

# THE ACADEMIC-ENTERPRISE EXPERIENCES FRAMEWORK AS A GUIDE FOR DESIGN EDUCATION

João Carlos MARTINS<sup>1,2,3</sup>; João Luis PEREIRA<sup>1,3</sup>; Marcelo OLIVEIRA<sup>1,3</sup> and Cristina COELHO<sup>1,3</sup>

<sup>1</sup>Polytechnic Institute of Viseu (IPV)

<sup>2</sup>Polytechnic Institute of Viana do Castelo

<sup>3</sup>Center for Studies in Education, Technology and Health (CI&DETS), IPV

## ABSTRACT

The establishment of support platforms for the development of a new culture in design education, in order to achieve both research exploitation and its results, as an approach to the industrial community, challenges higher education institutions to rethink their functioning, divided between investigation on their own initiative or on demand, and its usefulness / practical application. At the same time, through design education, how can they be the engine that aggregates all these frequently antagonistic interests? Polytechnic institutes are predisposed to collaboration and interdisciplinarity. In our course of Technology and Design of Furniture, the availability of a production unit, testing laboratories, and expertise in engineering, design and marketing, encourage the development of a holistic project. In order to develop such knowledge, we adapt three important ways of thinking in designing interactions influenced by the traditional approach, namely, 1) identifying and understanding a design problem, i.e. a market need, 2) defining the design process and knowing what can be used for design education, i.e. opportunities for design education, and 3) sustainability of this framework and design projects' alignment with education in the same field. We explain our approach by arguing from the academic-enterprise experiences perspective. This concept is proposed as a way to achieve those three ways of thinking in design education. Then, a set of interaction attributes is defined to explain how engineering and product design education can enhance meaningful relations with manufacturers, stakeholders and society in general. A final discussion is presented with the implications and benefits of this approach. The results suggest that through academic-enterprise partnerships in design, several goals such as students' motivation, product design innovation and potential for knowledge transfer to industries can be achieved.

*Keywords: Design, education, collaborative, research, industry.*

## 1 INTRODUCTION

The training experience reported in this paper is part of the mission of polytechnic education as a sub-system focused on short-term higher education dedicated to practice and related to sciences, engineering and technology. This level of education is oriented to the application and development of knowledge, and understanding and solving concrete problems.

This article describes a teaching experience in Technology and Design education developed within the School of Technology and Management of the Polytechnic Institute of Viseu (ESTGV-IPVC). This institute is defined as a centre for creation, dissemination and transmission of culture, science and technology, coordinating activities in the fields of education, vocational training and research, and exploring external collaboration between industry and academia, from a perspective of mutual appreciation.

The Department of Wood Engineering (DEMad), with its specialized and technical human resources, promotes the development of the wood and furniture sector encouraging R&D and Innovation activities, providing services and support to these companies, by conducting examinations, consultancy, laboratory tests or participation in applied research projects. Active since 1989, this department coordinates a technology laboratory for the Wood and Furniture Industry (LTIMM) and the Technological Research Centre of Wood and Furniture Engineering (CITEMM).

With regard to education, DEMad is the educational and scientific coordinator of the Degree in Technology and Furniture Design. In this context, it has a group of teachers consisting of engineers, designers, researchers and technical assistants. The course aims to develop in students a set of creative skills and project management, based on application of engineering, production and materials technology, for furniture product design.

The teaching experience developed in the course unit of Industrial Project, whose mission is to capture enterprise-based projects for the training center, strengthening interrelationships between academia and companies in the region for the purpose of academic training and with the aim of "Creating Economic Value by Design" [1] for these companies. The methodology follows a teaching / learning strategy, and the practical exercise of product design, found its basis for action in literature that was selected through authors' link to the teaching of design [2], [3] or design practice linked to industry, [4], [5], [6].

## **2 SPECIALIZED EDUCATION AND INVESTIGATIVE CAPACITY AS CENTERS OF ATTRACTION FOR STUDENTS AND COMPANIES.**

In opposition to a more general education of product design in the 1st cycle of higher education, a degree in Technology and Furniture Design at ESTGV-IPV, given its timber engineering matrix, familiarizes from the start its students with the tools and techniques for designing furniture products and the technology involved in its manufacture: production methods, understanding the uses and limits materials and the ability to ensure that the product is suitable for human use. Besides a theoretical basis given throughout their training, students are encouraged early on to make use of industrial equipment provided by the school, in particular at LTIMM (Figure 1-Left). This lab is used by students and teachers for the construction of prototypes and manufacture of their projects. The quantity and diversity of equipment available in the area of 3500m<sup>2</sup>, brings the lab close to medium-sized national industrial units, which allows students to experience very realistic situations.



*Figure 1. The Laboratory of Technologies for the Wood and Furniture Industry (left) and Technological Research Centre of Wood and Furniture Engineering (right)*

The CITEMM (Figure 1-Right) is the unit of R&D and Innovation that enhances research projects both internally and in external collaboration between the wood and furniture industry and academia. Articulation of this collaboration provides the curricular units of the course with the possibility of bringing students into direct contact with needs and demands, with a focus on physical, mechanical and chemical testing of materials and structures for application in wood and furniture industries.

## **3 LEARNING ENVIRONMENTS: BETWEEN RESEARCH AND EDUCATIONAL FURNITURE PRODUCT DESIGN**

The relationship between research in technology and furniture design as the study and production of knowledge, and higher education in the same area, is not easily established. It is, however, a necessary relationship for school courses to acquire scientific credibility, in particular, crossing teachers' research with practical teaching of design [7], [8].

In its genesis, Portuguese polytechnic education, is oriented to R&D activities aimed at understanding and solving concrete problems to "...provide a solid cultural and top-level technique, develop the capacity of innovation and critical analysis and scientific knowledge that is theoretical and practical and its applications for the pursuit of professional activities."[9].

The fact that the teaching staff includes researchers with different but complementary interests in the area of training highlights the importance of collaboration and cross-disciplinarity in engineering and product design education. Investigations in lignocellulosic materials, production processes or finishes, intersect with the investigations on methods of design and new project development.

#### **4 PROJECT-BASED LEARNING FROM A BUSINESS PROPOSAL.**

In the the course unit of Industrial Project taught in the final year, students are given the possibility to work on Project-Based Learning from a business brief. Students work with real issues and problems, make use of an appropriate methodology in creating solutions, learn to defend and argue their ideas, and communicate the results. In developing their projects, students rely on the collaboration of lecturers with degrees in Engineering, Product Design and Marketing, and the heads of companies involved in different phases of the project. During the development of the project, students should be able to:

- Interpret situations and propose solutions for them;
- Establish standards of raw materials and equipment selection.
- Search and select raw materials and subsidiaries;
- Participate in the definition of manufacturing methods;
- Participate in the preparation of maps of material requirements;
- Participate in decision-making based on data analysis;
- Integrate multidisciplinary teams;
- Use control and monitoring procedures.

##### **4.1 The Business Brief**

The project proposal came from a local company that produces and sells various decorative objects, pieces of furniture and lighting. Between Led and Design (<http://www.entre.com.pt/>) appears on the market as a design, lighting and hand made shop. Formed by a multidisciplinary team of architects and designers, their work focuses on interior design, providing an integrated service which includes customized products. The company is looking for new partnerships, ideas and solutions that can integrate its portfolio. The project monitoring process took place both in the company and at the school (Figure 2).



*Figure 2. Project proposal presentation at school, by company staff*

Students were asked to designed pieces of furniture with certain characteristics and a specific target audience in mind. In interpreting the culture of the partner company in this project, its mission, vision and values, students have acquired a knowledge base that enabled them to initiate a process of designing products appropriate for the concept of the brand / company. Through experiencing the business dynamics in the organization's headquarters, and the contact with the technical team and its

practical activity, students felt that the project came close to the constraints and opportunities that arise in day-to-day business (figure 3).



Figure 3. Immersing students in the business environment

#### 4.2 The project development process and monitoring of the company

The design, understood as a problem-solving process, involved a methodology associated with product development presented by several authors [2], [4], [6], [9]. The design process adopted comprised the following steps:

1. Problem analysis
2. Research and investigation
3. Defining the problem
4. Generation of ideas and concepts
5. Selection of ideas and concepts
6. Realization of models (virtual and physical)
7. Product Specification
8. Prototyping
9. Tests
10. Evaluation

At decisive moments, such as definition of the problem or selection of the best ideas, the company was invited to give directions on all solutions and to select those considered most appropriate for the problem initially defined (Figure 4). This moment was crucial for a good continuation of the project in line with the goals set by the company.



Figure 4. Presentation to the company of the various solutions: selection of the best ideas

After selecting the idea, product specification followed. At this stage the students had to detail accurately the dimensions, materials, components, accessories, finishes, processes and manufacturing

technologies so that together they would ensure good and easy interpretation of the attributes of the product and its manufacture. In analyzing the results, the company is once again asked to reflect on the quality of work.

Following appreciation of the previous stage's work, some machining experience on wood components took place at LTIMM which led to the necessary adjustments and corrections in terms of resistance and structure performance. By economic constraints, the final models were concluded mainly using cardboard, and wood was only applied in some internal structures (Figure 5).



*Figure 5. Wood processing (left) and cardboard model production (right)*

The project concludes with the exhibition of final solutions which, despite the material limitations, reached a detail level close to the real products. At this time, each student orally presented their proposal for the piece of furniture. At the end, the students gave a report of all the work: research, sketches, descriptive and explanatory statement, photographs of mock-ups and models, including the various stages of its construction, technical drawings and specification sheet. This document was essential for academic evaluation of all the work done by students. This was also the time for the company to make contact with the final product in the form of a full-scale model (Figure 8). The company can at this point select the models for prototyping.



*Figure 6. Presentation of the furniture models*

The whole process benefits from the research practice of the teaching staff who intervened, according to their specialties, in all phases of the project. Design was most requested at the stage of generating ideas and exploring opportunities for new solutions, while engineering had more active collaboration in detail and product specification, and realization of models and prototypes.

## **5 CONCLUSION**

This approach between academia and an external business organization allowed students to experience the enterprise culture. The academia's demonstrate ability to respond to enterprise needs in terms of

product innovation. With the inclusion of business proposals in the Industrial Project 3<sup>rd</sup> year course unit of the technology and furniture design degree, we can conclude that students, when confronted with real problems, actively collaborate in developing solutions with good results. They also show a greater willingness to meet the demands of the discipline, increasing their enthusiasm for learning and gradually improving their participation, as measured by the high rate of attendance, punctuality and commitment to the task. The application of knowledge acquired in the different disciplines of the course has become a priority. The intervention of specialized teachers in the fields of engineering and design is appropriate to the needs of each student according to the different phases of the project. Students are given the opportunity to develop skills, in addition to those acquired in previous projects of Furniture units. Underlying such educational processes is the change of focus in design education, which is no longer focused on teaching, and begins to prioritize learning processes, making it easier for students to acquire work habits as a key to their performance and future professional success. The results suggest that through academic-enterprise partnerships in design, several goals such as students' motivation by participating in real projects, product design innovation and potential for knowledge transfer to industries can be achieved.

## REFERENCES

- [1] Heskett, J. Creating economic value by design. *International Journal of Design*, 3 (1), 2008, 71-84.
- [2] Boeijen, A. van, et al. *Delft design guide: design methods*, 2014 (BIS Publishers, Amsterdam).
- [3] Milton, A. and Rodgers, P. *Research methods for product design*. 2013(Laurence King, London).
- [4] Baxter, M. *Product design : a practical guide to systematic methods of new product development*. 1995 (Chapman & Hall, London).
- [5] Pugh, S. *Total design: integrated methods for successful product engineering*. 1998 (Addison-Wesley, Harlow).
- [6] Ulrich, K. and, Eppinger, S. *Product design and development*. 2000 (Irwin/McGraw-Hill, Boston).
- [7] Cross, N. *Designerly ways of knowing*. 2007 (Birkhäuser, Basel).
- [8] Margolin, V. and Buchanan, R. *The idea of design*. 1995 (MIT Press, Cambridge).
- [9] Martin, B. and Hanington, B. *Universal methods of design : 100 ways to research complex problems, develop innovative ideas, and design effective solutions*. 2012 (Rockport Publishers, Beverly, MA.)