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Representation means to condense complex information: the updating of new media for the construction field

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Abstract

Purpose:
Purpose of the paper is to present a few comments about the renewal of the representation techniques, explored in the building and construction areas, as methodological and operational equipments that the digital design tends to upgrade.

Method:
The foreword above the topic of this work summarizes the picture of the needs expressed by the construction field in Italy, focusing on the main problems that arise analyzing the current production system. In Italy it has been started a research project in the announcement "Energy Efficiency Industria 2015", named InnovANCE, which provides for the development of the first unified and interoperable database in the construction industry, identifying the strategies for integration in the construction process, from the design phase to construction and management.

Result:
These methods answer some urgency carried out by data complexity inherent with building construction, relating to each other different professionals in a new system, reforming the assets and the processing mode, requiring explicit coordination of activities and procedures.

Discussion & Conclusion:
We discuss on the added value of the outcomes of the research in progress, focusing on the use of operational methods that are best suited to manage the complexity information carried on in the project representation.

1 Introduction

Purpose of this paper is to present a few comments concerning the renewal of the representation techniques, explored in the building and construction areas, as methodological and operational equipments that the digital mediation tends to upgrade. This trend addresses towards objectives increasingly large and with more accuracy to the production, management and life cycle processes.
The foreword above the topic of this work summarizes, very briefly, the picture of the needs expressed by the construction field in Italy, focusing on problems that arise when we analyze the current production system with specific reference to the intricate question of public works and the close relationship between drawings and textual documents and schedules for the quantity take off.
It is an introductory overview essential to understand the effort required, even in education and research fields, to change and to begin more virtuous processes, able to reverse the current downward trend and overcome a crisis which, unfortunately, appears more and more persistent. The varied and dense structure of the construction industry has given rise to a number of requests (including technical ones, but not only those!) with regard to support functions necessary to improve the decisive role of the project and its working practices; the aim is to find ways to govern the complexity of the different forms of representation, through their dual analytic-synthetic feature, contributing to create reports, comparisons, checks and choices. Those options, once established, must be viewed as an information system flexible and reliable over time, implemented and dynamic, able to support rapid and appropriate decision-making. [1]
The ideas gained during the participation of Massimiliano Lo Turco for a design competition (singular design intervention for terms and conditions, here presented as a case-study[1]) that are the focus of this paper; in this research, really experimental, we try to show how much important was both to reinterpret the relationship between design concept and its representation in different levels of detail requested; at the same time it was essential to work with skill and culture for using the relational nature of their information technologies. [2]
The results achieved, thanks to a positive development of the same experience, revisited for a new research

[1] *The case study refers to the executive design of a university residences, in the field of Public Works: the project activity has put in place the collaboration between researchers from the Department of Structural, Geotechnical and Building Engineering (DISEG) and the Building Service of the Politecnico di Torino. The collaboration started after the publication of the Ministerial Notice for the request of co-financing on the "construction of new housing and residences for students" according to the Law 338/2000. Politecnico participated with two projects (Mollino and Codegone residences) for a total of 240 accommodation places. On 28/12/2012 it was approved the Official ranking, through which the Politecnico di Torino will benefit from the ministerial contribution.*

project[2], are providing additional guidance and involve new fields of investigation: going on to investigate and working on the method, although prompted by a series instances changing and timely that the issues involved continue to offer; we would like to comment on the initial results and issues not fully resolved to discuss it with those who, in their research, are engaged on the same subjects.

2 Purpose: the imperative need to streamline processes

Some general data to focus on the main problems of the public works system:

- in Italy the construction industry represents an important share of national GNP - Gross National Product - (about 10%), a part of which (about 2.5%) consists of public works of new construction or maintenance, indispensable for the operation of the country;
- Italian public works are characterized by higher costs than the European average, uncertain and too long timetable; then, in spite of the time spent in the planning stage and the overabundance of rules, the government is often unsuccessful in contractual disputes with additional charges for public spending;
- the construction industry can be identified as a sector characterized by complex activities, essentially marked out by significant long schedules, with unrepeatable environmental, design and technological features;
- the professional activity presents a scattered organization, individual and not too pushed to innovation, although in recent years the design activities in Italy have absorbed more than a billion Euros a year.

An unbearable situation which requires, in order to exploit the full potential that the construction industry can be expressed, to work for the improvement of the system efficiency by focusing on technological innovation, as was the case in most other industries. The change of design tools and management, initiated and supported by information technology has opened unexpected perspectives for the accuracy and accelerate design time, providing new devices support to optimize structural, energy and environmental performance. This led to simplify procedures, to improve the quality control, with an early detection of errors, allowing to establish a collaborative dialogue among the many actors involved in the supply chain of the construction process. The ability to share data and alternative solutions in the building project or renovation / maintenance / restoration over the course of the process through the peculiarities of Drawing (from concept to completion on site, with regard to maintenance till a disposal compatible with the environment), eliminates the main cause of many critical situations, favoring the qualitative improvement in the skills and professionalism of the industry, which is a necessary condition for the competitiveness on the global market.[3]

In Italy it has been started a project funded by the Economic Development Ministry in the announcement "Energy Efficiency Industria 2015". This is the InnovANCE project, coordinated by the ANCEenergia consortium, which provides for the composition of the first unified and interoperable database in the construction industry, identifying the strategies for integration in the construction process, to from the design phase to the construction one and its subsequent management; the aims are shown in the next section.

QUESTIONS	AIMS	SOLUTIONS
• fragmentation of production stages • number of stakeholders • heterogeneous size enterprises	• organization of system • interaction between professionals • standardization of production phases	• intervention on the supply chain **QUALITY STANDARD**
• lexical hesitation • disciplines variety	• common language • scientific coordination • warranty	• unique coding • shared semantics **BARCODE**
• data fragmentation	• collecting information • data organization • access speed	**CATEGORY DATABASE**
• information usability	• implementation in business applications • interaction of business applications	• interaction between Information Technologies **INTEROPERABILITY**

Fig. 1 Problems and proposed solutions are outlined in a scheme that identifies the primary elements to be taken into account during the research process

3 Method: data uniformity for collaborative drawing

In detail, the research project has the following purposes:

- to define a classification code and unique identifier (called "Bar Code Construction") for products, services, activities and resources used in the construction industry, which aims to make easier the contracting stage between the parties;
- to develop a standardized data sheet for each product, service, activity and resource, whose information contents will be available to users in paper, electronic and / or multimedia format, to ensure companies with a valid technical support and to limit disputes between the parties;
- to set up a common database, linking actors in the building process and allowing a rapid and comprehensive consultation of the information contained in the data sheets, through the design technology based on building components called Building Information Modeling (BIM);
- to develop a web portal that allows users to take advantage of the encoded information in any phase of building production, from the design phase to the construction one and its subsequent management.

The InnovANCE project will achieve multiple benefits, most of all the elimination of misunderstandings between actors in the different phases of the construction process (clients, designers, companies, component operators, manufacturers, users, etc.).. These misunderstandings are particularly critical for this field, that generate relevant technical / economic inefficiencies, as well as waste,

[2] *The authors are currently working on the InnovANCE Project, which aims to create the first national database for construction, interoperable and free access, containing all the technical, scientific, economic, legal information useful for the construction industry. The Research Project, was presented by a partnership of public, private, universities and research centers as part of "Industry 2015" on Energy Efficiency: http://innovance.it/it/*

delay and, of course, a large number of disputes. The key point, as often happens, is the lack of coherence between the different products derived from information assets residing in the project: at this regards the procedures of a parametric and multirelational approach allow not only to ensure maximum consistency between drawings, but at the same time enable a more efficient control and management of schedules and descriptive processes, expressed through performance calculations, reports, specifications, emphasizing the analytical role of the Drawing area.
As part of the construction process, many software applications are used for the same project: information flows between the various operators generally in a disordered way: this is due to the fact that the formats of each software are often specific to the individual application, but not are directly readable by other applications. The risk of inconsistencies and data loss is always very high. Thus it is necessary to create and define standardization processes capable of carrying data information which every actor needs. A vehicle, therefore, that it is able to carry full information for different needs and operations.
In Italy, the increasingly close relationship between the representation techniques and management of the construction process is also evident in the regulatory environment: the Public Procurement Regulations requires that "*for the drawings must be checked each item, describing it in terms of geometry and, unless stated its features, it is uniquely identified by a code or through another identification system that can place it in reference to the description of other documents, including the technical ones* ".[3]

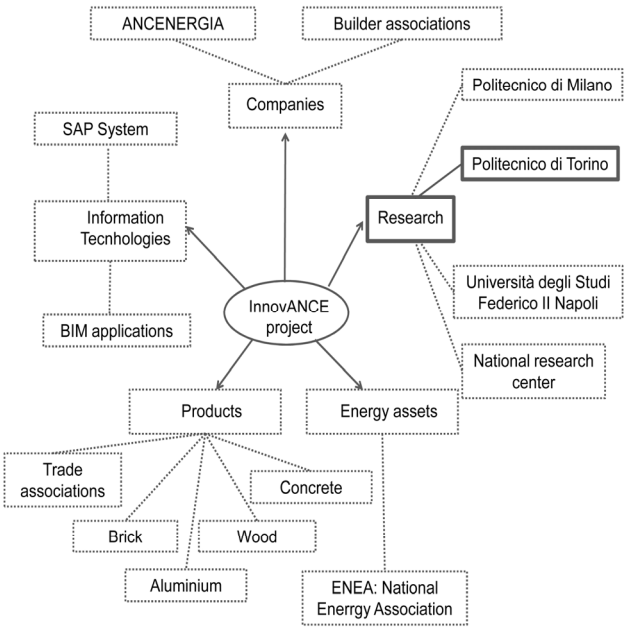

Fig. 2 Diagram of the partners involved in InnovANCE research project and the different involved fields, highlighted the contribution of the Politecnico di Torino

In relation to the proposed coding system, the classification process, (intended as a sort classes of all the entities that have the same properties) is a general problem extended to all fields of knowledge. In order to be considered an efficient language classification system, it must have two essential characteristics: it must be able to define exhaustively a topic, including all belonging concepts, allowing the membership of each element of the topic to a single class. To be effective, therefore, a classification system must be stable and flexible, therefore conceived with a modular structure. The unique ID of each subject, object or activity in the construction industry[4] is accomplished by assigning a name that is defined in the standard as "strong name" and composed by the common name of the subject, object or activity to identify, and one or more features taken in sufficient number and quality for the requirements identification.
The coding system[5] is structured in seven fields (category, type, function, performance, geometries, dimensions and chemical and physical ones). For assembled systems (for example, a wall), there is also an indication of the number of constituent elements.
Research activities allow to set up a two-way relationship between the InnovANCE and the BIM platform[6], through the preparation of an add-in that allows you to read the database and import it into the parametric application, so integrating the project documentation. The possibilities offered by the BIM methodology combine perfectly with the characteristics of the InnovANCE project, in particular with the same data structure of the database that both actually share.

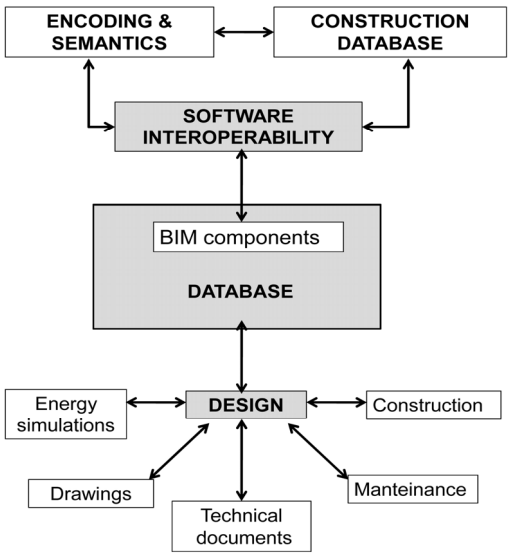

Fig. 3 The project is based on the construction data base: through this the entire chain procures the information needed to produce, maintain and manage the building

[3] *Cf. Art 53 of the Regulation Proceurement (D.p.R. 207/2010).*

[4] *The work primarily analyzes the building and construction features, but is expected to extend the scope to structural and energetic ones.*
[5] *The database is set up in the SAP environment. The data that allow the encoding of technological systems have been developed by a working group coordinated by BEST Department of Politecnico di Milano and validated at the semantic level by 'Institute of Construction Technologies and the National Research Council (ITC-CNR).*
[6] *Systems integration and interconnection with the InnovANCE platform are designed to ensure maximum independence and interoperability with all platforms BIM technlogies. The application used for the testing phase is Revit Architecture 2013.*

4 Results: evaluation of the outcomes through the trial

We want to discuss on the added value of the outcomes of the research in progress, focusing on the use of operational methods that are best suited to manage the complexity information carried on in the representation of the project. Surplus value, it was said, is not only characterized by the ability to manage graphic representations at different scales connected through a single three-dimensional model, but it answers some urgency posed by data complexity inherent with the project and the construction by actively supporting the engineering process: it relates actors to each other in the in a new system, reforming the assets and the processing mode and requiring explicit coordination of activities and procedures.[5]

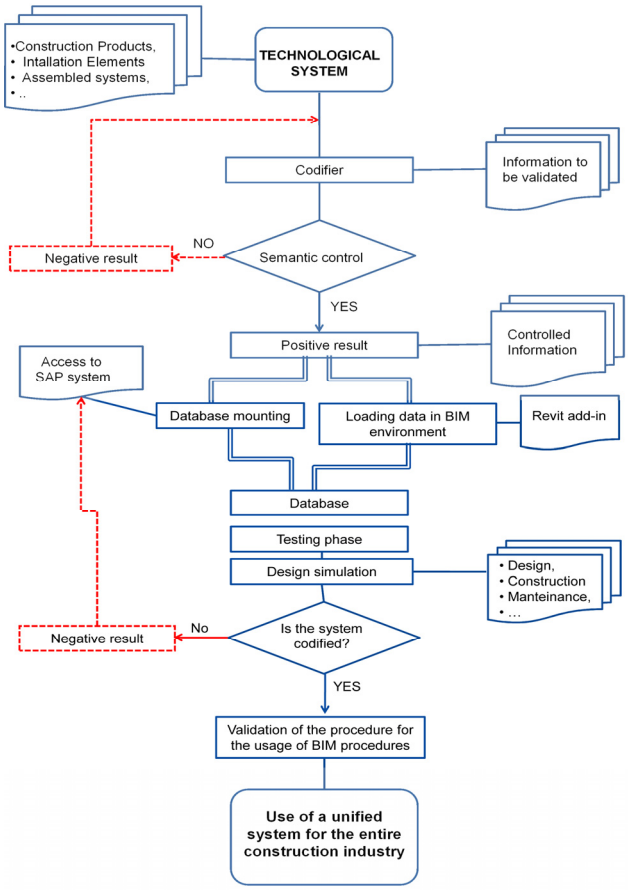

Fig 4. Procedural activity workflow of the trial. Highlights sections concern the activities conducted by the working group of Politecnico di Torino

The working group coordinated by the Department of Structural, Geotechnical and Building Engineering (DISEG) of Politecnico di Torino[7] - most of them belong to Drawing and Representation Techniques areas - has involved in the testing phase, through design simulations, to evaluate the effectiveness of the proposed method.[8]

It was chosen this particular case study because in a few months it is expected to continue in parallel some activities related to the project (construction and facility management) carrying on of the research project: we expect to widen the study in the direction of the various activities, resources, equipment and human resources involved, as well as a more precise control of the technological system.

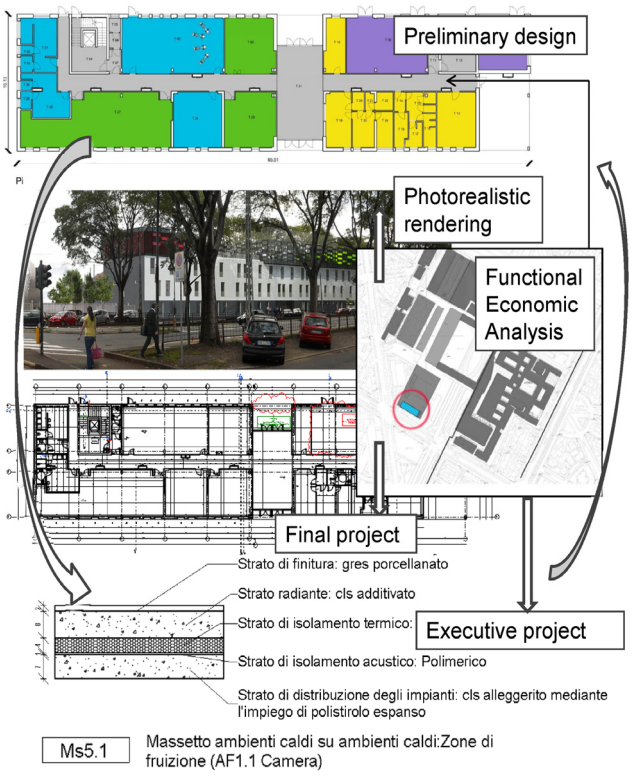

Fig 5. Carlo Mollino university residence. Scheme of the different products allocated within the database that manages and coordinates various types of information

In respect, it was made a critical comparison between the traditional approach and BIM procedures, together with an analysis of the results derived from the results of research carried out for the various stages that characterize the building process. This could be an important pilot project from which we will derive useful information to be spread in the professional world.[4]

With regard to the case study, the building, is located between corso Peschiera and Corso Castelfidardo and corso Ferrucci, in Torino. It consists of a ground floor where the major functional areas for studying, socializing and sports \are located. Two upper floors are accommodation for students, divided into double rooms and mini apartments. On the top it was placed a football field and two changing rooms.

[7] The working group is composed of prof. B. Chiaia (coordinator), Prof. G. Novello, prof. C. Caldera, Prof. A. Osello, ing. M. Lo Turco, Eng. M. Del Giudice.

[8] In recent months it has started the testing phase which involved the following activities:

a) access to the encoder through the installation of the SAP system, which contains the basic data set up, and allows the generation of new codes;

b) the loading of these codes within the BIM platform, by installing an Add-in into the parametric platform: this procedure allows to consult the database mentioned above, by associating such encoding to the different building component.

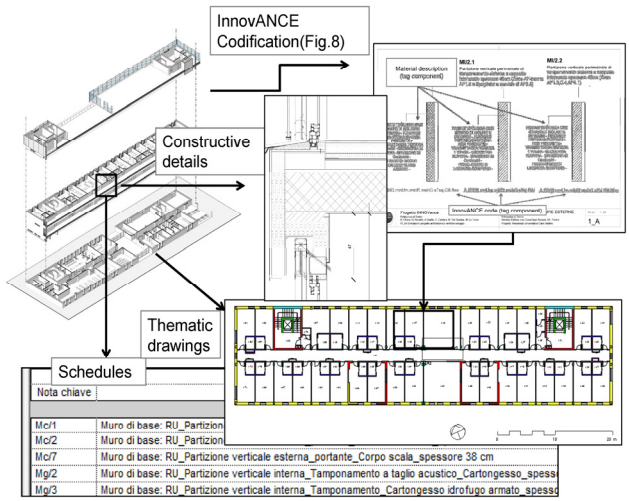

Fig. 6 Scheme of the different ways to represent the same building component: spatial displays, orthogonal projections, schedules, detail views, thematic drawings

The degree design level and the type of public work, let to operate a series of tests, using the opportunity to update the processing required for the preparation of contract documentation, using information taken from previous processes integrated with specific resulting from the InnovANCE project.The experiment was conducted on the main building components such as walls, windows, curtain walls, doors, pillars, firtsly focusing to the technological systems that characterize the envelope, such as walls and windows; because that element are the main components that have the greatest impact on the energy performance of artifacts. This phase represents a systematic analysis work related to a critical analysis to the main components that constitute the examined building.

Design simulation using InnovANCE updating

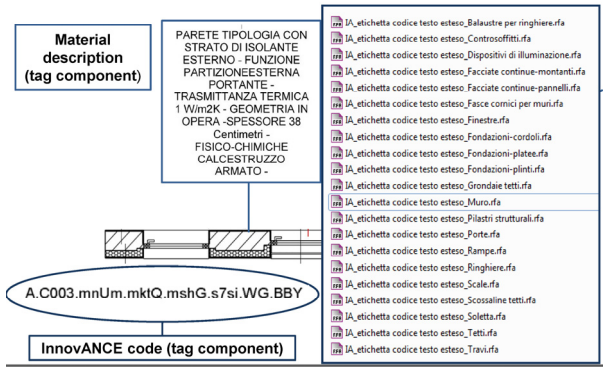

Fig. 7 The use of family labels with a description of the components and the code derived from the SAP system

To make the information associated to the various components even clearer, we prepared label families for specific each component, able to read the information concerning the encoding system (i.e. parameter name: ANCE code) and the extended description of the component, that contains the main features of the coding system (function, thickness, transmittance, size, ...) to support the quality of the process.

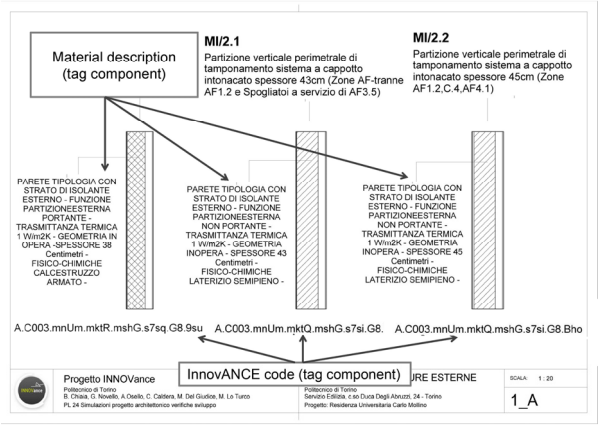

Fig.8 The wall schedule shows the information derived from the trial conducted: the InnovANCE code is associated to the building components through labels

5 Conclusion: first activities under construction

Our research group is still developing simulations aiming at the introduction of a series of spot checks on the consistency and congruence between BIM objects and their parameters resulting from the encoding system, so as to automate procedures that minimize the risk of error by the user and resolve some conflicts emerged in the early experiments. These difficulties are being solved through a series of discussions done in close collaboration with the various partners involved, should be considered as stresses aimed at a better qualification of the research process and can contribute to the success of the general objectives set.

In previous design experience conducted[9] with BIM methodologies [6], the most obvious benefit is the permanence of information of different nature: this is a topic element not only for the success of the design process but also for an equally controlled and organic process of management /maintenance. At this regard, Politecnico di Torino created a dedicated department to deal with the integration of processes and information systems (known as IPSI), which launched Facility Management (FM) plan in autumn 2009. The plan aims to optimise the management of the University's internal processes, by providing an information system containing the data on the various activities, thus creating a single database as a reference point for sourcing information and carrying out subsequent analyses.

With regard to the InnovANCE research project, future insights provide the ability to encode in a BIM system also assembled type of plant and the single construction product, to make even more rich information assets

[9] *The renovation project of the old heating station of the Politecnico di Torino is a good example of integration between the various professionals, both for the survey of the state of art, conducted through the laser scans directly imported into the parametric software parameter, and regarding to the preparation of the project, having experienced worksets technology for a collaborative work. Cf. A.CINA et alii, Metodologie integrate tra rilievo e progetto: l'utilizzo delle scansioni LiDAR in ambiente BIM, In: 16° conferenza nazionale ASITA, Vicenza, 6-9 novembre 2012. pp. 469-476.*

residing in the database and relate it to data from technical file.
Some administrative policies of many European countries are encouraging the adoption of BIM methods: in this regard, Great Britain has already decided to adopt by 2016 BIM processes for all public works, with an estimated reduction of the time and cost variables that may reach 30%; the Finnish Senate Properties, a privately run government agency operating under the auspicies of the Finnish Finance Ministry, represents one of the finest examples of BIM systems to the management of public buildings.
Even in Italy there is a desire to spread the positive results produced by this research, in particular for those that might being involved in public works: these actors could be the Ministry of Infrastructure, the Authority for the Supervision of Public Works (transparency and control); the Ministry of Economic Development (business and competition), the Ministry for Public Administration (system efficiency), the Ministry of Education (research and innovation).
The Italian state of art of the construction field is today characterized by a plurality of positions behind which lie many cultures that express different conceptions of design approach This paper has explored the capabilities for a better qualification offered to the architectural design by some processing methods that exploiting the properties of parametric modeling and processing of information, help in facilitating the communication of content that is appropriate for the various levels of detail. These dynamic content are required by the increasing complexity of the design activities, often shared by a wide variety of subjects, and considered as carriers of distinct cognitive purposes; but for the success of the interventions they should be strongly coordinated to an increase in the quality of the system.
The concept of “quality” in the building sector defines particular aspects of the building process for which a direct relationship between requirements and performance is necessary. The qualitative properties of a construction must be specified at the design stage, because the design model is a tool designed to provide all the instructions for construction which, once built, must meet the demands set out in the design. Information flows in the building industry to today are compared with the continuous return or feedback of that same information, given the need to relate different types of data to each other and take account of their reciprocal influence.[7]
Design has always constituted a privileged means of communication, but the subject of “design as a measure of quality” does not end with the communication of the ideas or with the specification and verification of the ideas with regard to those who implement them. The expectations of contemporary society are measured, as already mentioned, in terms of requirements and performances and designers are faced with the issue of documenting the qualities of a building object, which, however, are not easily presented by the tools of projective geometry or modelling.
The monolithic character of traditional building is flanked today by the requirement for an analytical dimension that can be broken down, the design of which results from the overlap and reciprocal co-ordination of the various sub-systems and the use of BIM tools seems to be the best answer to these requirements.[8]

Acknowledgement

The collaboration between DISEG Department and the Building Service of the Politecnico di Torino was born some years ago: the management structure lacked the relevant skills required to implement procedures that comply with the most methodologies described in recent memory. Thanks to the coordination between the researcher of Drawing and Representation Techniques areas and the Chief of the Building Service, Arch. G. Biscant, it started a good partnership that included on the one hand theoretical insights and research; on the other one, a parallel experiment to assess professional strengths, shortcomings and potentialities of BIM methodologies. In this respect, eng. M. Lo Turco and eng. G. Cangialosi play this double activity by 2009, the year of the first project made by BIM technology.

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