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SUPPORTING TEAMWORK IN CONTRACT FURNITURE DESIGN

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ABSTRACT
Contract furniture design is oriented to develop customized products for the creation of a finished commodity for hospitality, offices, retails, restaurants, stores. It is assuming a growing importance all over the Europe and represents a preferred channel for promoting Made in Italy offer. Numerous competences with different skill, abilities and background are necessary to fulfill market requirements. Stakeholders are arranged into complex inter and intra temporary networks where sometimes-conflicting interests and purposes need to converge into a single and integrated design solution. Contract furniture combines product design with interior and architectural design requests to provide coherent furniture by assembling custom high-quality items from different firms. As a consequence, the design process is complex and collaboration is imperative to achieve the expected goals. This paper explores contract furniture design and defines a technological platform to support team working. The proposed methodology is applied to an industrial case study in the hospitality and retail sectors. Method application brings to define the system platform architecture and its main software modules.

Keywords: teamwork in design, collaborative and participatory design, design process modeling and management

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1 INTRODUCTION

Contract furniture design deals with furniture for hotels, B&Bs, guest houses, offices, bars, restaurants, leisure facilities, retails, stores, ferry-boats, etc. The term "contract" refers to the written agreement that is usually signed between the seller and buyer. The presence of such a "contract" has four main consequences: the commitment is determined by several figures such as the owner, the general contractor, and the architect; time constraints are established in advance and must be strictly respected; the design phase is long, iterative and unstructured since the design of each single item is usually defined in relation to the other products or services; the goal is furnishing large spaces so the design project must be defined combining product and architectural features; the negotiation phase is complex since the cost budget is global and comprehends all the furniture (Power and Jansson, 2008).

The analysis of contract furniture reported in this work outlines that contract design is very complex and has some peculiarities, which make it different from traditional product design: coordination among all involved actors is hard to realize, time scheduling is continuously affected by changes and unexpected events, and cost control is complicated. Unlike other industries such as aerospace or energy, contract furniture is mainly characterized by small and medium-sized enterprises (SMEs) with low technical skill (e.g. dealers, fitters, masons, carpenters). They are arranged into horizontal chains without a leader company charged with coordination of deliveries, executing times, interactions among suppliers, etc. Despite these complexities, contract furniture represents a real promising market: European hospitality market represent about the 34% of the total market and new emerging countries like South America and Brazil can offer great business opportunities (CSIL, 2011).

The present paper describes an innovative idea from an Italian industrial cluster, which proposes a new way of making contract furniture design to reduce time-to-market and product costs. It is based on an innovative technological platform able to support collaboration between manufacturers and architects-designers, share product data and knowledge among suppliers, designers and architects, co-design customized solutions, and create a fast track for general contractors with the participation of target consumers. The research proposes a methodology for eliciting process requirements, weighting them according to user needs and finally selecting the most proper technologies. The method is applied to an industrial case study that is represented by a three-years project (DesigNET) funded by the Italian Ministry of Economic Development. Findings about the analysis of the contract furniture design process and the definition of the supporting platform architecture are described in the paper.

2 BACKGROUND

2.1 Collaboration in contract furniture

The emerging complexity in both product and architectural design triggers the involvement of different competencies to handle all design aspects (McDonnell and Lloyd, 2009). As furniture design combines product and architectural design requirements into a unique process, it emphasizes the collaborative aspects due to its characteristics: high level of product personalization, low cost, high product/environment quality perceived by the customers, high durability, respect of international technical-functional standards. Moreover, the required design network is definitely extended, temporary and changeable according to external factors (e.g. location, timing, costs, provided competences and items) (Bullard, 2002). The analysis of contract furniture reported in this work highlights its inner characteristics. Contract furniture differs from other industries such as aerospace, energy or shipbuilding, mainly due to the smaller size of enterprises, the type of organization (i.e. horizontal *vs* vertical supply-chain), the lack of la large-sized leader company and the low professional skill of involved stakeholders. These elements make contract design similar to architectural design. However some differences can be outlined. Contract furniture has to handle problems of complex project management, coordination of suppliers often geographically distributed all over the World, product customization and integration, design and manufacturing, mutual effects of decisions in product and architectural design and respect of both local and international normative.

Despite market potentialities and design features, literature overview lacks of studies about contract furniture process. It is defined as a particular form of mass customization that relies both to traditional mass customization and to specific B2B requirements (Fogliatto et al., 2012), and has a multidisciplinary and multi-scale dimension able to create processes, services and products (Power and Jansson (2008). In some way it looks like a participatory design (PD) process in terms of users' involvement, high iteration and multiple knowledge integration (Preece et al., 2002). Indeed, it implies high level of collaboration and synchronization, from the integration of single "pieces of work" which are individually developed (i.e. tasks, decisions, analysis), until the combination of different working actions due to the actors' working way (i.e. work at computers, talk to other designers or specialists, solve problems by acting on the product models).

Recently the spread of virtual environments (VEs) creates new ways and "places" for designers to collaborate and design. VEs represent a new approach to create collaborative design (co-design) by providing mutual support to different experts in a coordinated work to solve a design problem together (McDonnell, 2009). However, the traditional co-design approaches mainly refer to product design (Stadtler and Kilger, 2008; Germani et al., 2009; Mengoni et al, 2010). None of them has been conceived for contract furniture collaboration. As a consequence, existing co-design environments lack specific functionalities to properly support contract furniture design. In the last years, few web communities and interest groups assumed a contract furniture-oriented perspective: they provide idea and information sharing among manufacturers, architects and product designers (e.s. BCFA, WCD, WFO, CDM, 2012), but they are not able to manage technical data, schedule tasks and activities, support product configuration nor offer any shared tools to support design and make all the actors actively participate. Benefits of using Computer Supported Cooperative Work (CSCW) systems in contract furniture design are evident in terms of collaboration improvement and process management. The main problem relies in the definition of system requirements and identification of proper tools fitting the above-mentioned contract design challenges. Quality Functional Deployment (QFD) based techniques offer a solution for system requirement definition and tool benchmarking (Cohen, 1995). They actually consist in the integration of processes through House of Quality matrices that are filled in by experts. Each House consider a specific correlation step and allows qualitative data received from a previous House to be transferred into quantitative data, and to be prepared for the next House. In a previous work, the authors adopted QFD to drive the design of a co-design platform architecture based on specific SMEs-chain needs with a successful result in terms of time to market reduction, process quality achievement, user interface usability and acceptability and system interoperability with other Information Communication Technologies adopted by stakeholders (Germani et al., 2012).

2.2 Supporting technologies for contract furniture design

Computer Supporting Cooperative Work (CSCW) solutions have been developed to enable data sharing and remote cooperation typically for product design purposes (Li et al., 2004). The most promising ones provide a shared and distributed workspace where designers and manufacturers can access a product model, often in STEP standard, representing design information at several levels of granularity and check the status of their assigned tasks (Sirisan, 2002), but none of them address contract furniture challenges. Focusing on hospitality and retail, a preliminary review of potential supporting software tools leads to the following classification:

- CAD-based configuration systems: they refer to commercial systems or open-source platforms dedicated to the furniture sector, e.g. Metron (http://tesysoftware.net), 3CAD evolution (http://www.3cadevolution.it), Mobilia (http://mobiliasoft.com). They are client-based and allow handling CAD models and configuring them and generating the complete BOM. They adopt a single company perspective, so they cannot support co-design within an extended network;
- General-purpose 3D modelling systems: they are 3D modelling tools mainly adopted for architectural design, e.g. Google Sketch-up and Sketch-up PRO (http://www.sketchup.com/intl/en). They are general-purpose and easy-to-use, so they can be easily adopted to create an environment and populate it with product models. They are client-based. Some of them support model sharing through the web. However, rendering quality is low and most design tasks are not fully supported;
- Web-based 3D configuration systems: they are free or open-source platforms for interior design that allow creating a 2D-3D environment where furniture items can be positioned and rendered, e.g. Sweethome3D (http://www.sweethome3d.com), DomusPlanner (http://www.domusplanner.com). They are intuitive, low cost, and allow data sharing through the web. However, they do not support technical product configuration so that they are not suitable for architects and/or manufacturers;
- Co-design tools: they afford to visualize 3D models in a shared modality by multiple users, navigate the space also by walkthrough, mark-up file, chat and comment during designing, e.g. Oracle Autovue (http://www.oracle.com/us/products/applications/autoVue), Actify SpinFire (http://www.actify.com/products/spinfire-cad-solution-system), Autodesk Streamline

(http://www.autodesk.it/streamline). They are low-cost and multi-systems, but image quality is low and real time modelling is not usually supported;

- CAD-based plug-in for configuration management: they are plug-in applications developed for specific CAD commercial systems (i.e. SolidEdge, SolidWorks, PRO/E, Catia) to manage product variables and assembly configuration, create relationships among product features and dimensions, and handle modular assemblies. They fully support design tasks, but rendering quality is poor and data sharing is not available. They are not easy to use for non-expert users.

Beyond these tools, there are several IT development frameworks and platforms that allow realizing specific applications for high-quality rendering or data management purposes, e.g. .NET (http://www.microsoft.com/net), X3D (http://www.web3d.org/x3d), OpenGL (http://www.opengl.org), and JReality (http://www3.math.tu-berlin.de/jreality).

The limits of the above-listed technologies require a challenge for contract design supporting tools. It could be achieved by the application of QFD to define system requirements, functionalities and infrastructure features. The new system has actually to be able to combine project management, design automation and web-enabling solutions to support participatory contract furniture design. It must allows users to configure product variants and the architectural environment where they are placed by respecting a set of knowledge-based rules, create a 3D model of the customized solution and the related Bill-of-Materials (BOM) to be used for negotiation and fulfilling the order, support real-time collaboration and realize high-quality aesthetic rendering for e-marketing applications.

3 BENCHMARKING METHOD TO SUPPORT TEAMWORK IN DESIGN

In order to define a new system able to efficiently support participatory teamwork for contract furniture industry by overcoming the existing limitations of co-design tools, a structured methodology is defined (Figure 1). It adopts QFD-based approach to elicit system requirements, benchmark available technologies, and drive system architecture definition.

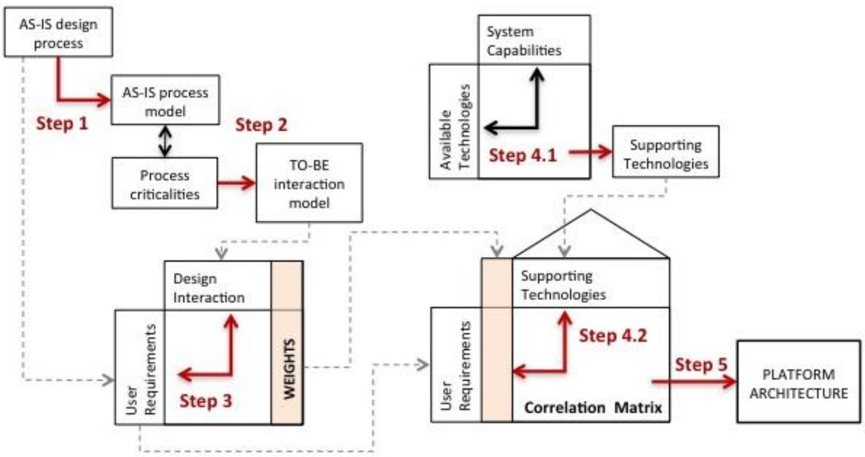

Figure 1. Overview of the proposed benchmarking method

The proposed method can be summarized into 5 main steps:

1. **Analysis of the AS-IS contract design process**: the design process is investigated by questionnaires and direct interviews by involving the main process actors. It allows modeling the actual process by mind maps and highlighting the main criticalities. Analysis concerns the process activities development and tasks, the collaboration issues, input and output data typology and management, design offer features and variability. All feedbacks are collected and the most frequently responses are considered;
2. **Elaboration of the TO-BE interaction model**: in order to overcome the AS-IS criticalities, a TO-BE process model is conceived. It considers the perspective of all actors involved and complies with user requirements. After than, an optimal interaction model is defined and a set of possible use scenarios are depicted to assess the impact on the different final users;
3. **Elicitation of users requirements**: a set of expected user requirements are elicited from the previous analyses and each requirement is provided by a weight (5-point scale) expressing its relevance according to both experts and process actors feedback;

4. **Benchmarking of the supporting technologies**: firstly, the most suitable technologies are selected and analyzed according to their capabilities (technology classification). Then, the different technology classes are correlated to the user requirements by means of a correlation matrix, which highlights whether and how the analyzed systems satisfy each requirement. Benchmarking exploits a correlation matrix able to combine system capabilities and requirements, and to weight them according to the requirements' relevance. For each analyzed technology *j*, a total evaluation value (*TEj*) is calculated by equation (1):

$$TE_j = \sum_{i=1}^{n} Ai * Bi \qquad (1)$$

   where *Ai* is the weight of the *i-esimo* requirement, *Bi* is the assessment of the *j* technology for the *i-esimo* requirement, and *n* is the number of considered requirements.
5. **Definition of the platform architecture**: the selected technologies are integrated into a unique system platform and the system architecture is then defined. User interfaces and the platform modules are stated, and the input/output data flows are outlined to drive system development.

4 CASE STUDY: A PLATFORM FOR CONTRACT FURNITURE DESIGN

The methodology has been applied to support a cluster of companies aiming to operate in the contract furniture sector within the DesigNET project (http://www.designet-italy.it). It started in 2011 and is funded by the Italian Ministry of Economic Development. It lasts three years and involves 17 Italian companies (i.e. product manufactures, suppliers and design studios) that vary in size, organization and core business. DesigNET focuses on hospitality and retail contract design and aims to promote Made in Italy innovation and lifestyle by creating a multi-disciplinary organization and offering high-tech co-designed integrated solutions. The goal is to realize a collaborative network thanks to an innovative technological platform able:

1. to showcase the DesigNET companies innovations and competencies,
2. to configure the designed space as a whole and the single products in details to meet commitment expectations and companies' capabilities,
3. to design custom products, variants or new integrated solutions in an effective collaborative way.

4.1 Contract furniture design: the AS-IS process

The AS-IS process analysis is fundamental to outline the main characteristics of contract furniture process and to highlight the research challenges. Investigation is carried out by questionnaires and interviews and is guided by experts from Academia and industry. The AS-IS process is reported in Figure 2. The main findings of the process analysis refer to the following aspects:

- *Process features:* the arrangement of a contract cluster starts from a new project that is generally proposed by a buyer, a general contractor or a designer/architect. They are generally responsible in the selection of the partners, who create a temporary network that increases in terms of participants' number during the project duration. In most cases the architect is assigned to identify the proper design solutions to be included in the furniture or those that need to be integrated and customized. He/she becomes the first interface between the buyer and the manufacturers/suppliers. The architect manages most design issues, whereas the general contractor or directly the buyer/owner supervise economic and temporal issues. Negotiation is time consuming and brings to iterative modifications until an agreement is achieved. Such negotiation is repeated for each furniture supplier. An unstructured and sometimes-horizontal chain where numerous small-sized companies works together coordinated by the architect or the contractor, characterizes contract furniture process. It differs from the traditional vertical chain characterizing complex projects e.g. in aerospace where a large-sized company usually leads all the process and verifies the results.
- *Representational media:* the means of design representation are numerous and vary according to the design stage. From abstract and unstructured representations during conceptual design (i.e. sketches, images, simplified digital models) to CAD-based representations and simulations during embodiment design (e.g. structural and thermal performance, kinematics, process simulation, ergonomics).

- *Team composition*: the design network is extended, temporary and changeable according to external factors, and the working team is multifaceted as it is made of company internal figures (i.e. marketing staff, engineers, stylists, top managers, CEO) and external ones such as the buyer and/or owner, external designers, general contractor, architects, commercial agents, installers, mediators, end- users. The interaction between all the involved actors is intensive during the conceptual and detailed design as well as the realization phase. During design, interaction allows defining a solution appreciated by all partners and compliant with the project requirements. During manufacturing, interaction allows respecting cost and time constraints.

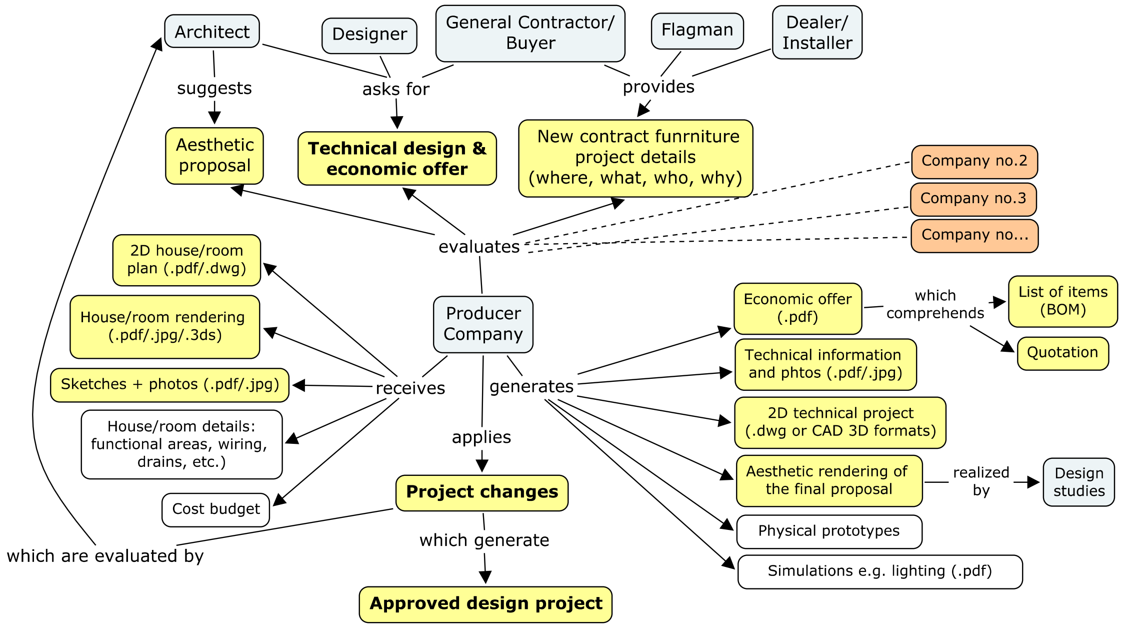

Figure 2. AS-IS process model

- *Key factors for success*: they are loyalty, reactivity and novelty. The creation of a solid partnership between the manufacturers and the designers/architects is fundamental to be firstly involved (loyalty). Timeliness is decisive to win the competitive bid so that the company has to clearly define items features and typology from the earliest stages to enable the contractor to generate accurate and reliable estimates (reactivity). Finally, the offer has to be fresh and distinctive in order to differ from the competitors' ones (novelty).
- *Criticalities*: they are related to 1) the achievement of a mutual evaluation of both technical aspects and aesthetic impression of the overall furnishing, 2) the realization of a shared design environment where the relationships among the single items can be expressed and discussed (i.e. level of integration, compatibility, assemblability), 3) the understanding of the buyer expectation to elaborate a satisfying proposal, 4) the organization of process activities according to partners' roles and the synchronization of different companies' tasks to respect cost and time constraints.
- *Contract design challenges*: those process aspects that needed to be supported represent the research challenges. 1) *Requirement elicitation*: furnishing is characterized by specific aesthetic and functional requirements depending on the needs of the target market, the country, customer profiles, contract typology (e.g. hotel, retail, store). 2) *Personalization*: it is much more than a simple product dimensions' variation, as it is extended to finishing, functions and technological features that are usually not expected in mass production, and it can be achieved only by combining parameterization, configuration and feature innovation. 3) *Regulation compliance*: items must respect not only international standards but also specific country regulations concerning different aspects (e.g. ergonomics, security, safety) and different user profiles (e.g. children, teenagers, elderly people, disable people). 4) *Unique interface*: contract furnishing requires a unique interface between the buyer and all involved stakeholders to realize a turn key project covering the buyer's needs. 5) *High perceived quality*: the perceived quality of the designed environment strongly depends on single product configuration and on their integration and mutual relationship. It implies that furnishing design must respect a unique aesthetic style.

4.2 Contract furniture design: the TO-BE model supported by challenging tools

The TO-BE process aims to overcome the outlined criticalities and address the identified challenges. Figure 3 shows the conceived TO-BE interaction model. It proposes an innovative use scenario and represents how the contract furniture design process could be carried out once supported by new supporting tools. In particular, it requires four main user interfaces:

- a web-based virtual marketplace promoting in an appealing way the products offered by different manufacturers that can be arranged into temporary clusters according to the user selections;
- a configuration tool able to support the 3D configuration of both products and architectural space according to predefined rules and design best practices;
- a management tool to make companies upload products and solutions, preset the product variants (e.g. colors, finishing, functions, features) and add technical documentation;
- a co-design area supporting real time collaboration among multiple dislocated users.

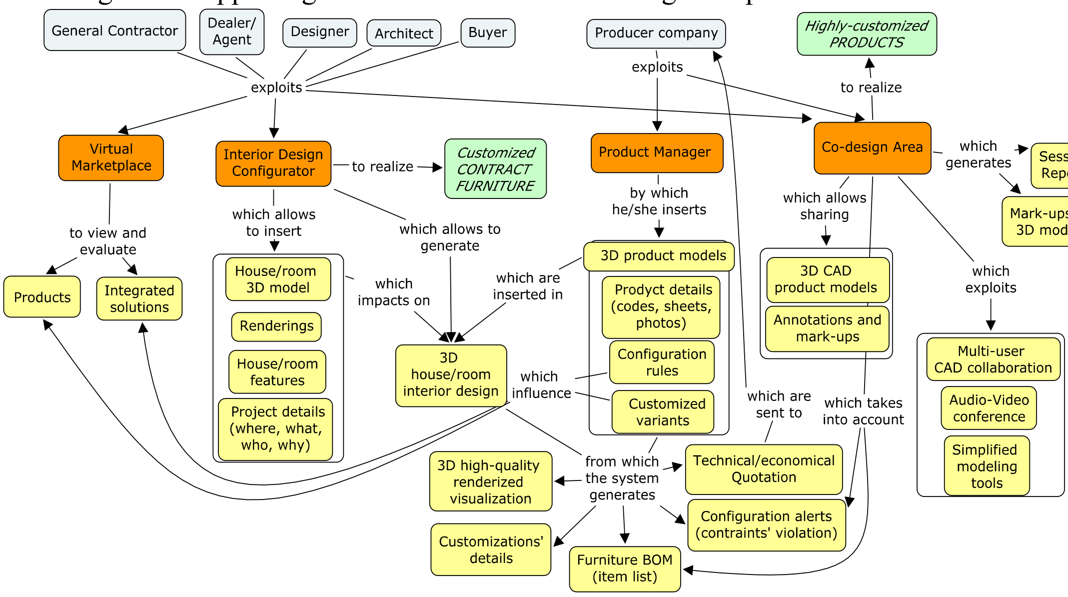

Figure 3. TO-BE interaction model

4.3 User requirements definition

Requirements elicitation is achieved by combining the TO-BE interaction model with the expected functionalities of the user interfaces. Requirements are grouped into six categories (Table 1). DesigNET cluster companies have been involved both in requirements improvement and weights assessment. For each company, two mangers from R&D dept. and from the marketing dept. are asked to express the importance that each requirement has for the company but also for the architects and designers he/she collaborates in contract furniture. In addition five external designers, that usually works in hospitality and retails, and two general contractors are involved in this assessment. Weights data are averaged on 40 total judges.

4.4 Benchmark of available technologies

For each of the five technology classes, one or more tools are selected and compared. They are: a Java web-based system (i.e. JReality), two HTML5+WebGL Frameworks (i.e. X3D and C3DL) and two web-based configurators for interior design (i.e. Sweethome3D and DomusPlanner), two co- design tools (i.e. Autovue and Hops streaming), a CAD-based plug-in (i.e. SolidWorks eDrawing), and finally two general-purpose 3D modeling tools (i.e. Google Sketch-up and CoCreate OneSpace). In addition four SW development frameworks (i.e. .NET, ASP.NET, WebGL, OpenGL.) are assessed. Two experts, one from Academia and one from the largest company of the partnership (i.e. iGuzzini) evaluate each tool (j) assigning 0-3-9 values (Bi) for each user requirements (i). For each tool values are weighted according to the requirements' relevance (Ai) and then summed according to equation (1) to obtain a total evaluation. Figure 4 shows the final evaluation reporting the averaged values achieved. Highest values indicate those systems, which better satisfy contract design needs.

The most proper technologies for the DesigNET context of use result to be as follows: 1) ASP.NET technology to develop the platform web applications as far as the virtual catalogue and the configurator interfaces are concerned; 2) OpenGL (Open Graphics Library) to realize the graphic engine and manage high-quality rendering inside the configurator; 3) VB.NET framework to develop the configurator engine in order to manage 2D and 3D geometries, product variants, configuration rules, constraints check, user roles and permission, databases, BOM creation and data exchange. It will be common to configurator and manager interfaces; 4) WebGL platform to support programming the 3D web-based interactive interface of the virtual catalogue; 5) Autovue Oracle platform to be integrated the .NET framework to support real-time collaboration.

Table 1. User requirements for contract furniture design

CAT.	USER REQUIREMENT	Weight
Visualization	UR1. Real-time selection of the available product variants	4
	UR2. Virtual marketplace (web-based)	5
	UR3. Import of 2D model by .dwg/.dxf formats and creation of the related 3D model of the environment	4
	UR4. Indication of doors, windows and other remarkable points (e.g. drains, electrical connections)	3
	UR5. Import of 3D CAD models of furniture items (single products) by standard format (.stp)	4
	UR6. Wizard procedure to easily guide users in data input (cost budget, design features, desired functions)	5
	UR7. Inserting 3D product models into the environment by drag&drop	4
	UR8. Exploring both products and environments by walkthrough	4
Rendering	UR9. Realistic visual representations of 3D models of both single products and integrated solutions	5
	UR10. Real time rendering of the environment during configuration	3
	UR11. Export of the rendered 3D model of the global environment in a secure format (not editable)	4
	UR12. Export of the final 3d model for VR or AR applications	3
Model-ing	UR13. Basic modeling tools (e.g. protrusions, holes, etc.)	3
	UR14. Basic measuring tools (e.g. distance, area, volume)	5
	UR15. Generation of thickness on 2D models	2
	UR16. Extraction of simple 2D geometry from 3D models (e.g. edges)	3
Rule Configuration	UR17. Dimensional rules and definition of acceptable ranges for distance, areas and volumes	5
	UR18. Basic interior design rules (e.g. acceptable distances) and best practices to support item positioning	4
	UR19. Management of product alternatives on the basis of design constraints and user's preference	3
	UR20. Modification of 3D product models after importing by stretching or resizing	2
	UR21. Reporting of cases in which standard products must be customized (by specifying the changes)	4
	UR22. Wizard procedure to guide the user's choice of the different product categories	4
Data Manag.	UR23. Automatic generation of the global environment BOM	5
	UR24. Correlation between product and technical data (e.g. photos, technical sheets, 2D drawing details)	4
	UR25. Notification to the user about price for standard product and for customization (by percentage)	4
	UR26. Notification to the company about new configuration integrating its own products	5
Collabora-tion	UR27. Real time collaboration between multiple users	5
	UR28. Remote visualization of 3D models	4
	UR29. High-quality rendering	2
	UR30. Audio-video communication	4
	UR31. Mark-up on 3D models (e.g. notes, comments, attachments)	5

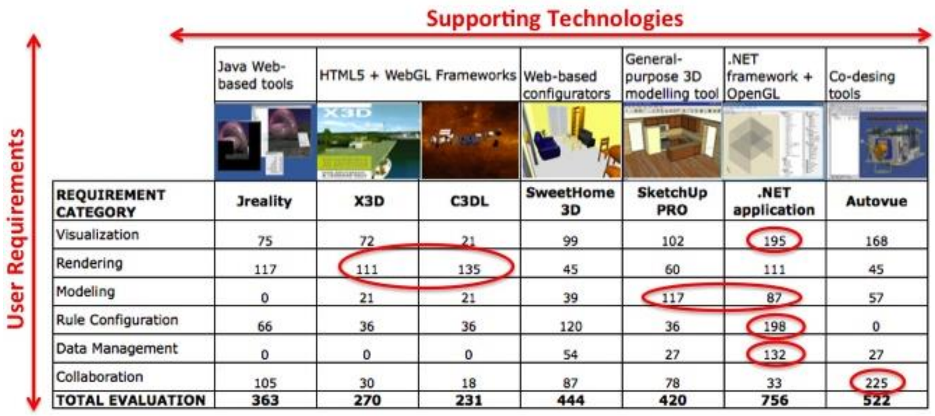

Figure 4. Technology benchmarking for contract furniture design

4.5 Platform architecture and technology integration

The selected technologies need to be properly integrated to realize a unique system accessible by different user interfaces supporting diverse viewpoints and levels of abstraction. Indeed, as the stakeholders differ for their personal background (e.g. engineering, architectural, economics), purposes (e.g. technical, economical, product-centered, holistic, etc.) and needs (e.g. the interior architect has to configure the space, the designer to shape a new customized product, the contractor/buyer to find out the cheapest solution and have a global overview of the furniture offer and the manufacturer to create an offer based on user requests) it is imperative to provide at least four user interfaces with different functionalities and levels of usability. The platform architecture is structured in two main modules whose access is provided by the different user interfaces. Main input and output data are defined and then organized into a unique system platform as shown in Figure 5.

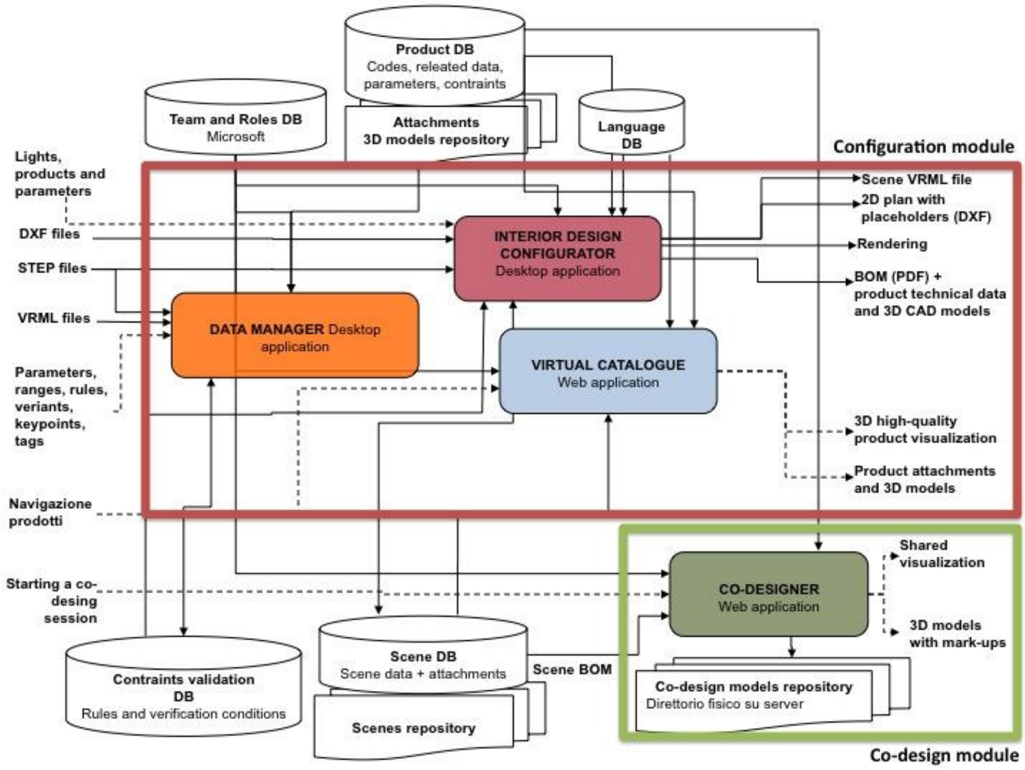

Figure 5. Platform architecture and overall system design

The configuration module aims to configure the desired space by choosing the most appropriate items to furnish the empty space. It has three main interfaces:

1. *Virtual Catalogue*: it is a web-based marketplace where the user can view a rich catalogue of products and integrated solutions proposed by manufacturing companies and evaluate all product variables by an high-quality 3D rendering, refreshing once a parameter changes (e.g. color, finishing, dimensions, accessories, performance). Each item is correlated with its technical documentation (e.g. 3D models, 2D drawings, manuals, data sheet). Such interface is barrier-free since it is on the web and has a public access throughout the most common Internet browsers;
2. *Interior Design Configurator*: it is the configuration engine and allows the user to create a personal project, importing a 2D or 3D space model (e.g. hotel room, store space) and populate the empty space by selecting the catalogue items. It supports product configuration and positioning into the space by following the manufacturer's guidelines (e.g. a bookcase that requires to be attached to the wall) and respecting some technical constraints (e.g. the minimum empty surface of the wall and its minimum resistance) by exploiting a knowledge-based set of rules which explicit the relationships among products and the environment;
3. *Data Manager*: it is a technical product configurator that allows the manufacturer to upload and define their own products, all feasible variables and the possible ranges of parameters' modification. For each item the company has to provide a 3D model, indicate the product existing or customizable characteristics (e.g. materials, surface finishing), specify the optional accessories (e.g. handles typology), define the customizable features and their allowed range of variation (e.g. max-min length), add the installation constraints to be respected (e.g. maximum distance to the power socket of 30 cm) or the suggested configuration constraints (e.g. wall contact is required). Additional data can be further attached such as user manuals or product renderings.

The co-design module supports the technical configuration and co-creation of customized products or integrated design solutions by a web-based collaborative space. Such a tool is fundamental when the existing products cannot satisfy a certain demand and a customized product is required or when the architect has to create a special solution for the configured space. It has one main interface that is called, *Co-designer*. It is the technical collaboration area offering a shared co-design space to support product configuration in a collaborative modality on the web. All actors involved in a specific project (i.e. designer, general contractor, R&D company staff, company commercial manager, supplier) can access a common area, share 3D models and documents, and contemporary interact by audio-video conferencing. Real time collaboration is important to identify changes and find out the best solution.

5 CONCLUSIONS AND FUTURE WORK

The research addresses main challenges of participatory design in contract furniture. It provides a structured methodology to create a supporting platform to manage product configuration and co-design tasks in the extended network. It represents a step forward in co-design since it investigates and analyzes an unexplored field of research. The main research contributions refer to: the identification of the process requirements and the main open issues in contract furniture design; the definition of a TO-BE user scenario and interaction model; and the definition of a benchmarking method to compare and select different technologies according to the specific user needs. The method application allows the platform architecture to be conceived by integrating the benchmarked technologies. The same approach could be adopted also to identify CSCW tools able to support other complex participatory design processes such as those characterizing automotive, aerospace, building in general. Actually such a platform is going to be implemented. After that, it will be tested and its performances will be evaluated by directly involving the different target users. Focus group and usability analysis will allow authors to verify the achievement of the expected benefits in contract furniture design.

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