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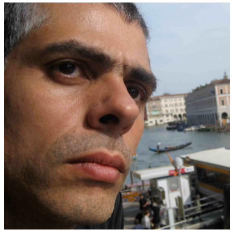

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Information Modeling in Creative Process.
Innovative possibility of BIM in architectural and urban processes
Information Modeling nel processo creativo.
Un'innovativa possibilità di BIM in processi di progettazione architettonica e urbana

Questo articolo esamina l'uso del Building information Modeling - BIM nel processo di progettazione e il loro contributo per migliorare gli edifici. Vengono definite le fasi del processo di progettazione e la proposta di un suo modello teorico, per analogia con la teoria della costruzione della conoscenza. Nel modello teorico sono stati considerati gli approcci della conoscenza secondo le visioni empiristica e razionalista. Il tema è stato affrontato secondo le conseguenze di tali approcci in fase di progettazione dell'idea. É presentato un caso di studio di uso pratico del BIM. Il caso di studio è stato analizzato rispetto al modello teorico proposto. La conclusione sottolinea l'importanza dell'uso del BIM in fase di progettazione dell'idea, principalmente attraverso simulazioni di design.

The paper studies the use of Building Information Modeling - BIM in the design process and their contributions to do best buildings. For this, are defined the stages of the design process and proposed a theoretical model of the design process, by analogy to the theory of knowledge. In the theoretical model were considered the approaches of knowledge empiricist and rationalist. It was discussed the consequences of these approaches in the stage of the design of the idea. It was also presented a case study of practical use of BIM. The case study was analyzed against the theoretical model proposed. The conclusion indicated the importance of the use of BIM in the phase of conception of the idea, especially through simulations and (critical) tests (of our hypothesis) of design.

Parole chiave: Building Information Modeling; BIM; processo di progettazione

***Keywords**: Building Information Modeling; BIM; design process*

1. INTRODUCTION

The information technology or IT has introduced new possibilities for improve the knowledge in various areas of human activity. The IT helps the taking of decisions and the generation of knowledge by identifying, analyzing and managing information using computerized systems. In the area of architecture, engineering and construction, the Building Information Modeling or BIM is the information technology that is being pointed out as the most promising and as a new paradigm for the creative process of the built environment.

The BIM technology has its origin in the researchers developed by Chuck Eastman for incorporation of the concept of Product Information Modeling in Architecture, Engineering and Construction Industry (AEC). Eastman *et al* (2011, p. 16) defined BIM as a technology of modeling associated with a set of processes to produce, communicate and analyze models of construction. The conceptual structure is a model that contains information necessary for the building´s planning and construction. The model tries to define all aspects of the building in its life cycle, such as components, processes, documents, performance and others. This model must be a single reference to the whole design process throughout the life cycle of the project, involving all their agents. The various professionals of different design´s disciplines must be involved in the elaboration of the model. BIM can be defined as an integrated and collaborative project´s practice in which those involved in the process use their abilities to produce a single model (BARLISH and SULLIVAN, 2012; ANDRADE and RUSCHEL, 2009).

BIM has three basic aspects: the parametric modeling for development of single model; interoperability for integration, collaboration and the exchange of information of those involved; and the possibility for the management and evaluation of the project throughout its life cycle.

The parametric modeling and representation a computational object-oriented in which are inserted attributes fixed and variable to the same. These attributes are information on the various characteristics of the objects. The fixed attributes are defined from properties such as shape, performance, cost, constructability, and others. The variable attributes are established based on parameters and rules so that the objects could be automatically adjusted as the control of the user or change of context (EASTMAN, TEICHOLZ, *et al.*, 2011). The variety and quality of these rules will determine the level of accuracy of parametric modeling (BARLISH and SULLIVAN, 2012; ANDRADE and RUSCHEL, 2009).

Interoperability is the ability for the identification and exchange of data and information between tools used in the design process (EASTMAN, TEICHOLZ, *et al.*, 2011). Interoperability allows professionals of various involved disciplines exchanging or adding information to the information model of the building on their projects in a collaborative and agile way.

The capacity of management and evaluation of various aspects of the project allows treat the project truly as multidimensional, allowing do simulations of the same.

The technology has other potential not yet discussed and explored. Among these, we have the interaction of model information in the various scales of the built environment, allowing the integration of the building design with the urban environment design.

The technologies of urban design also have used concepts of information models. The main technologies that work with data and information in urban scale are the GIS, and recently the GeoDesing.

According to Camera et al (1998), the term Geographic Information Systems (GIS) is used for systems that are the computational handling spatial data and produce information not only based on their characteristics alphanumeric, but also through its spatial location. Give the manager (urban planner, designer, engineer) that the information available on a given subject, to the extent inter-related from the geographical location, because the records of occurrences must be georeferenced. For the author the need for storage of the geometry of geographic objects and their attributes means a basic duality for the GIS. For each geographic object, and need to store their attributes and the various graphical representations associated.

There are at least three major ways of use of a GIS:

- As a tool for the production of maps, with the intention of viewing;
- such as support for spatial analysis of phenomena and decision making through the application of models;
- as a geographical database, with functions for storage and retrieval of spatial information.

Because of their inherent characteristics to promote organization and synthesis of data and information, the GIS have become important tools for decision support in planning and territorial management. With the development and expansion of its use, came the interest in optimizing its employment and go beyond just a box of tools, to think then in the use of the tools included in a larger process, the planning of the processes of spatial intervention. In this sense, the GIS, which were the initial step, become part of a system, based on promotion of logic of planning, which are known as GeoDesign, and its unfolding, metaplanning (planning the planning) and planning support system.

As integrated system that accompanies the entire life of spatial intervention, the objective and the structuring of an integrated process, which goes from the diagnosis, up to the design, discussion of the decisions with the community, simulation of the propositions and evaluation of its implementation. As defined Flaxman (2010): "Geodesign is a design and planning method which tightly couples the creation of design proposals with impact simulations informed by geographic contexts."

For that the processes are realized, in fact, as support for the processes of planning - because also as the BIM the expectation is to accompany the life of the intervention from its conception – it's important clear definition of actors and their responsibilities, processes involved and their repercussions. This leads to interest in interoperability, visualization, integration of knowledge and actors.

It is believed, therefore, that the processes are happening in parallel, so that the BIM is for the projects at the regional and building scale, while the GeoDesign is for projects in urban and territorial scale. Although with their specific characteristics and needs, there is the possibility of future integration, in complex system of three-dimensional information for planning and space management, of the scale of objects to the territory.

The other point in common, which clearly shows the parallelism between the principles of BIM and Geodesign and the tendency for simulation and modeling territorial based on calibration of landscape, in actions that Moura (2012) defines as Parametric Modeling of Territorial Occupation (PMTO).

BIM and GeoDesign are technologies that can help us to design better-constructed environments. They present similar moments of discussions on its innovative possibility. In this sense that we put this collaboration for the review: studying the innovative possibility of BIM we expect to give subsidies to other authors to build their reflections on the possible integrations with GIS, Geodesign and urban design.

Despite its origin as a model to facilitate construction, we believe that the BIM presents innovative possibility in the design process. Among the possibilities include the interactions between technology and:

(1) The creative process of the design;
(2) the documentation of the design;
(3) the critical analyzes of the design;
(4) the construction of the same.

The main change of BIM in the creative process of the design occurs in the way that we can receive and analyze the information necessary for the conception.

In the documentation of the design, BIM brings changes in the generation and management of documentations of the same. These characteristics are the most perceived and discussed currently in the BIM´s use (GU and LONDON, 2010; POPOV, MIGILINSKAS, *et al.*, 2008; ELLIS, 2006; HAYMAKER, KAM and FISCHER, 2005; FISCHER and KUNZ, 2004). This introduces greater consistency, speed and availability of information, allowing a greater control of the processes. However, some authors have been discussing the possibilities of interaction of BIM with the creative process and the conceptual phase (SANGUINETTI, ABDELMOHSEN, *et al.*, 2012).

In critical analyzes of the design, BIM brings possibility of visualizations and simulations of wide aspects, with speed and accuracy in the same.

In the construction phase, the technology could allow the execution with precision and efficiency. Although it is normally associated with the production of information and documents, BIM should not be viewed as just a representation after the activities of creation or synthesis, i.e. as documentation phase describing the conception phase. We believe that BIM should be examined as a technology that interacts with the way that we concept, we represent and we build our environments, i.e. as the technology interacts in creative process, documentation phase, analyses and construction.

BIM is a recent technology and brings new possibilities and changes in the way that we concept, we represent, and we built our environments. Therefore, the use of BIM has some issues to be explored and studied. Among them are:

[1] What is the position or role of BIM in the creative process of a built environment? i.e., in which moments of the creative process of the built environment the BIM is being and can be used?

[2] As we can, through an appropriate use of BIM technology, perform best buildings?

In our view, the creative process of the built environment is a wide process that: begins with a problem; is followed by conjectures and hypotheses; the solutions are synthesized in an idea; that is represented in a languages / drawings / documents; and finished in the effective realized of the object, i.e. in its construction. Within this process, we believe that the fundamental point to achieve good results and the idea. Good ideas can generate good buildings, but bad ideas never will generate good buildings. New technologies of the built environment can allow us to improve our knowledge only if they help us to have good ideas. A new paradigm is only legitimate if leads us in the direction of improving our knowledge. In architecture, engineering and construction, a new paradigm must always go the direction of us enable do best buildings.

2. INFORMATION AND KNOWLEDGE

As described in section *1 - Introduction*, good ideas are necessary to improve our built environment. In this way, the creative process phase is crucial for understanding how BIM can help us make better buildings. To move forward in the understanding of the possibilities of technology BIM, we propose to evaluate their characteristic in the singular aspects of this phase. Our approach is that the creative process of the built environment can be an analogy of a process of acquisition of knowledge or a particular process of problems solution.

How we acquired knowledge is much debated in our history. We can say that our western civilization is based on a tradition philosophical-scientific (POPPER, 2010). In this tradition, we try to understand and explain the world we live in and its phenomena. This tradition was started with Thales of Miletus in ancient Greece, who proposed explanations for the world and its phenomena based on reason, in opposition to the mystical theories about the world. The mystical theories about the world explain the phenomena by the imagination. In the tradition started by the pre-Socratic philosophers we try to scientifically explain our world through observable facts, relying primarily on our senses and reason (POPPER, 2010).

Two lines of thought stand out in our tradition of search for knowledge for the present analysis. The first is called empiricism. The empiricism believes that all knowledge is generated in the sensitive experience. Observations are the source of our knowledge of the world, and are the exclusive and fundamental origins of our knowledge. To the empiricism, our search and progress in the knowledge occur through experiments and

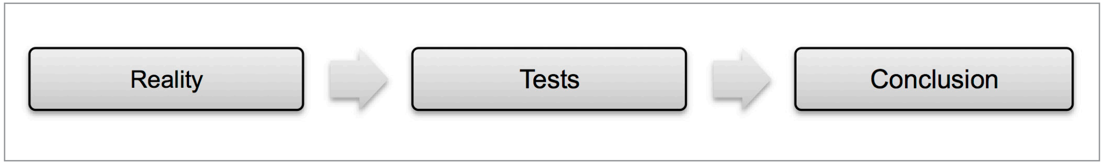

Figure 1 - Diagram representing the theory of knowledge empiricist (source: author).

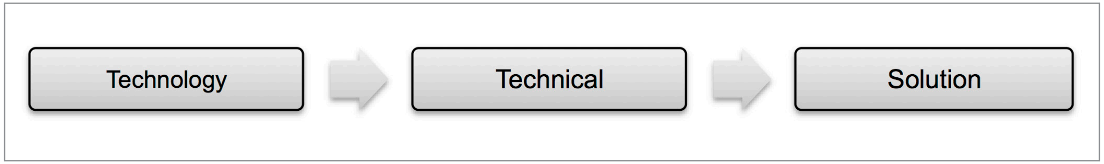

Figure 2 - Diagram representing an empiricist approach of the technology (source: author).

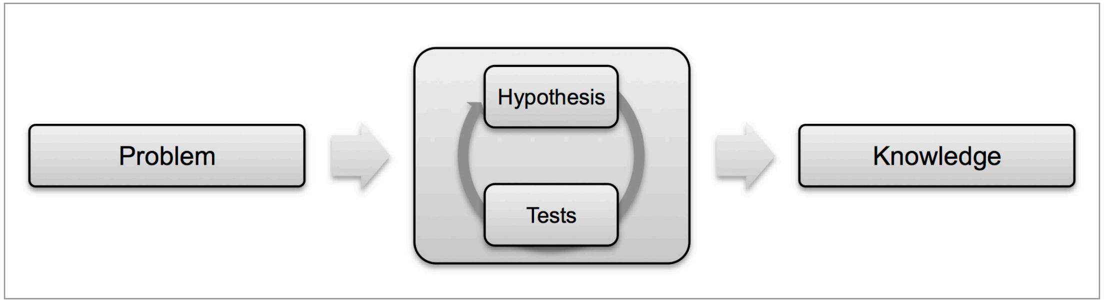

Figure 3 - Diagram representing the theory of knowledge critical rationalism (source: author).

observations and conclusions resulting from them (Figure 1). For the empiricism, the knowledge comes from the results of the experiment and is positive arguments (induced) on the truth of the phenomenon, so this theory of knowledge implies a positive belief of the truth. There are an objective and universal truth, with its laws and rules, with which the tests are faced and where the conclusions can be induced positively. In empiricism we can dispense with any previous attribute of the experiment, such as a problem.

If we take the empiricist approach to the search for technological solutions, established technology would represent the positivist truth. The technology's solutions for our need would be inferred from techniques of established technology (Figure 2). As a result the new solutions must be consistent with the established technology. In the process of finding new technological knowledge, defined as technological innovation, the traditional techniques and traditional procedure would be the benchmark for new techniques and procedures. Technological innovation would occur in an incremental way, based on tradition.

The second line of theory of knowledge appropriate for the present analysis is the rationalism, more specifically the critical rationalism. For rationalism, there are other significant ways in where our knowledge can be acquired. These ways are independent of our experience of the senses (MARKIE, 2012). For the rationalists, our reason is the source of our knowledge. In spite of their contemporary origins be attributed to Descartes and his book "Discourse on the Method", the historical origins of rationalism can be associated with the origin of our scientific tradition, i.e. with the origins of philosophers pre-Socratic philosophers, especially Thales of Miletus (POPPER, 2010). In the twentieth century, Popper made important contributions to the theory of knowledge rationalist. The Popper's contributions have strongly influenced in the contemporary science and theory of knowledge. According to the author, our knowledge comes from conjectures (or hypothesis) and refutations (or tests) of conjectures (POPPER, 2006). Thus, the knowledge comes from a problem, for which we formulated hypotheses and these are tested. The hypothesis that better explain the problem / question / phenomenon are incorporated into our knowledge (Figure 3). The knowledge improves cumulatively by the hypothesis that best respond to our questions and problems.

If we take the rationalist approach critical in the search for technological solutions, the technology does not induce the solutions. The technical solutions could arise of attempts to apply, in a practical way, hypotheses to solve problems or answer needs. The techniques would be adopted and incorporated into our technological knowledge when they have success (Figure 4). Thus, the established technology would be temporary, since: our problems / needs are contextual; may we have new hypothesis

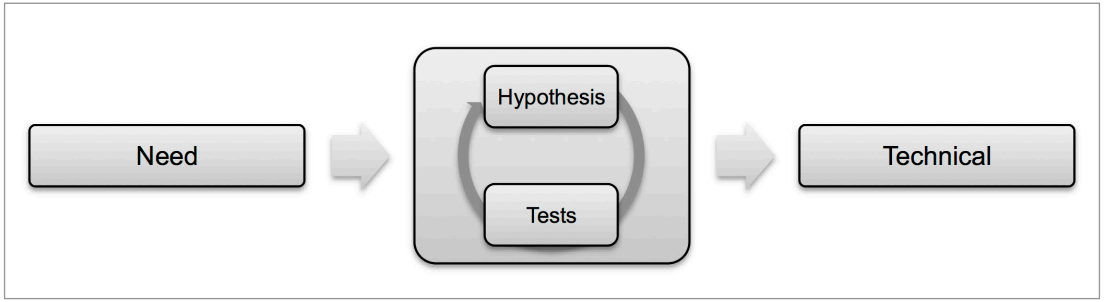

Figure 4 - Diagram representing a critical rationalism approach of the technology (source: author).

Figure 5 – Diagram representing the design as the solution of problems (source: author).

and new techniques that best correspond to the problem / need. The search for new technological knowledge, i.e. the technological innovation would occur by disputes between the new hypotheses and their applications, faced with the traditional techniques. Technological innovation would occur in a radical way, based on critical.
From the above we can define two ways of evolution of our knowledge: induced from what we already know on a positive reality; and induced from new hypotheses about reality. We can also define two possibilities evolution of technological:
[i] Induced from practices and techniques established and;
[ii] Induced from the exploration of new hypotheses.
The approaches [i] and [ii] will be used to look at the BIM technology in the issues [1] and [2].

3. CREATIVE PROCESS OF THE DESIGN

The built environment is the product of technology. The technology defines and limits our creative possibilities of the built environment. Before renaissance the interaction between the creation of the built environment and the technology occurred at the construction site, through the craftwork. After renaissance, with theories and tools for the representation of architectural idea (for example, the perspective) and also with physical theories of the behavior of materials and structures and their tools for calculations, the creation of the built environment can leave the construction site. The design was created. Since then, we could create models of our built environments, before build them.
For Malard (2003), the design process is a process of acquisition or production of knowledge about the object designed. Some authors define the production of knowledge from our cognition of reality (EINSTEIN, 1982). For Einstein, our knowledge is the repertoire of our concepts about the phenomena. For the author, our cognition starts in our reception of the prints of the senses, when some images emerge. These images are not symbols of a language, but they are sensitive representations of our perception. Then we organize these images in logical-groups to explain the phenomenon. If these logical-groups are consistent with our previous concepts, we understand the phenomenon. If these logical groups are in conflict with our previous concepts, we try to create an organization for the images perceived, i.e. new concepts for the phenomenon. We can try to realize new images on the phenomenon and create new logical-groups. When an image appears in many of logical-groups, it organizes the logical-groups not connected, becomes the order element of the phenomenon, setting a new concept. This concept / new knowledge can then be transmitted by signs, i.e. by a language (EINSTEIN, 1982). For Einstein, the language is not required for new concept and knowledge. But the language is required for practical applications of new concepts or knowledge. In the Einstein´s approach, the process for new knowledge presents two moments: the intellectual creation of knowledge; and the transmission of knowledge by a language.
The design can be analyzed by analogy with the creation of a concept. In the design process, the designer searches a concept that best meets a need / problem (Figure 5). This way, the design involves the solution of a problem (LAWSON, 2010).
The design of a built environment comes from the need to shelter our activities. The problem of design of built environment is our need for spaces and their qualities that allow us hold activities. The solution is always a physical object, a construction. In the design, we sought a concept that connects a need and a construction In the Einstein´s approach, the concepts presents two moments: the intellectual creation; and the transmission by a language. In the design process

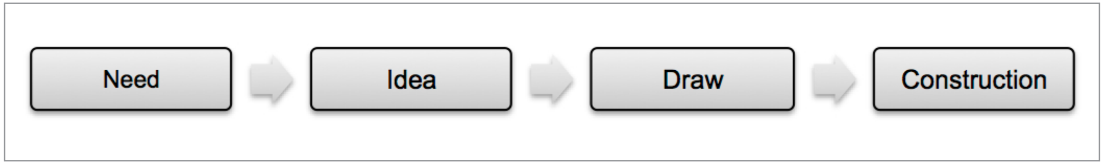

Figure 6- Diagram representing the design process of the built environment (source: author).

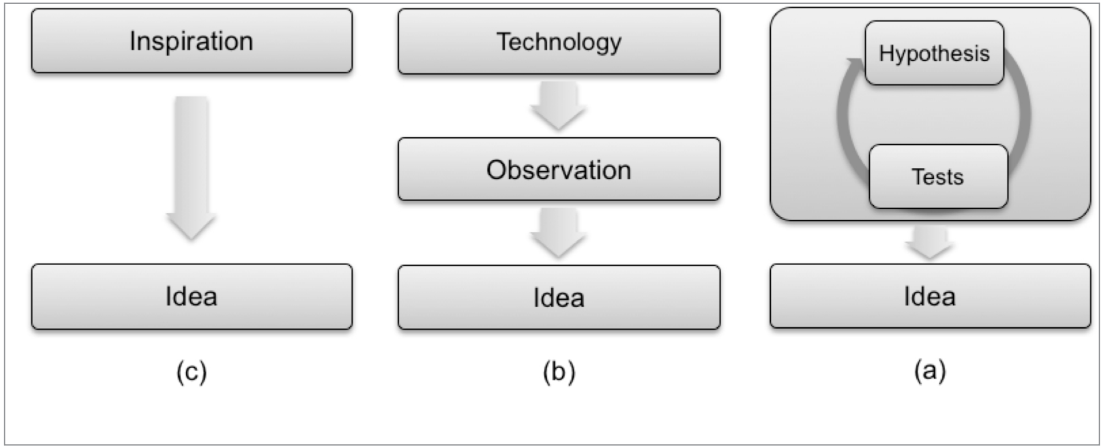

Figure 7 – Diagram representing some approaches for the conception of the idea (source: author).

of the built environment, intellectual creation is the idea and the language are the drawings, documents and representations (Figure 6).

About the Need

Although we have not changed much since emergence of the first cities about 7,000 years ago (We are biologically and physically the same and our basic activities of living and shelter are basically the same), our needs become increasingly complex. We broadened the quantity and complexity of the activities that need to be sheltered by environments constructed. We broadened also, our capacity to understand the performance of our constructions. With this, our ideas are covering aspects increasingly broad, besides the traditional structural, functional and aesthetic aspects. Currently we consider aspects of economy, comfort, efficiency, and environmental impact, among others. As a result, our built environment is extremely complex, technically and functionally, and its design process is multidisciplinary. This involves various designers with singular perception of the problem, singular creation of images and singular conception. In spite of the particularities of involved in the design process, the final idea must have coherence. However, many times, which is observed are the fragmentation of the problem and the isolated approach of the disciplines by designers. Fragmentation leads a conflict of concepts of the proposed solutions. With this, the final idea does not consider the interactions of the solutions proposed in all its aspects.The intellectual creation, i.e. the conception of the idea is a process of difficult understanding. Some approaches suggest that the process comes from inspirations (JONES, 1992; KNELLER, 1976). Other approaches treat the idea as a practical, rational and logical process (LAWSON, 2010; POPPER, 2006; MALARD, 2003; BASALLA, 2001). We can still think that the conception of idea presents moments in which each of these characteristics is combined. So, for these approaches, the ideas could arise from inspirations and/or induced from practices and techniques established and/or induced from the exploration of new hypotheses (Figure 7).

In section *1-Introduction* we describe the importance of the idea to do best buildings. Only we will take best buildings if we have good ideas. The approaches presented in Figure 7 have different potential to help us in this aim.

The idea as inspiration (Figure 7–a) is commonly associated with the artistic work. This vision was strengthened with the emergence of the academies of *Beaux-arts* and with the emergence of aesthetics as philosophical discipline (BAUMGARTEN, 1993). In the case of utilitarian objects, such as the built environment, the idea as inspiration has limitations: usually the technical knowledge is devalued and even overlooked. Arguments in this direction were discussed, for example, in text *Ion* of Plato. In *Ion*, Socrates sets out the inconsistencies of poetic inspiration defended by rhapsody Ion. Among the various arguments, Socrates debate, for example, on who could speak properly (and beautiful) about the art of fishing: the poet or the fisherman? We believe that the idea as inspiration, separated of technical knowledge, is not the best way to do best buildings.

The idea based on established technology (Figure 7– b) is a usual approach in history

(BASALLA, 2001). Recently, this approach gained strength, being adopted as paradigm of success in the technological development, associating this success with the control of processes and management systems (IMAI, 1986). Benchmarking of technical and procedures are used as reference for the idea and its future results. This approach allows treating properly known problems and allows an incremental improvement, slow and gradual, of the technology. However, once it establishes paradigms, innovation is undermined and there is a tendency toward traditionalism. In addition, there is the risk of a new idea being overlooked in favor of the use of a techniques established. This approach also has limitations when we need solutions to new problems / needs. Therefore, we believe that the idea based on established technology is important to promote appropriate solutions to known problems, but, in the face of the complexity increasing of the built environment, is not enough to make best buildings.

The idea originated from a critical-rational process (Figure 7– c), seems to be the main source of new technologies (BASALLA, 2001). This approach is appropriate for the exploration of solutions for new problems and for new complex aspects of existing problems. Once it questioned existing paradigms, technological innovation is stimulated. In a critical-rational process we have a great potential for designing better ideas and, as a consequence, we obtain better solutions. But the conception process is slower, with the possibility of solutions with uncertain results. Despite this, we believe that idea originated from new hypotheses and tests is fundamental to do best buildings.

About Drawings, Documents and Representations

Once defined the idea, it can be communicated. This communication occurs through a language, i.e. through signs, graphic representations, information. Adequate communication ensures that idea will be correctly realized. But the result will only be good if the idea is good. So, the drawings, documents and representations are important to ensure the correct realize of the idea, but are not sufficient to make better buildings.

4. BIM IN THE CREATIVE PROCESS

BIM technology allows being managed information of the project throughout its life cycle. With this, we can perform assessments and analyzes of the project considering its life cycle. The design of the project would be a virtual prototype of the same, whereas aspects such as physical dimensions, costs, performance, time, among others.

Tobin (2008) defines the evolution of BIM technology, considering its potential, in three moments, which were called by the author as BIM 1.0, BIM 2.0 and BIM 3.0.

In BIM 1.0, the technology is used more as a tool of that as a process and a conceptual structure of work. The process is still individualized, restricted to the designer, without the involvement and collaboration of professionals from other disciplines. It is mainly used for coordination of documents; add information to objects; and to make technical documents (ANDRADE and RUSCHEL, 2009).

In phase BIM 2.0, the technology involves several disciplines, areas of knowledge and several professionals. With this, the interoperability and cooperation became essential in the process, allowing the proper exchange of information between the involved. An important feature of this level is the possibility of analysis and evaluations of the design already in its early stages, with a high collaboration.

In phase BIM 3.0, the technology would be used so as to allow a practice integrated in the design process. Aspects and solutions of the design could be discussed in real time. This way, the information flow of multidisciplinary teams involved would happen continuously, without losses and overlaps (ANDRADE and RUSCHEL, 2009). BIM 3.0 enables a virtual prototype of the project, from the use of the potentialities of the three fundamental aspects of technology: parametric modeling, interoperability and management of information throughout the life cycle of the same.

Adoption of BIM only as a tool for draw and for management of documents and information allows it participates only in the language stage of the creative process of the built environment. It will allow that drawings, documents and representations are consistent and appropriate for the construction. It can also promote collaboration and exchange of information between the disciplines of project. However, despite the advantage of adopting the BIM as a tool for draw and for management, BIM must participate in the idea stage to take its full potential and help us make better buildings.

As seen in section 2 - *Information and Knowledge,* the idea can arise from inspirations and/or [i] and/or [ii].

Idea as inspiration disregards the technical knowledge. With this, in this approach, BIM will not participate in the intellectual creation, and their use and possible contribution shall be limited to language.

Approaches of the idea induced from practices and techniques established and of the idea induced from the exploration of new hypotheses, are strongly influenced by technological knowledge. With that, BIM has great potential to participate and contribute in the idea stage.

In the approach of the idea induced from practices and techniques established, BIM can be the reference of benchmarking of established technologies. BIM would incorporate modeling rules so that the ideas can only be represented in the model if the solution is compatible with these rules. This way is being adopted in several software modeling and design process. Software like Revit®, Archicad® and Vectorworks®, are based in libraries of real constructive elements, with their properties and constructive behaviors defined. Holdings of new hypotheses of design, such as, for example, shapes and structural systems of complex geometries, are hard modeling with these software programs. In aspects of management, these software and other as Navisworks®, have focus in drawings and documents, maintaining the independence of the disciplines. They are not very active in the collaborative conception between the disciplines. Therefore, software like Revit®, ArchiCAD®,

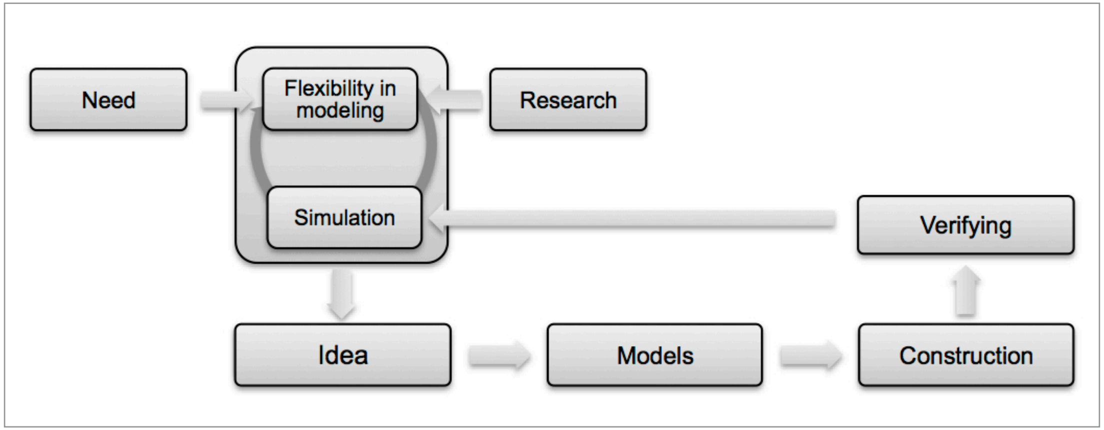

Figure 8 - Diagram representing proposal for insertion of BIM in design process (source: author).

Vectorworks® and Navisworks® bring benefits to the language stage, bringing little contribution to the conception stage.
In approach of the idea induced from the exploration of new hypotheses, BIM could allow flexibility in construction modeling, incorporating new knowledge from research studies. In modeling, technology can enable the development of shapes of complex geometries in addition to the introduction of unusual parameters in constructive elements and in their behavior. Software such as Rhino3D®, Grasshopper® and Digital Project®, and processes such as Parametric Design allow the modeling of complex geometries and the insertion of mathematical parameters for behavior to unusual shape of design (hypothesis), giving flexibility for modeling.
BIM can represent the behavior of construction throughout its life cycle, allowing simulate future scenarios of various hypotheses to verify the results of the solutions. Currently, computer analysis about behavior of structural, environmental, thermal, acoustic, aesthetic and other is usual. Software such as Ansys®, Robot®, Energy Plus®, Odeon®, SmartForm®, Vasari®, among others, can simulate various behaviors of our model. These simulations have being used in the final stages of documentation, having discreet participation in the conception.
Flexibility in modeling, insertion of mathematical parameters of behavior and simulations has great potential for use in conception stage. Flexibility in modeling and mathematical parameters allows us represent several hypotheses for our needs. Simulations will enable us test these. We must consider both the established technologies, as research of technological innovations. In our view, this approach is fundamental for better buildings (Figure 8).

5. CASE STUDY OF BIM USE

To help the understanding of the issues [1] and [2], identifying some of the advantages and difficulties of the adoption of BIM technology in practical cases, we present a case study of the development of a prototype with BIM carried out by a architecture company of Belo Horizonte - Brazil. The firm has expertise in the areas of architecture and urbanism, with experience in the development of design of institutional, cultural, urban, residential, commercial and large equipment. According to the firm, in the conception of design is sought a "conceptual approach innovative and consistent, having as its basic premise the concept of sustainability and a caring and reverent attitude in the formulation of proposals". The firm realizes projects of great importance and complexity for public and private organizations in Brazil and other countries.
In the development of the prototype, BIM technology was incorporated into the design process through the use of Revit®. The prototype was the first design in Revit® by the firm and it was used as an experimentation of the tool.
The project aimed the construction of an integrated center to support the people of the semi-arid region of Minas Gerais. The demands of the project include: rooms for research in innovation and technology, centers of development and education, classroom, auditorium, restaurant, accommodation, among others. Only the disciplines of architecture and urbanism was involved in the initial stage of design concept. Other disciplines such as structure, facilities and other, did not participate in this stage of process. According to the firm, this was due to the lack of technical training for the parametric modeling of the designers of other disciplines.
The concept began with a picture created by the owner-architect (Figure 09 and Figure 10). These images were created through traditional drawings, i.e. sketch by free hand. According to the architect, from these initial pictures it was

sought to adopt the technology of parametric modeling considering formal experimentations integrated with aspects of the function, tectonics and other. The modeling had its development conditioned by initial image. These first intentions of proposals were not changed.
BIM was used basically as a language of the solutions from the concept. Creative process was little influenced by the use of parametric modeling. BIM contributed with graphical representations and technical documents (Figure 11 and Figure 12). During the development of the model, it was necessary, many times, creating families of elements specific to the same. In the definition of families' attributes were considered only the shapes aspects of the elements, not being incorporated information such as cost, constructability, performance and other.
During the process was used AutoCad® to assist in the finish of documents such as plans, facades and sections (Figure 13), and the 3dsMax® for finalization of perspectives and views (Figure 14 and Figure 15). Were not carried out analyzes, assessments or computer simulations of performance of the final solution.
Although restricted to aspects of language, the firm noted advantages and disadvantages in this first experience. According to the firm, the main advantages observed were:

- Single reference for information of architectural, structural and MEP;
- Design process facilitated by a 3D model tied to technical drawings;
- 3D modeling allows the creation of a variety of shapes;
- Rapid change in the 3D model;
- Changes in the model automatically occur in all plans, sections, elevations and 3D;
- Anticipate of possible problems that could not be identified without the aid of a 3D model;
- Elimination of inconsistency between plans;
- High level of drawing details;
- Parametric objects with information that can be used in framework;
- Automatic generation of quantitative tables;
- Better coordination of the design process;
- Greater interaction between the involved

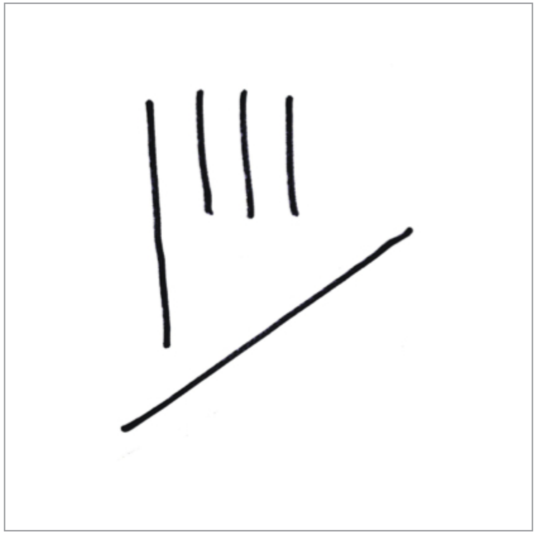

Figure 9 -– Sketch of initial idea (source: GPA & A).

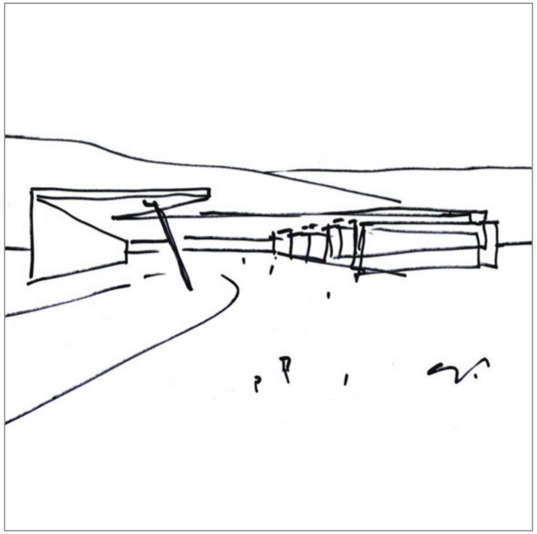

Figure 10 – Sketch of building (source: GPA & A).

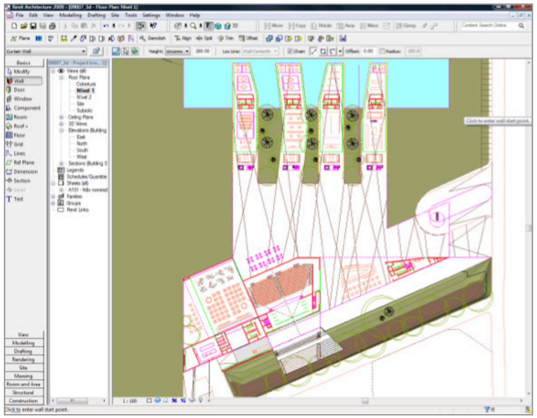

Figure 11 – Building modeling (source: GPA & A).

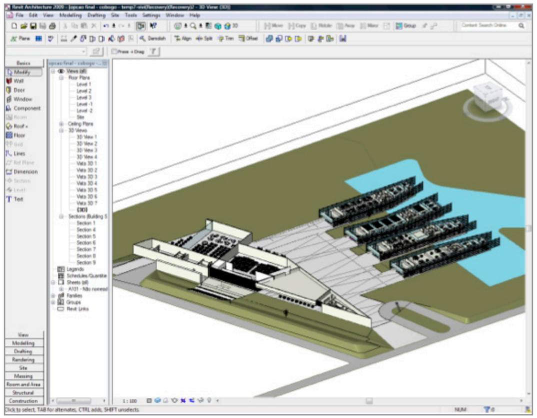

Figure 12 – Building modeling (source: GPA & A).

Figure 14 – Sections (source: GPA & A).

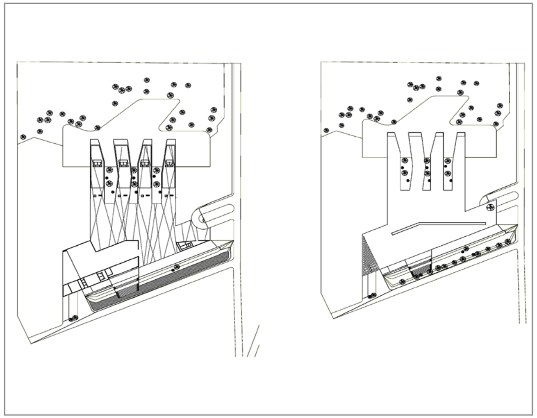

Figure 13 – Adjusted Drawings in AutoCad® (source: GPA & A).

team;
- The software played the role of various others, what means money economy.

According to the firm, the main disadvantages were:
- Difficulty in finding partners from other disciplines that use the technology to develop integrated design process;
- Necessity of creation of libraries and standards, lowering initially the productivity;
- Complex software that require long time of training;
- High cost of training;
- Large file that requires powerful hardware;
- Users have to have always the latest version of the software: it is not possible to save the file extensions in previous versions;
- Software uses standards for other countries, which requires a series of adjustments and involves some practical limitations.

In general, the experience was satisfactory. The firm will continue the process of implementing the technology by the entire team. For it, are being developed templates and libraries specific to the firm. There is also the intention to create a group of studies in BIM, involving teams from other disciplines, such as structures, MEP, builders and other.

In the case study, we observed that the conception had characteristics (of Figure 7- a), with this, in relation to the issue [1], the study showed that the BIM was used only at the language. However, the study indicated possibility of future use of BIM in the conception phase and potential benefits of this use for our aim of the issue [2].

6. CONCLUSION

The proposed theory and the case study indicate that, on the issue [1], BIM has the following characteristics:
· BIM is perceived and used as language of design process.
· BIM may participate and contribute in the conception of design process.

About the issue [2], the present study indicates:
· BIM must be adopted in different approaches

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Figure 15 – Perspective (source: GPA & A).

and it is fundamental the innovation, i.e. the exploration of new hypotheses.

The study sought to understand the possibilities and changes in the way that we conceptualize, represent and evaluate our built environments. Studies on the use of BIM in the construction phase were not studied here and these are suggested for future studies.

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