DIGITAL MODELING AS PERCEPTION OF THE ARCHITECTURAL OBJECT IN DESIGN EDUCATION

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Abstract

Among the competencies to develop future architects, the spatial and architectural volumetric relationships play an essential role for the professional exercise. This is the motivation of this work as the research teaching of architectural design, analyzing digital 3D modeling as an aid in volumetric and spatial perception to students. It is known that the spatial perception is a gradual process that continues throughout their professional career, so why not allow exhaust search in this work? Another key point is the constant evolution of computer design, that does not allow us to end the matter with regard to new modeling and visualization tools. The goal of this thesis is to propose a design technique with the three-dimensional modeling for facilitation of the understanding of the project and expand the cognitive abilities of students of architecture. Methodologically this work is divided into two stages, a theoretical and another practical. The first for reasons of teaching fundamentals, understanding of fashion and architectural space. The second stage aims at the elaboration of a didactic procedure for teaching project with use of digital modeling. The investigation is being developed in a research project with students of architecture from Brazil and Portugal where the technique is being elaborated and enhanced as the analysis of the results.

Keywords: Architectural Design Teaching, 3D Modelling, Digital Environment Design, Spatial Perception.

1. Introduction

The constant evolution of technology has changed the way we live, move and communicate. The production processes are constantly evolving, digital technology is part of contemporary life, the media are increasingly influencing dynamic, with media and social networks, our habits and personal relationships. Understand that technology is transforming the way that we see and perceive the world, this paper presents part of doctoral research in development that shows the way to search digital modelling as an auxiliary tool in teaching Architectural design.

The field of research is the teaching of architectural design in relation to the technological advances of the computer graphics and prototyping. Being the central subject digital modelling as a tool for understanding of the forms of the architectural object back to teaching architectural design.

The approach to three-dimensional modelling and prototyping takes place

due to the facilitation of access to digital tools by students, regardless their level in the courses of architecture, because they already have their own computer graphics knowledge. However, it is worth mentioning that the indiscriminate and without theoretical foundation use of these tools can cause a depletion of their repertoire, leaving future generations limited only mere software operators.

This article aims to present, preliminarily, developing research and the results obtained so far. To this end, the methodology will be based on theoretical and pedagogical concepts, in an analysis of the performance of students of architecture in a practical exercise and gathering of information and experience.

2. Three-dimensional thinking

The aim of this work is to analyze if the digital tools are able to assist the design decisions of the students. For this purpose, experimental exercise to analysis of the results of students ' experiences and understanding of digital modeling process is able to facilitate their understanding and help in decision-making. It is worth noting that the analysis of the results won't be in the quality of the project but rather if using the 3D tools there was some gain in the art of designing and understanding the volumetric and spatial relations. The proposed process looks at the initial stage of creation of the volumetric construction studies in counterpoint of thought only in floor plan.

It is understood that the plant is a compartmentalized representation of the whole and is not able to translate all the spatial relationships in architecture. The graphical representation of the design in plant is a technical convention and not a process for creating space, this is what should be just a representation of the object has become one of the most used forms of design. This procedure presents serious limitations since the height of the construction, its three-dimensional relationships and the surroundings are not considered when designing only in plant.

So far the more usual three-dimensional digital techniques are two-dimensional views, because the computer screen is a two-dimensional plane, the models simulate a three-dimensional representation where the observer can manipulate the object in its 3 dimensions, look at every possible angle to compare their relationship to the surroundings and perceptions at the sight of a real observer.

There is a common sense that with the experience, the designer would be able to develop three-dimensional thinking when drawing a plan, however it is known that this perceptual maturity can occur over time and in some cases even develop, making the architect only a designer of plants, putting the volumetry, spatiality and relationship with the surroundings in a secondary category.

3. Research

It's not the aim here to end up the subject digital modeling, and even assess the existing software varieties but to examine whether the digital modeling is able to assist the creative process. Although it seems a subject already inserted in the academy, the author points out that the teaching in some universities in Brazil and Europe still adopts the project of pre-digital period techniques, where everything begins in two-dimensional representations in plan. Even at the

universities where there is incentive of digital modeling tools, this is usually the most recent generations and teachers who are familiar with the potential of computer graphics. The ignorance of current techniques by teachers of pre-digital, generates a gap in teaching once they believe the computer will design for the student.

This work seeks to understand, or start understanding the following question: How digital tools, especially three-dimensional modeling, can influence the teaching of architectural design for future generations?

In order to get answers and understandings about the theme of this research, it is being developed an investigative work with students of architecture where the digital modeling is introduced in the early stages of design to note the experiences of future Architects.

4. Theory of knowledge and constructivism

The main pedagogical line of this work will have on the constructivism in its essence, for understanding there is a greater affinity with disciplines of design practices.

The Foundation prioritizes constructivist learning by the students themselves, creating their ways of learning a self-realization of the individual. So believes that there may be a creative learning because, rather than just accumulate knowledge, the student creates new patterns of ideas. (Carneiro, 1981: 27-28).

In the broad concept of Piaget (1977), the knowledge deriving from cognitive aspects in interactions between subject and object, which in their time depend on the affective aspects. The cognitive aspect involves several factors as thought, language, perception, memory, reasoning, or which are part of the process of intellectual development and provide the means for learning. While the affections are responsible for active energy for the behavior.

In the words of Macedo 1994, "Piaget is constructivist, conceive knowledge as resulting from a building, that is, a genetic or historical process for successive and better levels of structuring". (Macedo, 1994: 165).

Although this research proposes a practical methodology of development studies with the use of digital modeling tools, at no time is the training objective in a single technique and thus demystify this thought, very common in generations of teachers and professionals trained in the era pre-digital. To do this if you want to examine possibilities of conscious use of new technologies which, together with other areas of knowledge learned during academic and professional life, should be used to expand and improve the knowledge professional.

5. Teaching of architecture design

Although the inclusion of the areas of theory, facilities, construction materials and computer science is of supreme value for the culture of the future architect, the backbone of the course of architecture remains the discipline of design, where all other subjects are applied. Based on workshop practice, dates back to the beginnings of the profession. It is usual for the project teachers to use in the classroom their professional practice, or the reproduction as they learned academically. This fact can lead to criticisms and observations, however it is noteworthy that despite being essential to the introduction of

educational and pedagogical concepts in teaching project, this has the peculiarity of being an extremely practical discipline and requires professional experience and are based on the practice of office where students develop the projects according to a demand from the teacher.

The main objective of this study is to understand if the student has expanded his space and understanding the relationships of the parts of the project with all those generated. This intention has always been designers' goal, however in the age of the manual design this procedure was limited the handicrafts of graphical representation of the authors, who often had no theoretical knowledge to develop sketches the desired objects and volumetric designing generally from plants and façades. According to Zevi,

> "One day, around 1435, a Gutenberg ... invented the press ..., opened the world of poetic and literary writings ports (...) In 1839 Daguerre, ... invented photography and marked the passage of all visual experiences (...) Edison in 1877, ... managed to register the sounds on a Tin (...) in 1920, was the first radio transmission (...) But, in this whole process, the architecture remains isolated and alone. The problem of the representation of space, far from having been solved, not even being questioned. Because we don't have the exact definition of consistency and character of architectural space, there was no requirement to represent it and spread it. For this same reason, the architectural education is woefully inadequate. " (Zevi, 1996: 29-30)

The author also points out that the current forms of representation of architecture, plans, sections, and elevations are unable to represent the whole of the construction (Zevi, 1996: 30). It is worth noting that at the time of his writing, first edition in 1984, there were no graphical computing resources as we have currently, these were fully developed. Although the questioning of Zevi in the late 1980, the speech is still relevant, despite all the technological evolution of digital computer graphics of the past decades, such as CAD, BIM and parametric design, most of the universities surveyed. Traditional teaching tools are still used for design and represent the architectural object with orthogonal two-dimensional drawings. This appointment took to analyse the curriculum of some Brazilian and Portuguese universities, design disciplines still rely on traditional teaching putting computer graphics as a supplementary subject and technique of representation.

To understand that the goal of the workshop should be the encouragement of the study and creation of space and architectural forms for a real building, this is reduced because the production of the two-dimensional orthogonal drawings is considered part of the process of creation. A broader understanding of the subject, they should occupy a smaller part in the creative process, because it believes that the traditional graphic representations (plants, cuttings and façades) are not able to present all spatial relationships involved in an architectural design and as the name says just represent graphically a

set of ideas and intentions of the author. Even in the case of perspectives which are partial, because studies show the object from a fixed point that prevents dynamic observation of the object and the scale models undetermined the notion of proportion with the surroundings and with the full-scale observer. Another important point is that they don't always use traditional perspectives and three-dimensional models, is stimulated, because they need a long time dedicated and mastery of technique. In some cases, we can observe that the use of computer graphics Is part of the process to make an idea into three-dimensional plant, subordinating the object volumetry to an elevation plan of this only. Currently the digital tools can easily simulate the architectural object, with advanced knowledge if it is able to simulate electronic models so real that is about to confuse the observer without knowing what is real or virtual. With affordable devices it is possible to simulate user immersion virtual reality glasses, where the experience becomes even more real. However, this whole process begins on the digital modelling.

Although there are several modelling software SketchUp, adoption for development of practical studies if considered to be easy to learn, there is free version, and have intuitive commands, where the user does not need great knowledge of program to develop models. It is worth noting that the methodology is not based on the software, this was used to illustrate the technique, and the procedure of creation can be prepared in any program for three-dimensional modelling.

6. Methodology

Aiming to analyse the performance of students with the use of computer graphics for modelling in the early stages of creation, it answers the questions of the proposed elaboration of a practical exercise for development in the discipline of architecture project based on intuitive 3D modelling, using the concepts of project development, digital modelling and grammar concepts.

The analysis of the results will take place through questionnaires applied before and after exercise. To make It easier the development of working with groups of students, the exercise was drawn up along the lines of a fast rendering and modelling workshop elaborated during four classes where the student develops the preliminary study of a residential project. For modelling software SketchUp is used and the V-Ray renderer. The exercise proposed has practical character in a system of stages connected to development of preliminary studies and deployment project intentions volumetric sectoring for basement of design decisions. The modelling comes as part of the creative process, however it is not the main element and a validator and complementary tool for understanding of the studied object, for such proposes a didactics with defined stages and to support the design process. These steps are traditional for development and teaching.

7. The example

The study proposes a procedure that can be used for different models of buildings, residential, commercial, publishing, etc. The exercise was prepared in two groups, the first from 01 to 06 steps with research support and the second group, from 07 to 12 of experimentation.

7.1. Proposed process steps

1- Demand – Basic program with the function of construction;
2- Case studies - Search for knowledge of the contemporary standards;
3- Design concept - Discretion summary project intentions;
4- Relevant legislation – Note of competent legislation;
5- Project program – Preparation according to the research of items 2, 3 and 4;
6- Pre-dimensioning - Previous release of project areas based on items 4 and 5;
7- Volumetric Study – volumetric Model with sectoring of the digital elements and deployment in place;
8- Climatic conditions -Studies of climatic conditions observation;
9- Flow Studies – Observation of flows and sectors;
10- External Detailing – Ending of the external model with plastic intentions, proportions and materials;
11- Render - Setting materials and generation of images in virtual reality;
12- Prototyping (optional step according to availability of specific lab)- advanced phase for assembling model printing of physical model.

7.2. Proposed example

Proposed example after searching for steps 1 to 6 being developed by students the next step is the design of the site. It is to develop the sectors related to construction environments following the dimensions of pre-dimensioning. The product of the exercise is the primary sectoring and the detailing of the outside of the object with the plastic solutions. The intention of the exercise is the general external study as the basis for the development of complete project.

In the next part there will be displayed 3 studies prepared by students in the project-oriented research by the author of this article. As the research is in course there are still no relevant data regarding to the facilitation of design thinking, however in primary groups analysed data showed a good performance.

7.2.1. Example student A

In Figure 1 we can observe the volumetric study developed by the student with the sectors and the lot.

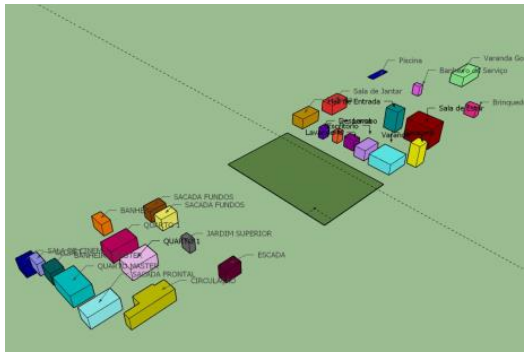

Fig. 1: Volume basis student. Source: collection of the author's research.

In the result of elaborate masses plan, Figure 2, it is expressed the full volume of the building.

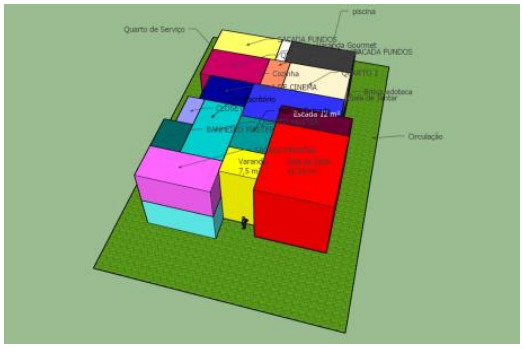

Fig. 2: Volumetric study by sector developed by the student. Source: collection of the author's research.

Standing volume ready, the student studied the relationship between environments, accesses, circulation and heat stroke. After detailed façades and complemented with blocks, made available on the internet, Figure 3. It is

worth mentioning that the student of the example presented here had no previous knowledge of the tool.

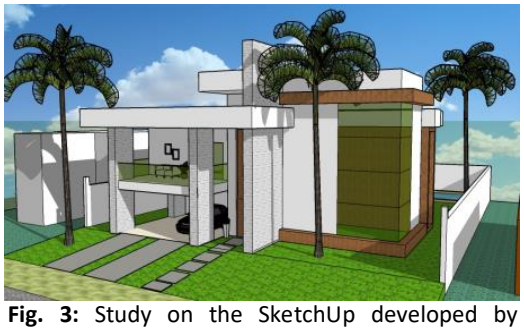

Fig. 3: Study on the SketchUp developed by student. Source: collection of the author's research.

7.2.2. Example student B

In the second example developed by student B we can observe the sectoring in Figure 4.

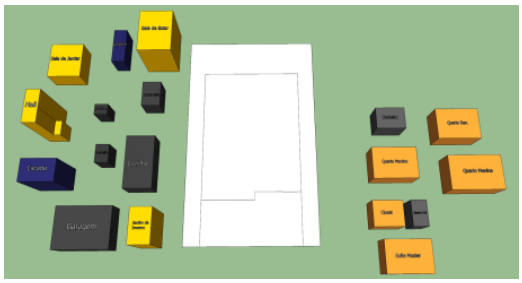

Fig. 4: The basis of the needs program developed by student B. Source: collection of the author's research.

The evolution of the study of masses is seen in Figure 5, which after adjustments and additions is shown in Figure 6.

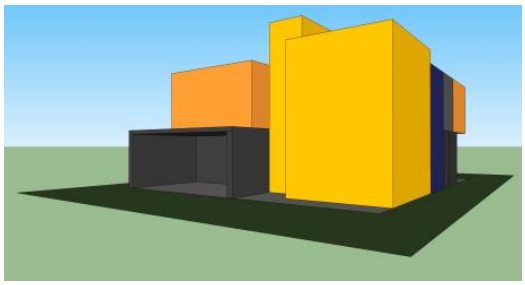

Fig. 5: Volumetric study by student B. Source: collection of the author's research.

In this case the student already had previous knowledge of the software. Despite the final image have been rendered, we can notice that both the students, in terms of plastic and creative element, presented satisfactory results, regardless of previous knowledge.

Fig. 6: Volumetric study rendered by student B. Source: collection of the author's research.

7.2.3. Example student C

The following will be presented by the work developed by the student C, a shopping centre, showing the stages of the creative process. Figure 7 presents the first study of form and Figure 8 presents the evolution of the form.

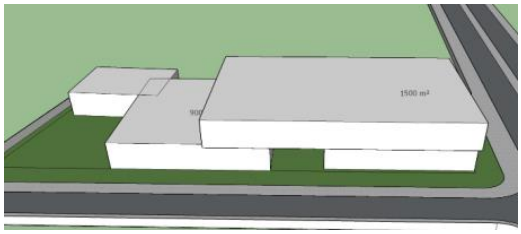

Fig. 7: Form study. Source: collection of the author's research.

Fig. 8: evolution of the form. Source: collection of the author's research

The detailing is presented in Figure 9 and the final rendered image and virtual reality is seen in Figure 10.

In addition to a more elaborate final presentation, the laser prototyping was used for the production of the physical

model. Prototyping is elaborated from the 3D model.

Fig. 9: Detail of the facade. Source: collection of the author's research.

Fig. 10: Project rendered. Source: collection of the author's research.

The physical model prepared by laser prototyping process is pointed in Figure 11.

Fig. 11: Prototypal model. Source: collection of the author's research.

7.3. Primary findings

Although the research is in development and the methodology of the exercise being adjusted through reports from students, we can observe some positive points with regard to understanding the shape and its relationship with the interior of the building. In some cases, the methodology is being used by some students for development of project with another teacher, and according to both the students and the teacher, it pointed out that there was a productive gain in the project because the internal decisions were buoyed following the results of the plastic form, which generated a more rational design and with full understanding of the shape and the plant generated.

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