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BACK TO 4.0:

RETHINKING
THE DIGITAL CONSTRUCTION INDUSTRY

A cura di

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INDICE

Interoperability for building process. Model and Method.

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Topic: interoperability, scan to bim, method.

Abstract

In this paper we intend to analyze the chances about the implementation of a Building Information Modeling (BIM) as a method in the construction process, investigating in particular the role that, in it, takes the concept of interoperability and how this can be developed according to the most appropriate approach case by case. Moreover, the aim is to define a critical examination of how the chances offered by new technologies are related closely with the management of the 3D model and its use for management purposes.

BIM is an interactive and clear tool organization of building processes, functionally worth in order to perform at all times punctual and strict controls through the parametric virtual model of a building. To lead from idea to realization and to the management, the approach to the methods and processes of BIM are configured as appropriate for the business realities that aspire to qualify as organized structures of integrated design, ready to compare with an increasingly aggressive marketplace. If we consider the existing, to get benefits by BIM approaches oriented to manage the building, it becomes a strategic objective.

Remarking the two main meanings of BIM as a model and as a method at the same time, we aim to study how it can be used in the management of the existing built and how the more established Anglo-Saxon procedures could be characterized the actions aimed to interventions in retrofit and functional requalification.

1. Construction process and interoperability

In the consolidated digital domain in the processes' management that characterize the intervention of existing buildings and new constructions, it still happens that the low accuracy and accessibility, or, often, the total lack of information about the artifact generate inefficiencies in the design activities as well as during construction. Moreover, this lack concerns the subsequent maintenance and monitoring, creating repercussions in several design phases and, therefore, in increasing economic wastes. In this sense, it is undisputed that, if properly applied, the BIM has been increased with the project quality through effective analysis cycles, for which, obviously, is however required a detailed planning and fundamental changes of processes in order to successfully get the highest possible value of information models.
In well-known system, BIM is a tool continuously developing aimed to different purposes and investigative levels. For this reason, the UK Department of Business Innovation and Skills (BIS) has defined the levels of ripeness of the design and construction processes through an index based on levels from 0 to 3, in order to classify the type of technical and collaborative skill relating to the adoption of BIM systems. From simple 2D to 3D CAD model formats, it moves on to a modeling tool where each modeled features are related to the whole information of the design project, including the management of time and costs, to the distribution of the outcomes in a manageable multiplatform and interactive cloud, hopefully for the entire its life cycle.

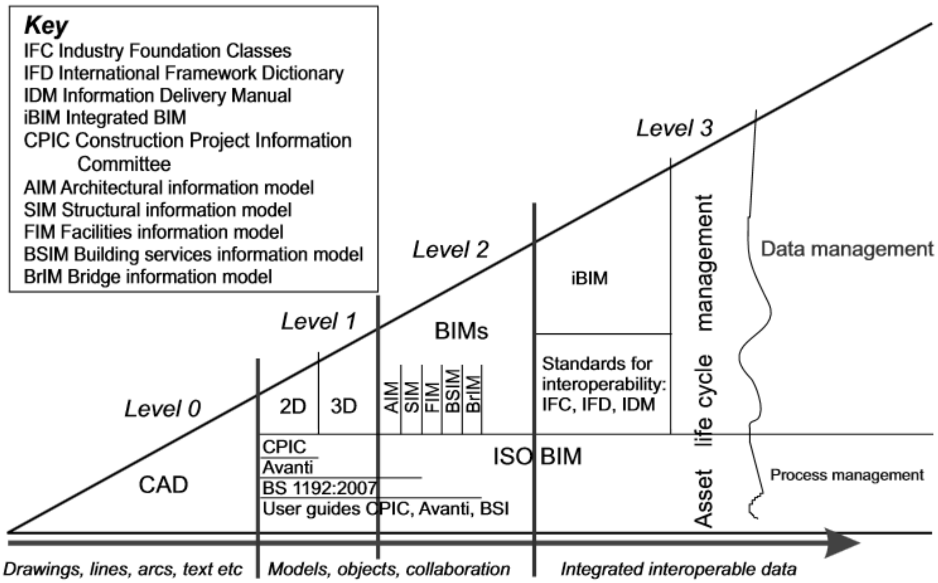

Figure 1 Diagram of Bew and Richards - levels of the building design process maturity

Since there is no application that can efficiently manage all this information at same time, it's a need to set a well-organized system on three levels:

- a technical system level, based on the concept of 'interoperability', that analyzes the ability to communicate with each other the several technological systems adopted;
- a logical application level, based on the concept of 'standard', in which are defined the rules adopted in each application in such a way to ensure a perfect integration of information from time to time involved. At this stage it is also necessary to define the Level Of Detail with which information must be handled and by whom must be used;
- a conceptual level, based on the 'optimization', in which is investigated the semantic value of the information represented in different information systems, in order to verify whether those in the traditional system from which you are part of those required in the new system.

About the first level, interoperability, a basic requirement in the use of BIM as a methodological approach, is defined as the ability to share data and information through systems used by a design team, improving efficiency in the building process.

it is now a fact, however, that the lack of interoperability, has high costs, which were quantified in terms of wasted resources and productive inefficiency.

The Building Information Modeling is so configured as a management method able, according to collaborative arrangements and to access to the conceptual designs through visualization, to govern the information and decision flows. That explains why it has been become crucial for industrial policies and broader strategies for the construction industry, by governments very distant from each other - from the UK to Singapore, from Australia to Norway – and with similar goals, such as the sharp reduction of public expenditure and the halving of the order handling times.

This occurred because the constraints applied at the public finances, related to the significant upswing of far East's markets, took a deep innovation of organizational models and contractual frameworks, increasing the role of economic and financial private entities.

On the basis of these requirements in the United States it is the real-time technologies are implemented for the exchange of fi les and documents, if they are regulated certain contractual issues and have drawn new alternative organizational structures that take into account the change introduced.

In Europe, 15 January 2014, the European Parliament approved the procurement reform (European Union Public Procurement Directive, EUPPD) with the use of BIM in the design activities for the public works. The adoption of the directive, has led for 28 European States the possibility of encouraging, expressly specify or require the use of BIM for civil engineering projects financed with public funds in the European Union, from 2016.

Before, in 2011, the UK government initiated with the industry a four-year program for the modernization of the sector with a key objective: a reduction of 20% of capital costs and the CO2 burden employed in construction and management of the built environment.
These fleeting notes highlights how crucial the goal of an optimized interoperability is in the design process. And it underlines why the tendencies of scientific community is so involved in the creation of more and more useful tools and platforms in order to allow the whole stakeholders to work in BIM philosophy.
In this sense, developed for it, the IFC format (Industry Foundation Classes), based on the ISO standard format for interoperability 16739: 2013, contains and describes the information and the parameters used in the construction industry in support of the Building Information Model, ensures interoperability and the data exchange with several software environments.
The IFC data model developed by buildingSMART is open, international and standardized for BIM exchanged and shared data across software applications. Currently the IFC is the only non-proprietary format and therefore all major BIM oriented software house implement this format, which also allows archiving and extraction of other file formats, Cobie (Construction Operations Building Information Exchange) in the first place, to ensure the high effectiveness in the task management stage.

2. Set up a Building Information Model

Obviously, the use of BIM methodology allows to collect in a coherent and coordinated way the whole documentation relating to an architectural and building artifact, helping the interaction with data and their analytical performance assessment.
This has been driven, since a number of years, to test these prerogatives in several matters related to building and construction in general. Acronyms have sprung up to more effectively described processes applied to more specific forms.
Among these, of particular interest, for operational implications in the Italian context, the possibility to apply BIM to the existing built environment.
Whether we speak of BIM for the valued architecture, to it is referred to the huge historical heritage to also redevelop less relevant elements (in which case it is usual to speak about Historical BIM, HBIM), it is a need to define a type of information able to be acquired and collected in specific digital models. While BIM helps to manage the several stakeholders involved in the building process introducing the skills in the models (in its architectural, structural, plant engineering and maintenance meaning) in order to plan implementation and to define quantities for the construction yard, in BIM applied on existing cases it is essential to focus particular attention in the definition of procedures for digital organization, resulting from an accurate building and architectural design, to describe accurately places and materials and matters' state of definition and conservation, in order to better schedule aware interventions.

Figure 2 Map of well-known documents related to the leading countries in R&S on BIM (Tersigni, 2013)

So, the survey of artifacts, especially historical buildings, and their constituent elements requires acquisition methodologies able to describe each single detail effectively. The survey outputs, not only in their geometric display, become an important instrument of knowledge and support for thematic analysis and diagnostic investigations on buildings, essentially for their maintenance program. For an approach like this one, however, the geometric model states as the "table of contents", available to achieve the data, for example, about the single system component, the degradation of the structural system or of the performed arrangements made in the past interventions, depending on the level of detail reached from the database.
BIM authoring environments, i.e. those that allow to work with smart features able to relate to each other, generally require an high level of expertise from the team. Therefore the creation of each element in brand new construction, from several libraries edited by producers or specifically designed, is challenging, but not as much as the production of BIM models of existing artifacts, where the information is first and foremost to find - through documentary investigation - then place them correctly in digital models.
In this sense, we are turning to the generation of smart objects with different descriptive levels, relying on accurate methods of detection of "reality capture". This is a technology aimed at the creation of feature starting from digital models at every scale and is essentially based on two types of processes: high-definition digital photogrammetry (photo-modeling) and 3D laser scanning. Both methods are able to capture and reconstruct each element producing point clouds as outputs of scanning actions, then creating, by less or more semi-automatic algorithms, the three-dimensional model.

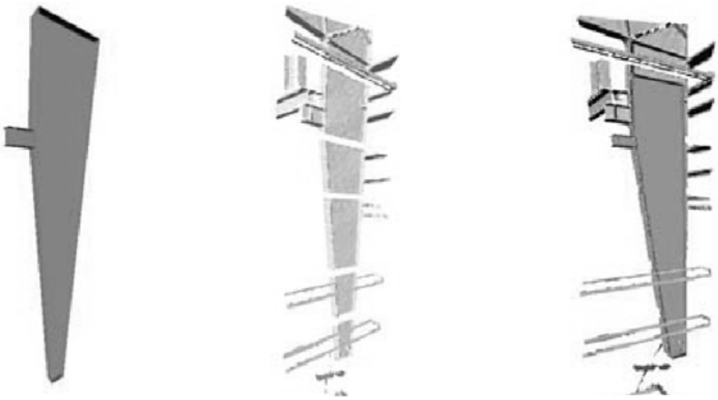

Figure 3 Control between model and acquisition by 3D scanning

These operational strategies alongside the BIM platforms are the ideal tools for the optimization of an important process and fast and modeling by digital survey.
The reality capture allows to relate to very quickly context of interest. When a project begins, involving about an existing building, the first operation that is appropriate to take in account, is to compare an artifact with its survey: it is necessary to know what we are facing. The huge time required to re-create the reality within which we must operate, stimulates the need to be able to more and more digitize it and insert it in the computer systems we work in shorter time and with greater accuracy.
The reconstruction of the context during a restructuring / redevelopment project allows to have available more quickly than in the past an accurate model to work on. It is also true that, nowadays, it exists the possibility of carrying out operations targeted to the acquisition of reliable data metrically by acting directly on the output and on point clouds or on the 3D mesh, the trend is that these data represent the input data precisely for the constitution of the possible automated implementable model in BIM environment (also referred to Scan to BIM). Thanks to such an approach can be documented in an extremely timely manner and an accurate quantification of various issues affecting the artifact.
On other hand, moreover, an advantage associated with the use of these technologies, concerns the chance to compare the laser-scans with the design model during the construction phase in order to have control of accuracy. Following this logic, it tends to be a valuable on the as-built documentation, accompanying the artifact in the life cycle during facility management.
The ability to reality capture applications in the world of architectural design are various, from land use planning until eroded by time or buildings damaged by a catastrophic event. These advanced acquisition tools, the capture reality software and BIM platforms, are the ideal tools for the optimization of an important process and fast and accurate modeling. Remarking on the concept of the two main meanings of BIM to frame it as a model and as a method, the BIM Project Execution Planning

Guide later described, is characterized when interventions are aimed at existing buildings, in particular for redevelopment (retrofit) and functional recovery.

3. Set a BIM as methodology

Obviously, defined a medium, it becomes crucial to understand what is the most appropriate technique, underlying aim of process management. To this end, one possible approach is provided by BIM Project Execution Planning Guide, developed by the project buildingSMART Alliance through a multi-step process. This process includes, in addition to interviews to experts, the detailed analysis of existing planning documents, group meetings with stakeholders, aiming to an efficient and effective structured map, using case studies to validate the methodology. Prerogative of BIM Project Execution Planning Guide for the correct implementation of BIM is the draft the BIM Project Execution Planning Procedures (BIM Plan), a tool created in order to outline the overall vision of the project, highlighting the implementation details to support of the project team.
The BIM Plan is developed in the early stages of a project and could be always monitored, queried and updated by all participants of the project; in addition, the BIM Plan could define the exchange of information between the parties and describes the project needs and the means necessary to support implementation. To achieve the goal, the team involved in the organization of this well-structured procedure, supporting planning and effective communication, should include and involve continuously all the key players in a proper success of the project.
For the preparation of a BIM Plan it is necessary to define the areas in which this methodology would bring advantages improving the degree of the known as Level of Development. It is the preliminary questioning about the project objectives to be achieved, or rather, what is the use you intend to make the model so developed. This consideration allows us to define the so-called BIM Uses, set of requirements that aim to represent the project objectives rather than the means to achieve them.
The goals that arises referring to a project may concern about different nature, ranging from intrinsic ones (reduction of lead times, reducing costs, increase project quality, improve energy efficiency etc.) to the ones relating to the management of the construction of the building phases (increased prefabrication, improve the management of workspaces, the site safety, etc.).
These goals are also referred to the administration phases during the their use (ordinary and extraordinary maintenance, preservation and restoration, restructuring construction, retrofit, re-organization of the spaces, emergency management).
It is important to note that many of these BIM uses are directly related to the demands and expectations made by the stakeholder but some of them are prerogative of the structures appointed to the project preparation.
Starting from the process maps defined in the BIM Project Execution Planning Guide before the definition of a general operating model is carried out for the implementation of BIM in the entire design process (from the survey of the state of the preliminary design stages, final and executive). Then specific models can be drawn up for the main technical and performance monitoring actions of the interventions.

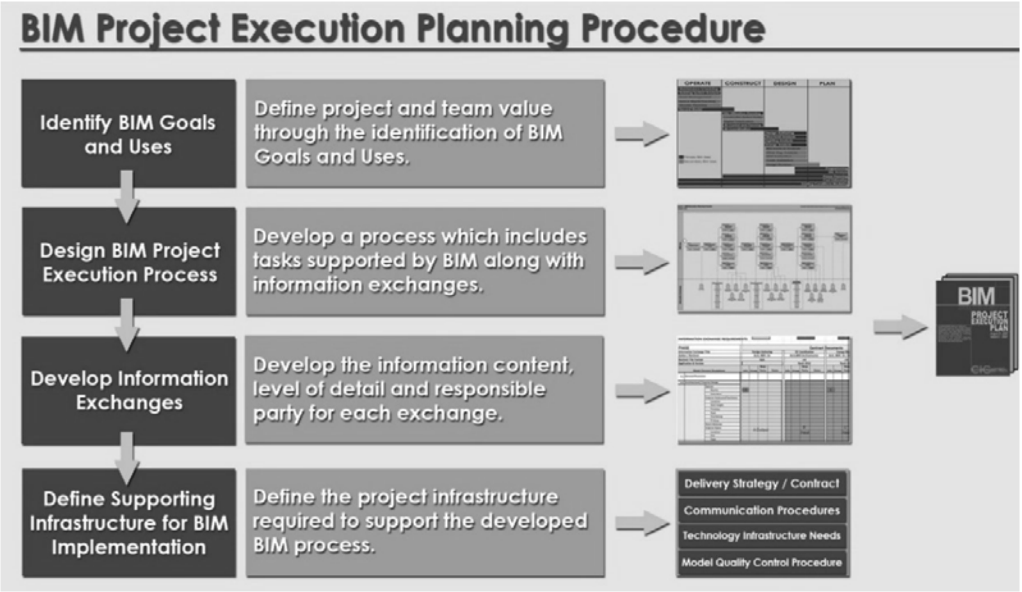

Figure 4 Steps to draw up the BIM Plan. (BIM Project Execution Planning Guide, 2011)

For each sub-detectable use, could be specified potentialities, required resources and skills within the team. BIM Project Execution Planning Guide does not intend to extend the method to the entire project but only there where the cost / benefit ratio resulting implementation of BIM use is optimal; For this reason the second approach step sees the preparation of the worksheet BIM use selection to evaluate case by case which BIM use should be developed in the project as a function of the added value of this and capabilities and tools available to the team.

4. Conclusions

The expertise developed in relation to the built heritage, and the resulting actions determine the production of a substantial amount of information , most of which are digital, concerned in a multidisciplinary nature, that are interpreted and compiled for congruent design choices. De facto, the incompatibility between systems used by the various stakeholders often prevents a rapid and accurate exchange of information related to the project. This could be the cause of several problems, including additional costs and not efficient design.

The constructions generated in software modeling environments have long passed the existing continuity between simple geometric representation and the idea about a container of more structured information, using features with intrinsic criteria. These criteria become bases for investigation and insights in the field of parametric modeling, of related semantic contents, process management both in design and in the historical and contemporary building management.

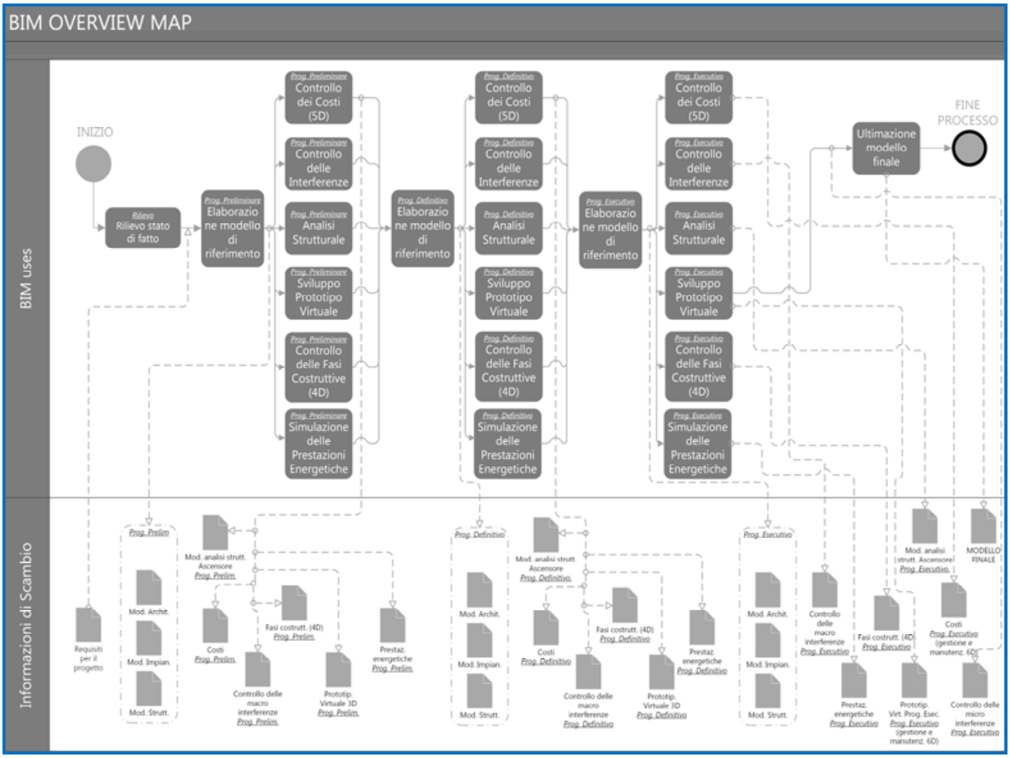

Figure 5 BIM Overview Map proposal for the redevelopment of a public building

In this context, the potential of BIM, beyond simplistic interpretations and emphases, should be further explored and matter by matter, setting, among other things, a promising development in the construction of digital archives, designed to manage some large amounts of survey data, in a broadest meaning.
Precisely for this purpose were introduced Levels of Development, understood as a measure of safety and reliability of the information, collected and entered in the various stages of processing, intended for various project teams, not to be confused, as often it happens, with the Levels of detail, referring rather to the graphic detail, according to an approach taken by computer graphics.
Consequently the solution of the problems of reliability of the information and models flow between the various stakeholders in the construction and management of technical documentation process is the core of any integration strategy.
In this direction it moves the current investigation course of action, aimed at validating, in the process, information models and related conventions.

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