. In *Commonwealth promenade apartments*, the pillars are no more visible on the elevation surfaces, and the façade seems to be constituted only by window frames. In this case, the items connecting panels and frame generate the composition scheme of the building outer shell, they look separate from the structure but integrated with window frames, and exclusively interrupted at each floor: there it is the "hung curtain wall".

2 The curtain wall in Italy and the role of *Curtisa* Society

The process of curtain wall development in the United States has been very dissimilar from the Italian one. In the overseas country, the production system is open to streamlining of processes, research of high efficiency and space adaptability to changing requirements over time. In this context, many applications of the curtain wall system can be found since the first half of the last century.
In Italy, on account of the slower innovation process, the outer glazed shell has been adopted starting from the 1950s. In this period, the designers of buildings with curtain wall system, look at international scenario as an important source of inspiration, especially for the new use of construction materials, such as steel and glass, and for the

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development of a new architectural and construction language, strictly connected to technological evolution. The manufacturers specialized in production, assembly and installation of curtain wall system elements have an important role. Companies are responsible for the solving of the whole technical and constructive issues, in accordance with architects. In this way, relationships between designers and societies become privileged and continuing, and the construction firm has to provide for final proposals and quantification, and also to carry out the works on the basis of the structural frame, designed in order to ensure the minimum number of limitations [2]. The Italian context of the 1950s recalls the United States situation of the late XIX century and many "office blocks" with glazed façades acquire international reputation and so on the construction companies, i.e. *Curtisa*, *Feal*, *F.lli Greppi* e *Alsco Malugani*.
In particular, *Curtisa* has become one of the best Italian companies able to design, produce and install metal profiles, working at an international level. The society was founded in Bologna in 1929 by Claudio Pizzirani, Luigi Pizzirani, Augusto Curti, Achille Folli and Giovanni Poggi and the production plant was situated in Ranzani Street [3]. Since the period after the Second World War, the society has been one of the leaders in the production of the so-called "ferro-finestra", to be intended as a metal window frame realized with special hot-rolled and rectified sections, with a cavity for air and seals providing for hermetically closing of the window.
In Italy, the "ferro-finestra" window frame is especially used in non-residential buildings and, despite the major cost in terms of initial investment, it results finally more convenient. In fact, if compared with the traditional metal window frame, it is lighter, incapable of being deformed, made of one single element able to guarantee adequate resistance, and not obtained by the assembly of more parts, whose joints always have weaknesses, and finally is characterized by long durability. The *Curtisa* company has started its activity by producing metal gates, then it has widened its manufacturing realizing metal window frames made of a tubular extruded section in aluminum alloy, i.e. hinged windows; sliding windows, *Serie 74*, *Slidor*, *Sursor*; hung sash windows (counterbalanced, self-balanced, with spring balancers); horizontal pivoting windows *Rotor* and vertical pivoting widows *Bi-verticale*; windows series *Unilor*, including sliding, hung sash and awning, horizontal and vertical pivoting windows; windows series *Duplor* that combines two different types of openings; and windows series *Estor* with folding opening (Fig. 1). Moreover, meeting the dynamism requirement of business centres, the company opens the production of window frames for internal partitions, i. e. *Anacustic*, *Divor*, *Ferdivor* (Fig. 2). As a consequence of the construction of buildings with glazed elements ever larger, the company implements the production with the realization of solar shading systems, such as *brise-soleil* named *Eclisse 400, Olivetti, Bernasconi, Torino, Firenze, Olona, Ravenna*, made of extruded aluminum sections, defined *allulega*, or iron sections, available in metal bent sheet, or in tubular or lamellar sections, in unmovable or movable orientation, that is manually or electrically controlled. Furthermore, *Curtisa* defines some patents, such as *Dry-system* for the weather resistance, *No-bang* for better acoustic insulation, and *Gray-stop*, a colored windows series encouraging designers to consider window frames as architectural elements. Finally, the company launches some windows complementary products, i.e. *Curtal-blind*, Venetian and Roman blind with adjustable aluminum lou-

vers; *Tendal*, shading and obscuration solution with exterior blinds inside the window frames; and *Antifly,* insect screen made of PVC coated fiberglass and perimeter sections in PVC [3].

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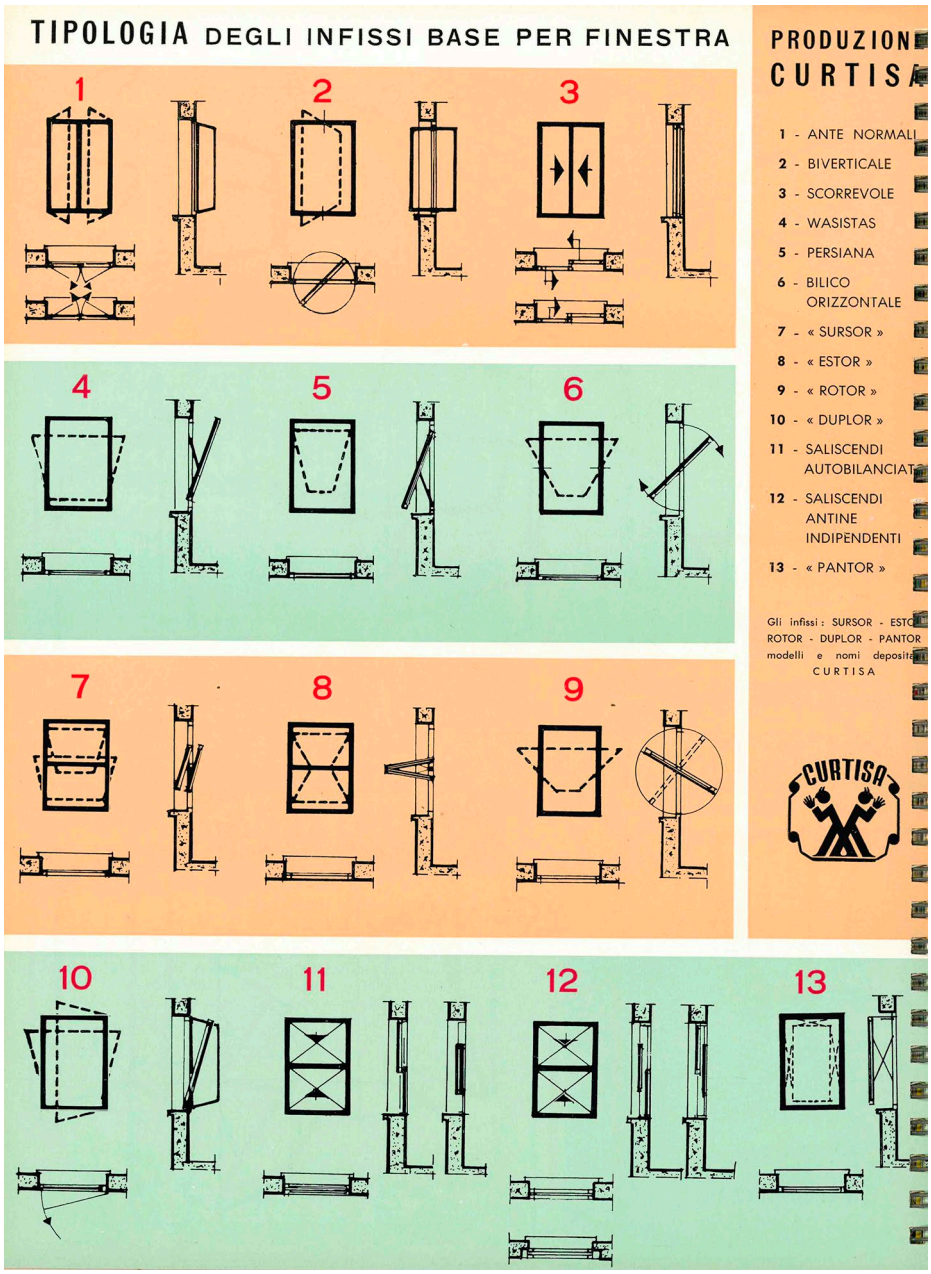
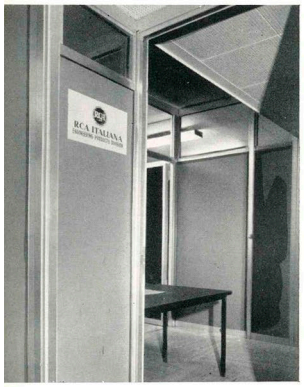
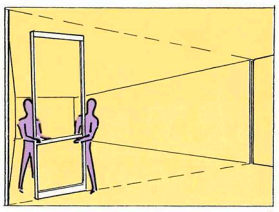


Fig. 1. Abacus of *Curtisa* window frames (source: *Curtisa* catalogue)





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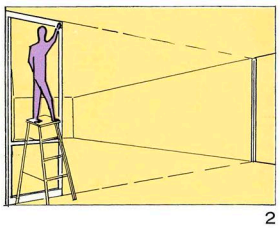


2

MONTAGGIO FACILE E VELOCE

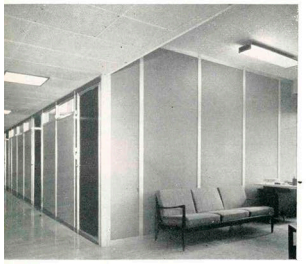
Fig. 1 - Montaggio dei montanti laterali della divisoria.

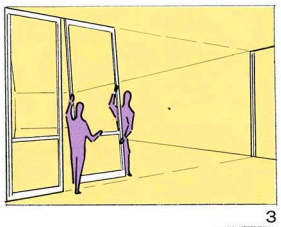
Fig. 2 - Bloccaggio in alto del primo pannello mediante gli spintori.

Fig. 3 - Posa in opera degli altri pannelli completi accostati consecutivamente.

Fig. 4 - Fissaggio dei pannelli fra di loro.

Fig. 5 - Montaggio del coprifilo nel traverso superiore e nei montanti.





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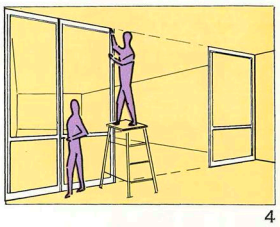

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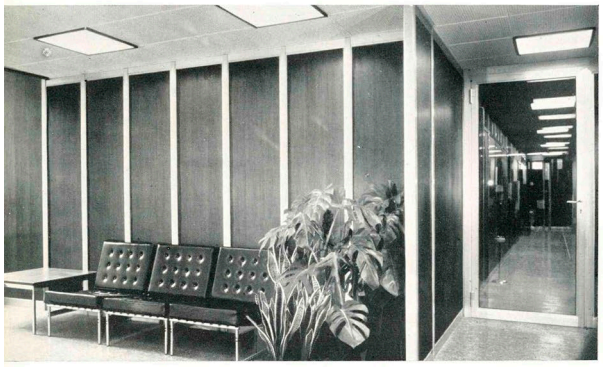

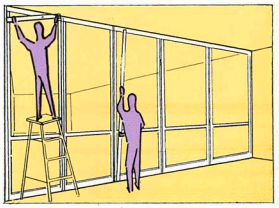

5

Spostamenti, formazione d' incontri, intercambiabilità dei pannelli, nessuna opera muraria: sono le prerogative delle divisorie « CURTISA » TIPO **DIVOR.**

CURTISA

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Fig. 2. Internal partitions *Divor* (source: *Curtisa* catalogue)

Curtisa fosters two different curtain wall systems (Fig. 3), suitable to all their products; in the first one, preassembled panels are screwed on vertical mullions; in the second one, the panels assembly and the attachment to the structure is directly made on the building site.

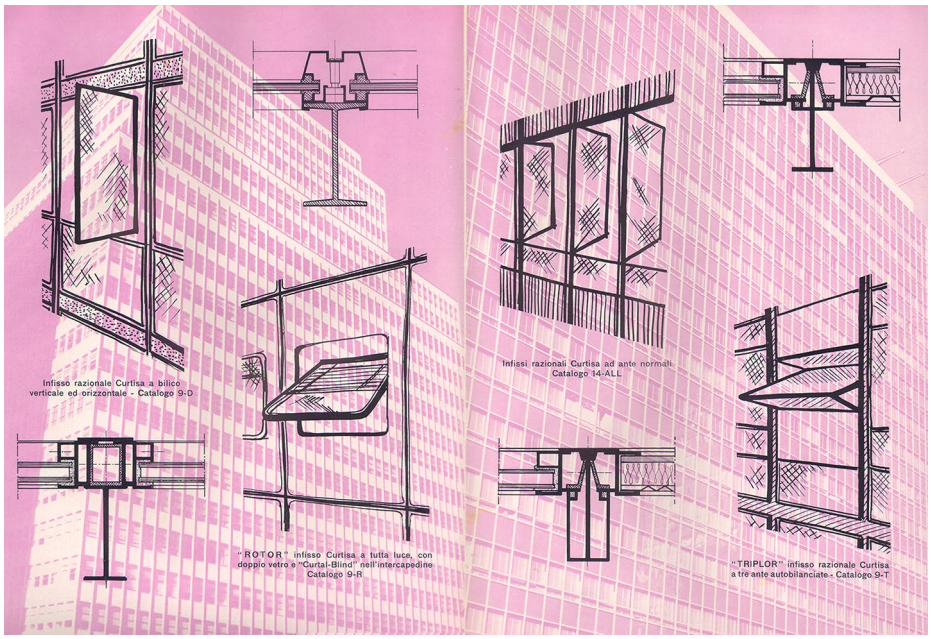

Fig. 3. Examples of the application of *Curtisa* window frames to the curtain wall system (source: *Curtisa* catalogue)

Considering the great variety and high quality of products, the company immediately achieves a leading position in the sector, providing its systems and solutions to many business and commercial buildings, including Palazzo Olivetti, Pirelli skyscraper (Fig. 5) and Swiss Center skyscraper (Fig. 4) in Milan; Palazzo Fassio in Genova; RAI-TV administrative offices (Fig. 6), Bombrini, Parodi, Delfino building, IMI (*Istituto Mobiliare Italiano*) and UIC (*Ufficio Italiano dei Cambi*) buildings in Rome.
The skyscraper for the Swiss Center in Milan, built and designed in 1953 by the Architects Armin Melli and Giovanni Romano, clearly reflects the solution used in the United States in the preceding decades.
In the Pirelli skyscraper, the curtain wall first system of the company has been applied, the structural frame is not visible, and the glass panes and steel frames have been preassembled and attached to the vertical mullions, which are at the same time the main casing for opening window sashes and the frame structure for the façade.

These vertical elements are attached to the reinforced concrete floors using a special component, allowing some movement that is necessary for ensuring excellent adaptability and solving poor workmanship and different dilatations.

Fig. 4. Swiss Centre skyscraper in Milan (source: *Curtisa* catalogue)

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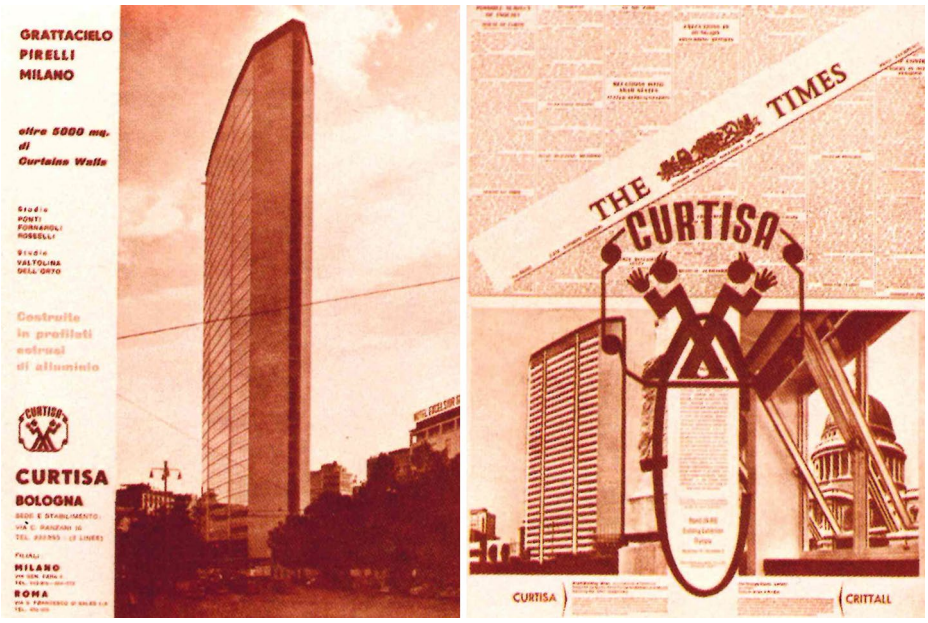

Fig. 5. Pirelli skyscraper, Milan (source: *Curtisa* dépliant)

RAI-TV administrative offices in Rome are another significant display of curtain wall realization, where the load-bearing structure is taken backward from the front line. The outer shell frame is directly attached to the external perimeter iron beam with some vertical aluminum items. The aluminum window frames are connected to the vertical aluminum mullions and respect a modularity based on 90 cm with a 90 180 90 90 180 90 rhythm, where all the panels can be opened and they are not horizontally divided so that one panel is 2,85 m high, the distance between two floors, whose thickness is covered by an opaque pane. Finally, Palazzo Olivetti, described in the following paragraphs, shows an interesting answer at the international level to the problem of shading and solar protection: the curtain wall is perfectly integrated with a *brise-soleil* system.

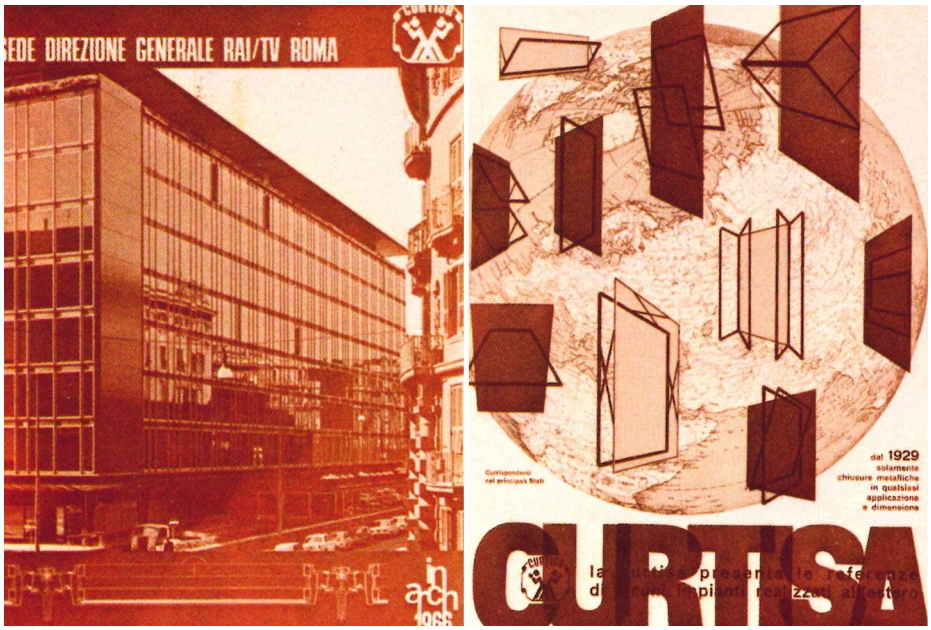

Fig. 6. RAI-TV Offices, Roma, on the left, advertising of metal window frames produced by *Curtisa*, on the right (source: *Curtisa* dépliant)

3 The architecture of Olivetti after the second War World

In Italy, after the Second World War destruction has affected various respects, then re-establish the political institutions, government, and economy was a priority in order to ensure the recovery process of the country. Despite Italian territory consisted in mostly of agricultural landscapes, since the 1950s, the country has been interested by the so-called "booming economy". In this period, the industrial sector has met a huge development together with the first infrastructures, many goods are then affordable to the majority of population and welfare has spread quickly [4].

In this context, many industrial excellences emerge, including Olivetti, a company founded in 1908 in Ivrea, that started its activity with the production of typewriters and office products. Thanks to plans, projects, initiatives and activities promoted by the company, a new industrial city, whose development is strictly linked to the factory, has been progressively realized in Ivrea. Nowadays the Olivetti city represents a successful response to the urban growth regulation issue as a consequence of the interaction between industrialization and territory. The buildings realized in Ivrea are

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significant and representative testimonies of the Italian and international architecture history of that period.
In 1932 Adriano Olivetti, the son of Camillo Olivetti, the founder of the company, takes the direction of the family enterprise. This event marks the beginning of an interesting transition process, fostered by the new entrepreneur, that lead to the strong characterization of the company identity, not only in stylistic and aesthetic terms thanks to buildings construction, but also in the definition of a new idea of the industrial environment, where social relationships and interactions between factory and territory, as well as workers conditions are the main purposes. The study of Olivetti history gives an interesting point of view for the critical assessment of Italian architecture commissioned by industrial clients and for the analysis of the relationship between industry and architecture. Thanks to Olivetti architectures, is gradually surpassed the widespread perception according to which the expenses for the construction of industrial buildings have to be reduced to a minimum consistent and any aesthetic or formal interests have to be abandoned together with the collaboration with architects, preferring the construction of impersonal industrial buildings [5]. Adriano Olivetti has always involved designers and architects in the planning process as he recognizes the great importance of their contribution; he collaborates with both Milanese architects, belonging to *Movimenti Studi Architettura* (MSA) that supports the rationalist style, and Roman architects belonging to *Associazione per l'Architettura Organica* (APAO) that follows the principles of organic architecture. Olivetti architectures are the expression of both stylistic currents: this is a clear reflection about the complexity of the Italian architecture in the reconstruction process during the period after the Second World War. Some of the main collaborators of Olivetti are Figini and Pollini, Quaroni, Bernasconi, Fiocchi, Nizzoli, Gardella, Ridolfi and Vittoria; they realize many buildings that are not just the expression of the brand, but the attempt to construct liveable spaces [6], in accordance with the intentions of the entrepreneur. Also, they are conscious that every intervention on the territory has a relevant impact on different respects, i.e. in terms of space, culture and society. Some of the residential and industrial buildings realized by Olivetti company are the extensions of Olivetti factory and the new I.C.O., the nursery and low-income housing in Olivetti village, the Social Services Area, the Center for Studies and Experiences, the Company Canteen and the Office Building in Ivrea, and Palazzo Olivetti in Milan. All these buildings are designed and realized between the Thirties and the Fifties of the last century, and they reflect the evolution of Adriano Olivetti design philosophy that from a rationalist language moves to organic architecture expressions. The first three extensions of the Olivetti factory designed by the architects Luigi Figini and Gino Pollini between 1934 and 1949 are the display of rationalist style in plan arrangements, façades composition and choice of materials. The curtain wall system is herein applied for the first time, and it is made of double steel frames connected to the reinforced concrete cantilevering floor structure.
The transition to organic architecture is evident in the Centre for Studies and Experiences (1951-1955), designed by the architect Eduardo Victoria, who is able to reconcile elements of both currents, so that this building appears like the symbol of feasible continuity between rationalism and organic architecture (Fig. 7).

Fig. 7. The Centre for Studies and Experiences in Ivrea, designed by Eduardo Vittoria in 1954-1955 (source: Associazione Archivio Storico Olivetti, Ivrea – Italy)

The confirmation of this gradual change can be also found in the realization of the Company Canteen (1955-1961); the building is designed by the architect Ignazio Gardella who uses an organic language, as requested by the entrepreneur, because is more suitable for workers spaces than for industrial ones and this definitively marks the abandonment of rationalistic aesthetics in Olivetti city. Also, the last extension of the Olivetti factory, defined the new I.C.O., and the Social Services Area, built by the architects Luigi Figini and Gino Pollini in the period 1955-1959, are included in this new scenario. The two designers partially give up the rationalist language that dominated their previous realizations in favor of well-structured volumes, fully integrated with the context and characterized by an accurate study of colors, already introduced by Vittoria in the building for the Center for Studies and Experiences, defined as the "cross blue building". For example, in the new I.C.O., two triangular blocks and lift towers covered with colorful ceramic tiles are opened from the compact volume (Fig 8).

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Fig. 8. The Center for Studies and Experiences built in 1954-1955 and designed by Eduardo Vittoria, its blue covering in ceramic tiles is clearly visible together with the yellow one of the New ICO towers (source: Associazione Archivio Storico Olivetti, Ivrea – Italy).

The Office Building (1959-1964), built after the death of Adriano Olivetti, is the community representative building; the architects Fiocchi, Nizzoli and Bernasconi adopt a more rationalist language, preferring forms simplicity and structural modularity (Fig. 9).

Thanks to the numerous and significant interventions promoted by Adriano Olivetti, the urban centre of Ivrea entered the UNESCO Patrimony in July 2018, 1st. In fact, the industrial city is "a splendid example in terms of architectural solution quality, as well as in terms of modalities of implementation" (original Italian quote: "un esempio eccezionale sia per la qualità della soluzione proposta che per le modalità di attuazione") [7]. The buildings, designed by famous Italian architects of the last century, belong to a uniform urban plan, including industrial, residential and service buildings: "in Ivrea, in fact, thanks to the culture of Olivetti factory and the experience of *Movimento Comunità*, architects and planners are involved for the first time, in Italy, in a broad design for the urban planning." (original Italian quote: "a Ivrea, infatti, la cultura di fabbrica della Olivetti e l'esperienza del Movimento Comunità, coinvolgono, per la prima volta, in Italia architetti e urbanisti in un disegno ampio di progettazione della città.")

Fig. 9. Olivetti Office Building in Ivrea, built between 1960 and 1963, designed by architects Gian Antonio Bernasconi, Annibale Fiocchi and Marcello Nizzoli (source: Associazione Archivio Storico Olivetti, Ivrea – Italy).

4 The Olivetti headquarters building in Milan (1950-1954)

Designed by the architects Gian Antonio Bernasconi, Annibale Fiocchi, and Marcello Nizzoli, the Olivetti historic headquarters in via Clerici (Milan) is built in 1954. According to explicit author declarations, the project aims to reflect the "style", rather than the greatness of the brand [8]. The designers' purpose is to find an architectural language with great attention to details, a feature that has always distinguished Olivetti products, since development up to advertisement communication [9]. Indeed, as commercial products, also Olivetti architectures reflect the company mentality and creativity. On the one hand, the constructions are the direct consequence of the changes affecting the production needs, that are ever more advanced and articulated; on the other hand, they follow Adriano Olivetti's political beliefs and considerations about work psychology [10], according to which buildings have to be designed at "the human scale… because factory is for man, not man is for factory" (original Italian

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quote: “scala dell’uomo… perché la fabbrica è per l’uomo, non l’uomo per la fabbrica”) [11].
The collaboration with the most important architects of that period [12], has led to different architectural styles in Olivetti constructions. However, some characteristics are clearly recognizable in all Olivetti architectures around the world, such as the utmost care in detail design, and the research of the innovation, preserving the *genius loci* within the architectural context [13].
The Olivetti headquarters in Clerici Street (Fig. 10) is situated in the very historical heart of the city, and in a densely-built context, rich of architectural heritage (Fig. 11). Therefore, the location of the building becomes one of the key issues of this project, especially for the presence of 18th century baroque *Palazzo Clerici* facing the entrance. The great dimension of the eight-storey main volume is mitigated by moving backward the façade, which is twenty meters from the four-meters narrow street, and creating a small square. The trapezoidal geometry of the area on Clerici Street is obtained by the U-shaped plan of the building, consisting of several volumes of different height that outline the central entrance space. The façade consists of a large curtain wall, that is screened by adjustable louvers of the sun shading system recalling the International Style language of those years, in particular the works by Oscar Niemeyer [14]. The two lateral volumes are adjacent to existing buildings, and for this reason, they are only four-storeys high (Fig. 12). Thus, Olivetti headquarters appears carefully and well-integrated in the area, despite the modern design and volume bigger than surrounding historical buildings. The palace is a successful confirmation that “the connection between ancient and modern is… a question of size and proportions, of spatial measurements” (original Italian quote: “il raccordo tra l’antico e il nuovo sia… una questione di dimensioni e di proporzioni, di misura spaziale”). Therefore, the architectural language is clearly distinguishable, both in terms of color and materials [8], declining every imitation.

Fig. 10. Main façade of Olivetti headquarters building in Clerici Street, Milan (source: Associazione Archivio Storico Olivetti, Ivrea - Italy, Fondo Fototeca/Foto Miscellanea Olivetti)

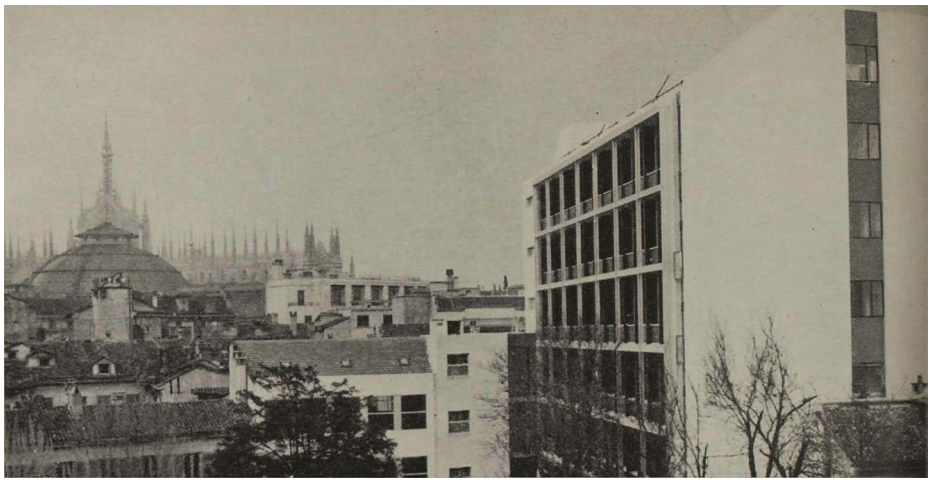

Fig. 11. Courtyard elevation with the view of the dome of Milan Cathedral on the background (source: Notizie Olivetti, n. 21, novembre, 1954)

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Fig. 12. The lower height of the wing near *Palazzo Clerici*, similar to the surrounding context – (photography: Federico Cinti – elaboration: Carlo Costantino)

The building emerges like a large, suspended volume, placed on a wide grid of reinforced concrete pillars coated with black oxidized aluminum, so that the fully glazed ground floor is able to convey lightness and showcase the best products of Olivetti in the exhibition halls [15]. The upper volume mass is further dematerialized using large panes in the curtain wall and freely orientable sunshades system in the whole façade, this solution creates visual continuity between internal and external spaces (Fig. 13).

Fig. 13. Detail of louvers sunshades on the main façade. The different approach used in the boardroom on the second floor is marked by the *brise-soleil* absence (source: Associazione Archivio Storico Olivetti, Ivrea - Italy, Fondo Fototeca/Foto Miscellanea Olivetti)

In the south elevation, the technical element of orientable brise-soleil becomes the main theme of the architectural composition, transforming the façade in a surface changing the distribution of solids and voids over time [16]. Furthermore, these elements ensure the best conditions of internal comfort and natural lighting for the company employees. This series of sunshades louvers is one storey high and provides protection from the radiation of the warm Mediterranean sun. Thanks to a mechanical system, the louvers can rotate around their own axis so that they are always positioned orthogonally to the sun during the day. The louvers are maneuverable in groups of ten from the inside by means of a control lever [17] in a way that each office can have complete control over the filtration of its own light. Every sunshades louver is formed by an extruded aluminum frame coated with a thin aluminum sheet in its natural color that creates a light corrugation on the frame elements.
The brise-soleil structure is attached to the reinforced concrete cantilevered beams and the curtain wall structure is installed near the frame structure. Window frames are laterally fixed using steel brackets to support the vertical hang sash windows that do

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not weigh on the external infill panels made of cold rolled aluminum sheet and placed under the window sill.
Built with dry construction techniques, the infill wall is formed by insulating material coated with aluminum sheets on every side. Manufactured by Bolognese company, *Curtisa*, the windows are horizontally divided into three parts: the central part is a hung sash window, while the lower and upper part can be opened using horizontal hinges to ensure ventilation and ordinary maintenance. Aerator with maneuverable vertical perforations is installed above the windows [17].
The aluminum is the prevalent material of external façades. A clever play of contrasting colors is evident between black oxidized elements, like pillars and coating sheets, and natural color elements, like windows, louvers and string courses (Fig. 14). The boardroom on the second floor and the ground floor do not have the orientable brise-soleil. Then heat and sun protection is herein provided using special athermic blue-tinted crystals similar to those used for the windshield of the most refined cars of that period [18]. In the boardroom there are paintings of Mattia Moreni and Marcello Nizzoli; and this is the only internal space revealed in the main façade by moving forward the sunshades.
Facing the inner courtyard, the north-east elevation (Fig. 15) is characterized by the clearest and deepest voids, produced by the structural frame that recalls the works of Mies van der Rohe [19]. This façade is similar to the main front for the presence of the curtain wall, and there are not brise-soleil due to the different solar exposure. The courtyard elevation is characterized by a dense pillar grid, highlighted by the black oxidized coating sheets. The pillars have small sections and the distance between them is only two meters. The lateral façades are blind except for the intermediate corridor windows. The headquarters has a usable floor area of 5.300 square meters and consists of a volume of 30.000 cubic meters. The structure and the planimetric distribution are characterized by maximum simplicity [18]. Four pillars rows compose the reinforced concrete structural frame, where the space between the columns of the internal rows is six meters and the distance between the external ones, near the façades, is only two meters. The elevators and stairs services are situated in two reinforced concrete structural cores at the ends of the building in almost symmetrical arrangement. Then, the fully glazed entrance hall allows the view of the inner courtyard, protected by the "Superintendence of Archeology, Fine Arts and Landscape for the Metropolitan City of Milan". Nevertheless, this transparency effect has been lost during the renovation interventions after the purchase of the palace by an Italian bank group. [20].
Designed by Marcello Nizzoli, the external fence has a significant role in the project (Fig. 16). Graphical elements from ancient alphabets, ideograms, and abstract structures are considered for the preliminary drawing proposal. In the end, a pattern based on stylized irregular geometric figures is chosen, where the main element is the letter T, the iconic symbol of typewriter scripts, and zoomorphic figures near the trees can be also recognized, symbol of decisional power in Mediterranean culture [20]. In the bright entrance hall, there are the decorative panels, painted with graffiti motifs by Giovanni Pintori (Fig. 17), Olivetti Art Director since 1950, when he won the advertising award "Palma d'oro della Federazione Italiana Pubblicità" [21].

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Fig. 14. Entrance square of Olivetti headquarters building in Clerici Street, Milan (source: *Curtisa* Catalogue)

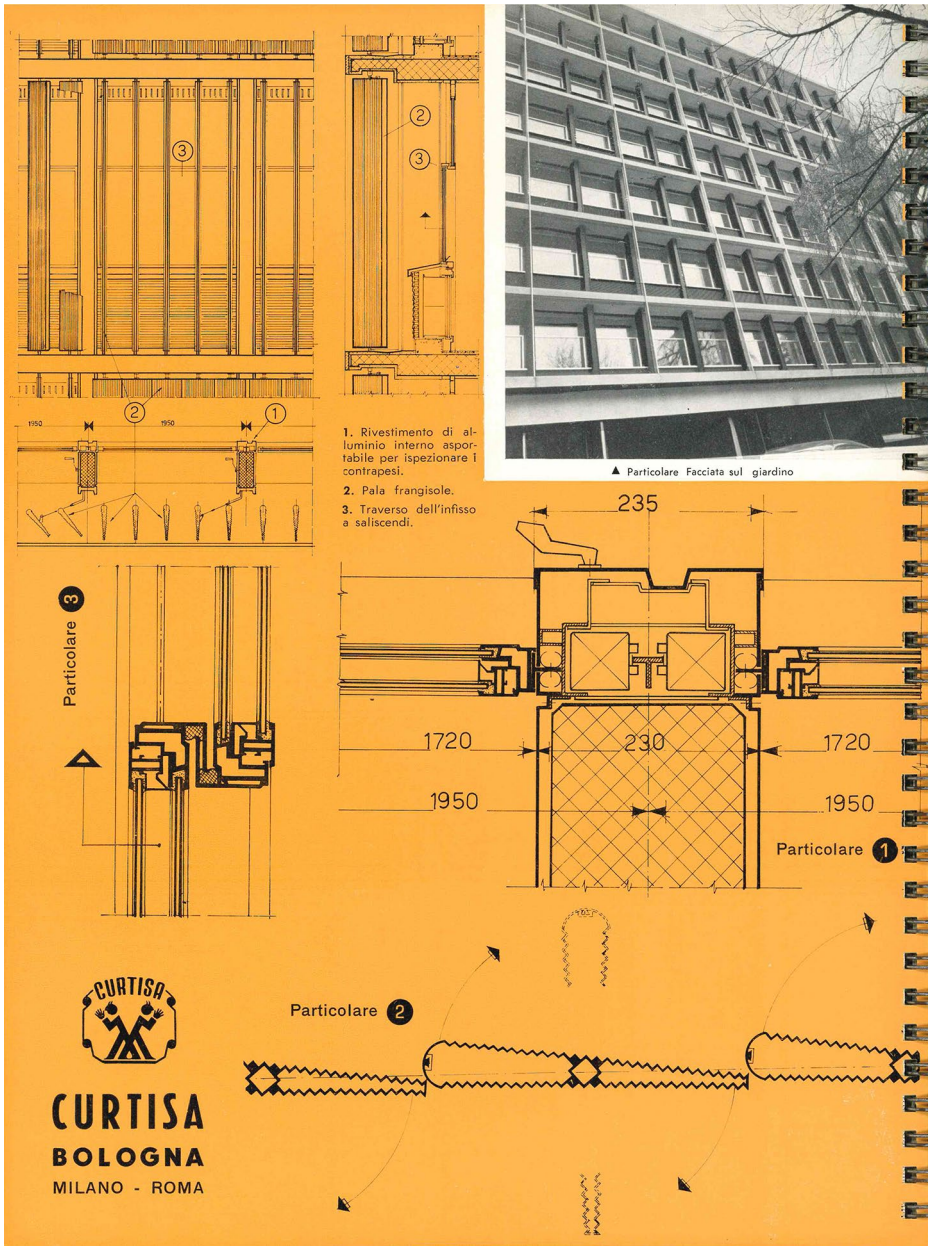

Fig. 15. Details of sunshades louvers and curtain wall. On the top right corner, the courtyard façade of Olivetti's headquarters (source: *Curtisa* Catalogue)

Fig. 16. The fence designed by Marcello Nizzoli. The T-letter pattern and the zoomorphic figures are visible within the geometric drawing (photography: Federico Cinti – elaboration: Carlo Costantino)

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Fig. 17. The entrance hall of the Olivetti headquarters building. The Giovanni Pintori painting is visible on the background (source: Associazione Archivio Storico Olivetti, Ivrea - Italy, Faldone 26)

Olivetti headquarters has two underground levels: on the first floor, there are laboratories, the computer specialist school (*Olivetti Bull*), the warehouses, and a garage for forty vehicles; and on the second floor, there are the machine rooms with a careful selection of innovative heating and cooling systems. A combined system of radiant panels and fan heating is used inside the offices. Furthermore, a cooling water refrigeration system can be used during the summer. The building contains an electric room with three 50kw transformers, a one-hundred lines telephone switchboard, an autoclave of 3.000 liters, three electric pumps and one air compressor, three lifts for staff, a freight elevator of 5.000 kg capacity for handling heavy materials in the warehouses and a *paternoster* elevator to lift the equipment to the offices [18].
On the upper floors, there are the commercial offices (Fig. 18) designed with adaptable disposition around the central distribution corridor. The common spaces are characterized by flooring in Botticino marble mosaic, covered with a black rubber carpet and by the sequence of office doors coated in red linoleum with handle in gold oxidized aluminum [22]. The lighting system with neon lamps is installed centrally on the dropped ceiling, made with insulation boards, while in the offices, the lighting is on the suspended ceiling aligned to the windows (Fig. 19).

Fig. 18. View of internal offices with the glass partitions (source: Associazione Archivio Storico Olivetti, Ivrea - Italy, Faldone 26)

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Fig. 19. The waiting room of Olivetti's headquarters (source: *Curtisa* Catalogue 12-A)

The partition walls are aligned with the pillar rows and can be alternated with closets of the same thickness of the structural elements. This combination of partition walls and closets allows the adaptation to the office space needs according to the different positions of prefabricated and removable walls over time. Patented by Rellok and released by *Curtisa*, the removable partitions *Anacustic* are made with a special extruded aluminum profiles frame, coated with crystal panels or painted wood-fiber boards with high sound insulation and width of 77cm (Fig. 20). Special rubber seals cover the entire perimeter of partition walls, so that the distributed pressure on the slabs is used for fixing and any kind of mechanical fixation is not required on the floors. This type of assembly allows you to "disassemble and reassemble the partitions walls wherever you want, within an hour without having to make holes or anchors to the masonry structures" (original Italian quote: "smontare e rimontare le pareti ove si voglia nel giro di un'ora senza dover effettuare fori o ancoraggi alle strutture murarie") [17].

The building process "meets a maximum of industrialization applied to the construction sector" (original Italian quote: "segna un maximum nell'industrializzazione della produzione edilizia") [8] at that time in Italy: almost the totality of the building elements are prefabricated and assembled on the reinforced concrete structure, both exterior like the orientable aluminum sunshades and the curtain wall windows, and interior like the partition walls [8]. The Olivetti headquarters in Clerici Street is one of the first Italian attempts to prefabricate the largest possible number of elements in order to "minimize any waiting time, typical of the traditional half crafted construction process and to reach the industrialization of the construction sector" (original Italian quote: "eliminare le inutili predite di tempo caratteristiche delle costruzioni semi-artigiane finora eseguite e di giungere alla industrializzazione dell'edilizia") [12]: while the structural frame is made of in-situ concrete, the prefabricated are assembled. Consequently, the completion of the non-structural parts lasts few months. Further-

more, the use of removable elements allows easy access for maintenance or expanding plant systems.

Fig. 20. The "*Anacustic*" removable partition walls. In the background, one of the offices and the succession between doors and closets (source: Associazione Archivio Storico Olivetti, Ivrea - Italy, Faldone 26)

The headquarters gains national and international notoriety, and it is at the center of critical debate because of the modern curtain wall façades, an astounding combination of glass and aluminum [23, 24, 25, 26]. The experts are agreed in recognizing the building as one of the foremost achievements in the field of industrialization and prefabrication applied to the construction sector at that time in Italy. The project aims to reflect the style of the Olivetti brand: modernity, high efficiency, refinement of detail, and great precision, without ever giving up a unique design [27]. However, there are conflicting opinions regarding the integration of this modern building in the very historical heart of Milan [8, 19, 28], even if the designers have considered this issue

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[18]. The high prefabrication and industrialization leads Zevi to identify the building as an "industrial masterpiece, a symbol of standard production, of assembly, of processing time in an ideal factory… and expression of a language in compliance with the rationalist poetry" (original Italian quote: "capolavoro industriale, intrinsecamente industrializzato, simbolico della produzione in serie, del montaggio, dei tempi di lavorazione di una fabbrica modello… ed espressione di un linguaggio coerente alla poetica razionalista"). He ascribed to Olivetti and its architects "the drawing up of the last page of a great chapter of modern architecture" (original Italian quote: "di aver scritto l'ultima pagina di un grandioso capitolo dell'architettura moderna") [29].

5 Digital modelling implementation

The contemporary use of existing buildings is strictly connected to an in-depth knowledge of the construction, in terms of history and processes, starting from the genesis up to the evolution over time. In this respect, digital technologies have a leading role in decision-making processes during both design and operational phases, in order to ensure protection and performance and functional refurbishment. The study of curtain wall system, as a representative element of office buildings in 1960s Italian architecture, and the consequent implementation using digital technologies, is necessary to ensure the preservation and regulations upgrading in terms of structural safety, energy and performance efficiency.

Digital technologies, HBIM and Digital Twins, applied to curtain wall systems are an interesting opportunity because of the complexity of glass and steel façades, intended as the perfect synthesis of technological innovation and architectural style. In fact, monitoring and prefiguring some elements evolution is possible with Digital Twins technologies with the final aim to prevent from neglect and plan maintenance interventions. The methodology herein proposed is founded on knowledge organization in a multidimensional context of the digital model, where 3D spatial geometry is integrated with 4D (time), 5D (costs) and 6D (life cycle assessment) models up to 7D ones, namely facility management systems that consider social, economic and environmental sustainability. However, there are some significant difficulties linked to building peculiarities and the parametric modelling has to be implemented with instrumental and diagnostic analysis, i.e. thermography, heat flow meter method, spectrometry aiming at delivering information about construction and state of conservation. Together with the definition of multidimensional digital models, the implementation with GIS and CityGML database is necessary for environmental analysis (solar analysis, pollution, climate change, morphological and geographical and hydrogeological and seismic conditions, etc.). Also, the adoption of genetics algorithms to solve complex problems with discontinuous variables are necessary to face the large number and heterogeneity of situations that influence interventions choices and cost-benefit optimization, such as "Non-Dominated Sorting Genetic Algorithm" NSGA-II, widely used in literature for existing buildings. Another interesting issue is the application of HBIM technologies to building timeframes (project, realization, current state), referring to some time modelling methodologies (Level of Development LOD,

Level of Geometry LOG, Level of Information Need LOIN and Level of Knowledge LOK). Furthermore, the transition from BIM to BEM (Building Energy Model) grants access to dynamic energy simulations with specific software, that enable analysis automation and real-time simulations using data from sensors.
Palazzo Olivetti curtain wall façades can be an interesting application of digital technologies (HBIM and DT), even the great innovation at the time of its construction. Nowadays, whereas on the one hand energy consumption, CO2 emissions, internal discomfort, maintenance intervention costs and operational ones need to be reduced, on the other hand reversibility and compatibility need to be maximized in the respect of architectural identity. Then, genetics algorithms can deliver optimized solutions to support decision-making processes. Finally, thanks to Virtual Reality (VR), Augmented Reality (AR) and sensors, in-situ information is connected to remote one in a biunivocal way to create two identical twins: the real building and the digital one.

6 Conclusions

The definition of window, herein intended as openings on external walls to meet the health standards, has always been changing over time together with the definition of windows casing as dividing element and, at the same time, element for visual communication between internal and external spaces. Since the second half of the 18h century, window frames have progressively become more relevant for designers and construction firms thanks to industrialization. In particular, the formalization of curtain wall is strictly linked to the technological development, that has characterized the United States and Europe during the XIX century, in terms of processes, facilities and materials. Other determining factors are the dissemination of steel or reinforced concrete structural frames, the progress in metals and glass manufacturing so that glass panes become bigger, the economic growth and the expansion of business centers in urban areas. Furthermore, the new social and cultural model strongly fosters advanced industrialization, mass production and prefabrication as parts of the idea of modernity and welfare. In this context, the curtain wall system is finally defined as an uninterrupted outer glass shell for office buildings, clearly disconnected from the load-bearing structure. Then architects are interested in designing the curtain wall both as an identity element for the architectural design and as a technological one. *Curtisa* Company has always been trying to improve its products and solutions, all the production information is very detailed to propose universally applicable and adaptable systems, with few variations to many different situations, as well as economically sustainable. Palazzo Olivetti in Milan is one of the greatest practical implementations of prefabrication, industrialization, mass production, optimization and use of highly specialized technologies, herein intended as “amplifiers” of quality. Palazzo Olivetti

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is the perfect combination of architecture and technology, and protecting this building means to preserve, at the same time, the technological innovation of that period in Italy. Digital technologies, herein intended as Digital Twin for curtain wall façade, become an essential tool for the future conservation of existing buildings and for meeting contemporary performance requirements.

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