DIGITAL FABRICATION AND EPHEMERAL ARCHITECTURE: TEACHING INNOVATION IN THE FINAL DEGREE PROJECT FOR THE CREATION OF NEW PROFESSIONAL OPPORTUNITIES

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Abstract

The aim of this paper is to incorporate new specific competences related to Digital Design and Fabrication for the Final Degree Project (FDP) of the Higher Technical School of Building Engineering of the University of Seville. These competences are currently not integrated in Degree courses, however, they occupy a greater prominence in the professional sector.

We propose that the students make contact with previous projects, undertaken by the professors. These projects are based on fundamental principles in Geometry and Digital Fabrication, which have been constructed in different countries and Universities. This previous work is analysed, discussed and reused in the classroom to try to promote links between Education and Research.

We present the Final Degree Project of Helena Santos Calvo (student), as a concrete example of this project of teaching innovation. Her work, entitled: Ephemeral Pavilions of Digital Manufacturing and light materials, optimization of the assembly phase, supposes a new advance in certain constructive problems detected in previous experiences.

Keywords: Final Degree Project (FDP), Digital Fabrication, Research projects, Innovation, Building Engineering.

1 INTRODUCTION

The Digital Fabrication is a new form of architectural production, which suggests rethinking our teaching activity. However, it is necessary to pay attention to new technologies without forgetting the theoretical foundations of the discipline, in our case the Geometry and the Technical Project in architecture, which are the bases of Digital Fabrication.

Our teaching proposal, introduces Digital Fabrication within the teaching of the Final Degree Project at the Higher Technical School of Building Engineering of the University of Seville. This FDP constitutes an autonomous and individual work by the student equivalent to 12 ECTS (300 hours of personal work). Digital Fabrication offers many possibilities in very diverse environments, so the field of study should be limited. In our case, we used the fundamentals of Descriptive Geometry for the design of ephemeral pavilions as an architectural object.

We bring into the classroom the theoretical and practical experience in design, manufacture and assembly of seven pavilions of ephemeral architecture, in order to involve the student in this technology. These pavilions belong to an international network of collaboration between universities: Universidad de Seville, Universidad Nacional de Colombia; Universidad del Litoral, Argentina; Universidad Federal do Rio de Janeiro, Brasil; Universidad del Norte, Colombia y Universidad del Bio-Bio, Chile.

Digital Fabrication is not a subject included in the degree’s curriculum in the Higher Technical School of Building Engineering of the University of Seville. However, some prestigious schools have defined the Digital Manufacturing as one of their main teaching and research topics [1]. This has given rise to ephemeral projects, which show the viability of this technology in architectural education. Therefore, incorporating digital manufacturing into the Final Degree Project is an effort and an opportunity for teacher innovation.

In the last course, students of Building Engineering worked with generic competences in the realization of technical projects, safety, industrialization-prefabrication, sustainable and recyclable materials. However, they lack the appropriate methodological knowledge to initiate a project of Digital Fabrication. They are also not familiar with the professional and research possibilities offered by this technology, and it is difficult to develop the intrinsic motivation in this discipline. When the student has not previously had a theoretical or practical experience they do not feel identified with the topic. This
lack of relationship between the traditionally known, applied during the course of the years of studies, and this new technology, make the students feel confused.

Our goal is to generate a teaching program where the student finds a professional or research possibility. We are convinced that Digital Fabrication can generate innovative projects and place the student in a competitive professional market. Digital Manufacturing requires more intensive studies than those derived from classic design studies [2]. The status of "Building Engineer" is linked to the improvement of construction processes, in terms of safety, resources, sustainability, time and costs. However, if we are to remain "competent" in the construction sector, these new digital manufacturing capabilities need to be repositioned.

The design of previous experiences is based on the study of developable surfaces. Five-Axis CNC machines can cut this type of surface. These machines cut flat sheets of wood material according to a division of pieces in the design process. Subsequently, another team joins the cut pieces and assembles them on the floor like a puzzle. A continuous flat sheet will go from the ground to a three dimensional form, making a self-supporting structure [3].

2 METHODOLOGY

To meet this challenge, we developed a methodology based on three educational actions and a final evaluation. The first stage is carried out in the classroom with theoretical learning where the professor is the main axis in the teaching line. The second stage tries to assist the students to be the creator of their line of work. The third stage corresponds to the elaboration of the final project, through tutoring and coaching.

The FDP means a constant decision-making processes for the students, where they must transform the initial idyllic idea of the project, into something concrete and feasible. Therefore, first we have to show the student the field of application that is available.

Stages of the teaching methodology:

1. Contextualization of the FDP as an innovation project based on Digital Fabrication projects. Exposition of the current situation and previous experience.

2. Relation of their skills and capabilities acquired during their degree studies with the processes of Digital Fabrication. The different stages are in a graphic scheme "Fig. 1 "[4] that summarizes the process in our field of application. At this stage, competencies are associated with the profession in an open debate. We must mark what can be the professional path, where the student can find a professional opportunity. We must expose the new needs of the profession. This requires a study of the state of the art in topics related to Geometry, Digital Fabrication and Building.

3. In an open debate, the student proposes their motivations regarding the theme they want to develop. Previously the student has made research the state of the art of Digital Fabrication. The classes are a dialogue where there is an exchange of motivations to find the line of work.

4. Finally, the student must prepare a document, with the corresponding index of a technical project. The student will present his project in 20 minutes and a committee will evaluate the oral exposition.
3 RESULTS

As we had anticipated, students have no prior notions of this technology. We had therefore to put together a strategy to make known the possibilities that could arise from this field of study. Since it is a requirement in the delivery of the FDP to present a technical document, we had to make sure the student understood what chapters' structure might be contained in the document. In this way, we constructed a text that would guide the student to contextualize the project and give it the technical aspect required for its evaluation [5].

The document entitled "Technical Project in Parametric Design and Digital Fabrication, developable surfaces and their applications in ephemeral architecture" (P.DP & FD) is another result of this work. With this pilot document, the students situate in which phase they want to work and where they can make a contribution. The document is an index with the aspects that must be evaluated in these types of constructions, whose objective is to generate confidence in the student, and collaborate in their approach to the final work.

At the time of writing the document, we realized that there was no prior technical definition to which we can refer this type of project. Not only the project index should have its specific sections, but also the government regulations in relation to this type of construction are scarce. This lack of regulation stimulated the students' motivation to go deeper into a specific phase of the production of digital manufacture. This led to studying the optimization of the assembly phase of these pavilions, as a new competence.

In the classroom, the four phases described as teaching method continued their course. In the first stage, we accepted and understood the lack of bibliographic material that we can contribute to date. For this reason, the presence of the document created for this purpose on the assembly stages was a fundamental support for the student. In the second phase, teachers created a group motivation work to promote in the students the potential of intrinsic motivation and creativity. It is in the third phase where the student "trusts in his project" and is able to begin to work autonomously. The students follow their process of self-learning, research and resolution of doubts in the tutorial action work. This guided process is very important to the success of the work, since the student must feel ownership of his project, exposing his own arguments that will mark the final quality of the work.
From this course, we were able to generate the first FDP putting into practice the techniques of teaching innovation in this field of study. Below we present the result of the work of a student from 2015-2016, following the premises of this teaching method for the FDP.

Helena Santos Calvo found special interest in "health and safety at work" and its relationship to the construction and assembly of ephemeral pavilions. Perhaps the most interesting pedagogical part was to promote creativity and the use of "trial-error" as a necessary phase of an innovation project.


The aims of the project are the realization of an assembly manual and safety recommendations for pavilions made using Digital Fabrication. These recommendations aim to integrate risk prevention in the assembly phase, in order to optimize the assembly process safely and effectively.

To this end, a series of recommendations are prepared, supported by a graphic document that can be deployed within each of the actions to carry out this work. The project starts from previous work; SSFS Pavilion "Fig 2" built in Seville, in 2015, as a basis to define the aspects mentioned above.

3.1.1 Technical Document. Project memory. Safety recommendations

Helena developed a technical report based on the document P.DP & FD, and focusing on the III phase of our graphic diagram of processes "Fig. 1".

The document divides into four sections. The first section made up of the conceptual framework, which shows the project background and responds to the index of document P.DP & FD. The second section corresponds to the recommendations of safety and ergonomics of generic assembly for this type of projects. The third section includes in particular the recommendations of assembly according to a series of points that correspond with a graphic document, as The IKEA Furniture Instruction Book. Finally, the fourth section is the conclusions and possible improvements to this work.

3.1.2 Graphic Assembly Manual

The assembly manual explains each step graphically to carry out the assembly of the SSFS Pavilion. In turn, a code of good practice is established to respond to the attitudes in the work place. The manual details a codification for repeated actions and milestones to be taken into account in the assembly process.

The format is provided as a drop-down format A2 "Fig.3" "Fig.4", with a final folded format of 148.5 x 140.0 mm.
3.1.3 Presentation and final evaluation

The final evaluation consisted in two parts: the review of the technical document and the public exposition of the project. The final grade was rated "outstanding grade".

The qualification and improvement contributions corroborated the interest of the project. The project, despite its qualification, was criticized for some issues of presentation that could have been solved with more time. However, it was widely accepted as a proposed topic. The graphic material implies an improvement work to be reproduced in future works.

4 CONCLUSIONS

In general, we have verified that the work does not begin to take shape until the students themselves trust their work as something innovative and important.

According to what we have experienced, the first desire of the student is to be immersed in the first phase of design and generate their own pavilions. However, formal design can become a labyrinth for the student who is not aware of these processes. The motivation found in the design implies another teaching challenge, that can be satisfied in another line of work.

Digital Fabrication comprises other groups of activities as well, from the pure design to constructive aspects which link to the competences studied in the Degree of Building. These include planning production processes, planning resources, improving processes and workplaces (digital laboratories), costs and data transfer, etc.

We are working on the regulating of these projects and forming a framework where students can understand that they are able to generate this type of Digital Fabrication project and find a place in this technological area.

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REFERENCES


