3D TEACHING: THE IDEAL COMPLEMENT FOR PROFESSIONALS
IN DESIGN AND CONSTRUCTION

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Abstract

Today, the requirement of professional skills to university students is constantly increasing in our society. In our opinion, the content offered in official degrees need to be nourished with different variables, enriching their global professional knowledge in a parallel way; that is why, in recent years, there is a great multiplicity of complementary courses at university.

One of the most socially demanded technical requirements within the architectural, design or engineering field is the management of 3D drawing software, becoming an indispensable reality in these sectors. Thus, this specific training becomes essential over two-dimension traditional design, because the inclusion of great possibilities of spatial development that go beyond conventional orthographic projections (plans, sections or elevations), allowing modelling and rotation of the selected items from multiple angles and perspectives.

Therefore, this paper analyzes the teaching methodology of a complementary course for those technicians in the construction industry interested in computer-aided design, using modelling (SketchupMake) and rendering programs (Kerkythea). The course is developed from the technician point of view, by learning computer management and its application to professional development from a more general to a more specific view through practical examples.

The proposed methodology is based on the development of real examples in different professional environments such as rehabilitation, new constructions, opening projects or architectural design. This multidisciplinary contribution improves criticism of students in different areas, encouraging new learning strategies and the independent development of three-dimensional solutions. Thus, the practical implementation of new situations, even suggested by the students themselves, ensures active participation, saving time during the design process and the increase of effectiveness when generating elements which may be represented, moved or virtually tested.

In conclusion, this teaching-learning methodology improves the skills and competencies of students to face the growing professional demands of society. After finishing the course, technicians not only improved their expertise in the field of drawing but they also enhanced their capacity for spatial vision; both essential qualities in these sectors that can be applied to their professional development with great success.

Keywords: Multidisciplinarity, 3D drawing, modelling and rendering programs, construction.

1 INTRODUCTION

Current professional requirements for university students are increasing more and more in our society in the last years. Therefore, the contents offered in the official degrees should be nourished with other complementary variables that enrich, in a parallel way, professional knowledge.

One of the most demanded technical requirements within the architectural or engineering field is the management of 3D drawing programs. Those programs are an indispensable specific training facing the traditional design as they include more spatial possibilities beyond conventional orthographic projections (plans or sections), allowing rotation of elements from multiple angles by modelling programs (SketchupMake) and rendering programs (Kerkythea) [1,2,3].

2 OBJECTIVES

The present work shows the teaching-learning approach developed for a CECLEC course entitled “3D Modeling and Rendering with free software. Construction details” in the Department of Building and Urban Planning at the University of Alicante which has a duration of 20 hours (2 credits) distributed in four sessions (5 hours each day) (Table1).
Table 1. Course outline is divided into four blocks, corresponding to the school days.

<table>
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<tr>
<th>SESSION</th>
<th>ACTIVITIES IN CECLEC COURSE: 3D MODELING AND RENDERING WITH FREE SOFTWARE</th>
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| **DAY 1** **FROM 16h TO 21h** | **INTRODUCTION:**  
- Objectives and methodology.  
- Usefulness of 3D modelling in professional life.  
- Examples of use.  
- Templates and units.  
- Work environment.  
- Tabs and content.  
- Windows.  
- Toolbars.  
**PREVIOUS CONCEPTS:**  
- Basic drawing functions.  
- Dimension and name.  
- Move, copy and rotate.  
- Scale, equidistance, extrusion.  
- Intersect, connect, subtract, trim.  
- Basic exercises. | **DAY 3** **FROM 16h TO 21h** | **RENDERING IMAGES:**  
- Installing Kerkythea render engine.  
- Installing plug-in to export to Kerkythea.  
- Export to Kerkythea.  
- Program Environment.  
- Installation of materials and standard libraries.  
- Setting up a scene and application of materials.  
- Editing materials.  
- Lighting the scene. |
| **DAY 2** **FROM 16h TO 21h** | **DRAWING CONSTRUCTION DETAILS:**  
- Import CAD files.  
- Creating groups and components.  
- Schemes and layers.  
- Working with scenes.  
- Plan sections.  
- Application of materials.  
- Adaptation of textures.  
- Establish styles.  
- Export to DWG.  
- Examples of application. | **DAY 4** **FROM 16h TO 21h** | **ANIMATIONS:**  
- Creating scenes.  
- Sections in motion.  
- Walk Tools.  
- Export to AVI video.  
**OTHER AREAS OF INTEREST:**  
- Obtain and share models.  
- Export  
- Other Plugins.  
- Other program modules. |

The course is part of the offer at the University of Alicante (Fig.1) within the scope of courses CECLEC (Curriculum Elective Credits) and is intended as a complement to the subjects of the Degree in Building Engineering and the professional development of former graduates.
3 METHODOLOGY

The proposed methodology is based on the development of real examples in different professional environments such as rehabilitation, new construction, opening projects or objects design. This practical application ensures active participation and time saving during the design process, by generating elements that can be represented, moved or virtually tested.

The teaching methodology is all practical in 5-hour classroom sessions. Moreover, the teacher is available throughout the development of the course in case it is necessary to clarify an issue both in person or on-line [4,5].

Thus, the contents studied during the course are divided into four different blocks corresponding to the 5 theory classes:

- The first block is dedicated to an overview of the agenda, previous concepts and basic functions.
- Practical applications of drawing construction details are raised in the second block.
- In the third block aspects of image rendering are explained.
- Finally, in the fourth block, the animations are considered.

Due to the different level of students' previous knowledge in this area, practical exercises were designed so that the knowledge gained was gradual and successive applied, securing basic requirements in the field of three-dimensional representation.

4 RESULTS

4.1 Basic exercises

4.1.1 Exercise 1: Make up a model with elements already built

The purpose of the Exercise 1 is to compose a generic node of a metallic structure using basic steel profiles already built (Fig.2). Thus, the student develops skills and fluency in using basic tools such as movement, rotation, moving objects and their assembly.
4.1.2 Exercise 2: Create a balustrade (revolution objects)

The purpose of Exercise 2 is to create a balustrade by using the drawing of its perimeter and with the support of an existing picture of the object (Fig.3). To achieve the desired result, the following steps have been set:

- A photograph of the balustrade is imported to Sketchup.
- Above that picture, half of the profile of the balustrade is outlined (to make a revolution) and a surface is formed.
- Later, at the base of the contoured surface and in a perpendicular direction, a circle is drawn to be used as an axis in the "follow me" tool.
- "Follow me" command is applied and the section of the balustrade is revolutioned forming the entire volume required.

4.2 Advanced exercises

4.2.1 Exercise 3: Making a model of housing from an autocad map

The purpose of Exercise 3 is to make a three-dimensional model of a house by using two-dimensional drawings of the construction (elevations, plants or sections) (Fig.4). In this practical exercise, students will apply the knowledge acquired during the prior session. To achieve the desired results, we review the following contents:

- An Autocad drawing is imported to Sketchup in any of the two possible formats (.dwg or .dxf).
- In case it is necessary, the drawing can be scaled with the tool "measure".
- The imported drawing appears as a group. It is important to maintain it grouped and not to exploit it in order to avoid later problems.
- We begin to outline the building walls and we completely close them.
• Subsequently, extrusion is applied across the walls at the desired height.
• A group of all the items drawn so far is created.
• The same process is repeated with other building elements such as floors, windows, roofs, etc.
• Once the drawing is finished, textures are applied with the “paint can”. Textures have to be selected entering in the group itself (by double clicking the mouse on the group) to avoid problems when rendering.

Figure 4. Basic floor plans and tree-dimensional image of a house in Sketchup with materials and textures.

4.2.2 Exercise 4: Creation of 3d ground from contours imported from cad
The purpose of Exercise 4 is to generate a 3D ground with the “sandbox” tools [6] (Fig.5). To do so, we apply concepts learned in previous sessions. The steps for its implementation are described below:
• A flat contour in .dwg format is imported to Sketchup.
• It can be scaled if necessary.
• Height is given to each contour.
• All contours are selected with the tool “from contours” of the “litter box”, forming the ground surface defined by these contours.

Figure 5. 3D image resulting from Exercise 4.

4.2.3 Exercise 5: Performance of domes
The purpose of Exercise 5 is to establish a process for creating domes and spheres (Fig.6). To achieve the desired result we have to accomplish the following items:
- A circle is created.
- A square is drawn perpendicular to the circle and passing through its centre.
- On the previous square, we draw an arch and a line that divides it into two sections, from the centre of the circle.
- We erase everything except the outline of the drawn circle and the surface of half arch drawn in the previous step.
- The surface of the half arch is selected and the "follow me" tool is activated. With the pointer follow the outline of the circle until the starting point.

![Figure 6. Process of drawing a 3D dome made in Exercise 5.](image)

**4.2.4 Exercise 6: photomatch (making a 3D model from a photograph)**

Exercise 6 is an implementation of a 3D model from a photograph of an object (in this case, a house is used) by using the Sketchup tool called PHOTOMATCH and following the steps below:

- The desired photo is imported, by enabling the new matched photo.
- Once the photo is opened in the program, the origin source is located by placing the yellow dot on the chosen origin.
- Then, red axes are located so that they mark an specific direction (it is possible to rely on elements that define the drawing direction) and green axes are located in a direction perpendicular to the direction of the red ones (Fig.7).
- Once all the previous steps are done, the “Ended” button is pressed. Then it is possible to start to draw above the picture in the directions that the house marks.

![Figure 7. Images of the origin axes and final view of the 3D drawing.](image)

**4.2.5 Exercise 7: Rendering models in kerkythea**

The purpose of Exercise 7 is the establishment of the export and rendering process from a 3D Sketchup model to Kerkythea (Fig.8) through the following points:

- After creating a model in Sketchup and applying the desired materials, the drawing is exported to Kerkythea program.
- In Kerkythea, we open the exported file.
• Once opened, materials which are intended to give some property to the objects (reflection, glow, light, etc.) are located. With the libraries installed in the program, materials used in Sketchup are substituted with Kerkythea materials to accomplish the required expectations.

Figure 8. Images of the Sketchup image and result after Kerkythea drawing of Exercise 7.

5 CONCLUSIONS

This course has allowed the use and management of an interesting program of three-dimensional design, presenting the basic principles for drawing with accuracy and professionalism. Thus, students have found that, using simple tools, these programs allow to draw three-dimensional objects very quickly.

The proposed methodology is based on the development of real examples in different professional environments such as rehabilitation, new constructions, opening projects or architectural design. This multidisciplinary contribution improves criticism of students in different areas, encouraging new learning strategies and the independent development of three-dimensional solutions. Thus, the practical implementation of new situations, even suggested by the students themselves, ensured active participation, saving time during the design process and the increase of effectiveness.

The course even exceeded the number of applications in the registration process even though the maximum number of students allowed was a high value (40 students). Because the matter was of great interest to all participants, attendance to all sessions was a success, reaching 100% every day (Fig.9).

Figure 9. Attendance sheet signed and image of the full class.

The methodologies and typologies of the proposed exercises enhance a good way of teaching that combines the acquisition of the necessary skills in the academic field and also are directly applicable to professional practice for the Building Engineer professional through the implementation of new ways to solve real problems [7].

This teaching-learning methodology improves the skills and competencies of students to face the growing professional demands of society. In conclusion, the proposed course faces the growing business needs and enriches the skills of students, improving their qualifications in the field of drawing and expanding their capacity for spatial vision; both are essential qualities that can be applied to professional development with great success.
REFERENCES


