https://doi.org/10.36315/2023v2end107
Education and New Developments 2023

TEACH INDUSTRIAL DESIGN STUDENTS HOW TO MAKE PHYSICAL PRODUCTS

Miguel Terroso
ID+ Research Institute in Design, Media and Culture, School of Design, IPCA, Barcelos (Portugal)

Abstract

Companies mention a lot of difficulty in finding industrial design professionals capable of knowing how to carry out the complete process of designing physical products, which naturally implies physical prototyping and not just the creation of virtual 3D models. Currently, there are many higher education courses in industrial design that do not value or promote in their curricula the skills to make physical models or prototypes, in many cases, students and professors are satisfied with a graphic image of a digital 3D model as result, which is a huge mistake for who is teaching and learning to make three-dimensional and physical objects. This fact is due to the disinvestment of design schools in workshops equipped with manual and digital manufacturing tool, the need for large investments in equipment also implies associated costs of maintenance and technical support. In this context, schools choose to invest in computers and CAD software which, although are fundamental equipment in carrying out an industrial design project and an important step in the prototyping process itself.
How can we improve the teaching process in industrial design project so that students can idealize, develop, and prototype physical products with high quality standards?
The Industrial Design Project 2 class wants that students develop an inspirational connection with the best international references in industrial design. Interior lighting is one of the areas where we can find companies with a design driven identity. In this scenario, students are challenged to design a table lamp for indoor spaces for one of these brands, using a technical kit consisting of an LED strip, simulating a collaboration between designer, producer, and editor. To carry out this project and to find answers to the question posed, a method consisting of four phases was applied: project preparation; research and definition of the theme; concept development; and final model. Each of these phases is made up of tasks that, when carried out, provide outputs that allow the project to advance to the next phase. The results obtained were prototypes of high aesthetic, technical and functional quality and with low-cost materialization values easily supported by the students. Yes, it is possible to idealize, design and prototype high quality physical products, providing students with personal and professional fulfilment and increasing their technical and research skills, as well as the ability to know how to relate digital and analogue tools.

Keywords: *Industrial design education, process and outcome, physical prototyping.*

1. Introduction

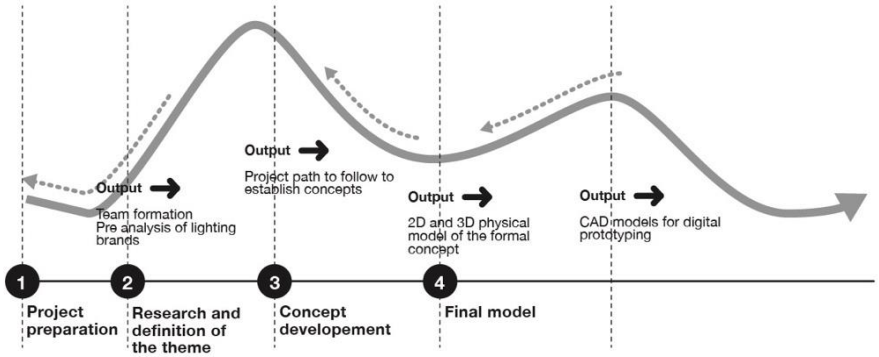
The division of labour associated with the development of industrialization in the 18th century gives us a first insight into the professional practices we associate with design. Design, in this context, is the activity whose practitioners design physical artifacts that are used by humans to mediate our physical relationships with the world (Cline, 2019). Industrial design is a professional activity of creating and developing concepts and specifications that optimize the function and appearance of products and systems for the benefit of users and the industry (Industrial Designers Society of America, 2010). Industrial designers design the products we use in our daily lives with a concern to make them easier to use, more efficient, cheaper to produce and better looking (Unver, 2006). The practice of industrial design has undergone a lot of changes since the appearance of computer-aided design (Sener & Wormald, 2001), moving from an initial phase of 2D design to later giving way to a wide range of 3D computer design and currently a huge variety of digital manufacturing processes. These transformations derived from digital tools affected the activity of industrial design (Oxman, 2006), as well as the teaching of industrial design itself. It is expected that education in industrial design will prepare students for the complexities of professional practice (Garner, 2005), the application of digital tools in teaching this activity was and continues to be a very important pedagogical practice for preparing students. However, many schools,

with the introduction of these digital tools, abandoned the inclusion, in their curricula, of tools and analogue techniques and, above all, the practice of classes in a workshop environment, where spaces equipped with machines and tools that simulate the industrial environment are used for the materialization of physical products are abandoned in favour of 3D modelling software that limits industrial design to virtual images of physical products and conditions the learning of design students who will be responsible for the design of physical products and who in many cases will finish their courses without any have done. This fact is due to the disinvestment of design schools in workshops equipped with manual and digital manufacturing tool, the need for large investments in equipment also implies associated costs of maintenance and technical support. In this context, schools choose to invest in computers and CAD software which, although are fundamental equipment in carrying out an industrial design project and an important step in the prototyping process itself. Nothing is as convincing as a working prototype. Also, students learn the most from their failures so encourage them to prototype rapidly and fail as fast as possible to learn as fast as possible (Chow, 2022). In this context, the following question was asked: How can we improve the teaching process in industrial design project so that students can idealize, develop, and prototype physical products with high quality standards?

2. Methods and objectives

A working method consisting of four operational phases was outlined, in figure 1 we can see a summary version with the main phases of the project and the main iterations. The first phase consists of preparing the project where working groups of two students are formed, then each group must do brief research on some of the international lighting brands with a design driven policy. This initial research helps each group to have aesthetic and functional arguments about each brand to be able to choose one of these brands, for which they will design the luminaire, thus simulating a real case. The next phase, research and definition of the theme, focused on research on the brand chosen in the previous phase, research on the brand's products, history, philosophy, actors, such as designers and architects, location, among other relevant information that would help to get to know the brand better. This research aims to help each group to define a project theme. This theme must fit in with the objectives and philosophy of the brand and at the same time help the groups to stipulate a project path to follow. After the project theme is defined, the next phase consists of concept development, where formal and functional exploration drawings are drawn up with the aim of transforming the abstraction of the theme into a product idea. These drawings generate several hypotheses of concepts for the luminaires, and after a selection of the most promising concept, three-dimensional models of cardboard in full scale are elaborated. These models have the objective of defining and validating dimensions, proportions, shapes, functional and formal details, they are the first input for the three-dimensionality of the product. The next phase consists of the elaboration of the final model, where 3D digital models are created using parametric modelling software and which will serve to validate the model of the lamp in detail and from which all the parts that make it up are taken, these parts will be produced through rapid prototyping and digital fabrication techniques and subsequently assembled into a functional prototype.

Figure 1. Model of the pedagogical method used in the process.



3. Description, discussion and results

This chapter intends to describe the application of the design process referring to all phases, always accompanied by opinions of improvement of the process that were detected by the players during their accomplishment. The project is carried out in the class of Industrial Design Project 2, in the second year of the bachelor's degree in industrial design at the Design School from the Polytechnic Institute of

Cávado and Ave, located in the city of Barcelos in the northern region of Portugal. Students are challenged to design an interior lighting product (table, wall or suspended) for international light brands and using a technical kit consisting of an LED strip, a switch, and respective cables, simulating a collaboration between designer, producer, and editor. The project is carried out in a team and the experience of use, constructive and functional details, as well as a careful choice of materials are valued. The classes take place in a studio format with a very strong incentive in the experimental component, and one of the main objectives of the project is the realization of formal and functional prototypes entirely built by the students and using digital prototyping techniques and tools.

The Industrial Design Project 2 class takes place during the first semester and intends for students to develop an inspirational connection with the best international references in industrial design. Interior and exterior lighting is one of the areas where you can find several companies with a design driven identity, especially in Italy, Germany, and the United Kingdom. These companies, in addition to having a very well-defined design culture and philosophy, collaborate with several contemporary designers in the design and development of their products, these companies have partners that allow them to design the best products with a concern for the smallest functional, emotional, and communicational detail.

The project begins with a preparation phase that consists of the formation of working groups made up of two students. The group work has two main objectives: pedagogical and financial. From a pedagogical point of view, it is intended to enrich the work itself, increase confidence among students, encourage mutual help and teamwork, preparing students to integrate work teams in their professional future. In the case of the financial component, it allows the cost associated with carrying out the work to be divided by two, lowering the costs inherent to the project with materials and prototyping. The preparation phase also involves prior research into some of the leading lighting product brands, with the aim of each group finding an inspirational link with one of these brands, whether in the products they develop and sell, or in their philosophy and mission. and in the way they communicate their values. This research also allows each group to get to know some of these brands, increasing the levels of design culture of each student.

The next phase consists of choosing one of the reference brands to be the brand for which each group will design the luminaire. After this choice, each group carried out more detailed research on the history, concept, mission and vision, the different types of products and markets to which they are intended, competitive advantage of the brand and products in relation to their competitors, designers who collaborate with the brand and the most emblematic projects carried out by the brand. The research results are later compiled in a short descriptive text, which will be accompanied by images that illustrate the text. Based on the research, each group proceeds to define a project theme, a theme that traces the main lines of the project path and that marks formal and structural elements, possible details, colours and textures, cultural influences, materials, trends and lifestyle, target audience and possible use environment. The theme is also summarized in a short text that forms the narrative and the concept of the project, which is also accompanied by images that illustrate it and that serve as inspiration for the transformation into lamp shapes. The result of these two steps is translated into two mood boards (Figure 2) that are posted on the classroom wall so that all groups can interact with suggestions and at the same time contribute to a healthy competition environment and promote the stimulation of everyone in regarding the project.

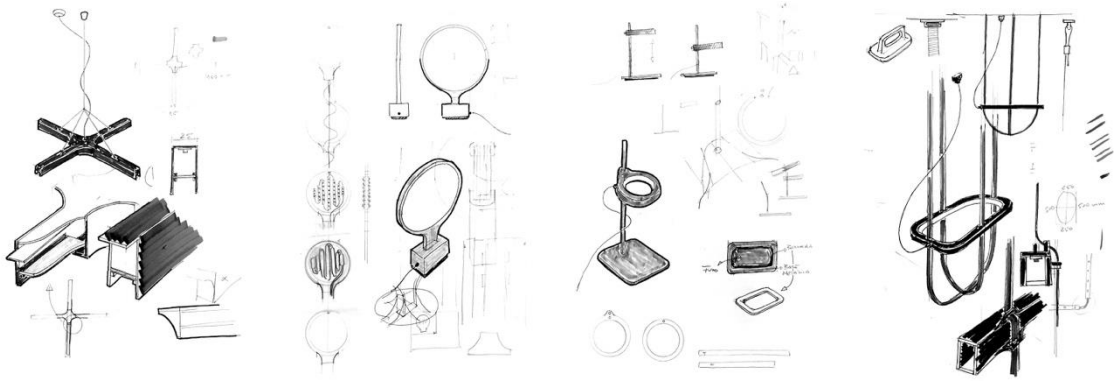
At this stage, the students showed a lot of interest and motivation in transforming the research into a visual format where the mixture of text and images make up the mood boards. When executing the mood boards, they demonstrated care in the layout of the same so that there was a harmonious connection between the two, showing care in the presentation.

Figure 2. Example of research and project theme definition mood board.

After executing the mood boards with the research on the brand and the concept of the project, the next phase consisted of the concept development, where the objective is to execute manual drawings of formal and functional exploration. Each group had to design several hypotheses for luminaires according to the established theme/concept, for which representation techniques were used such as perspective, side and top drawings, cuts and detail drawing. Colours were also used to distinguish parts and components, or to differentiate materials. The first half of each class was transformed into brainstorming sessions between groups and the second half for the execution of drawings on A4-sized sheets (Figure 3) where on each sheet it was possible to visualize the general idea of each concept, such as shape, details operating and construction.

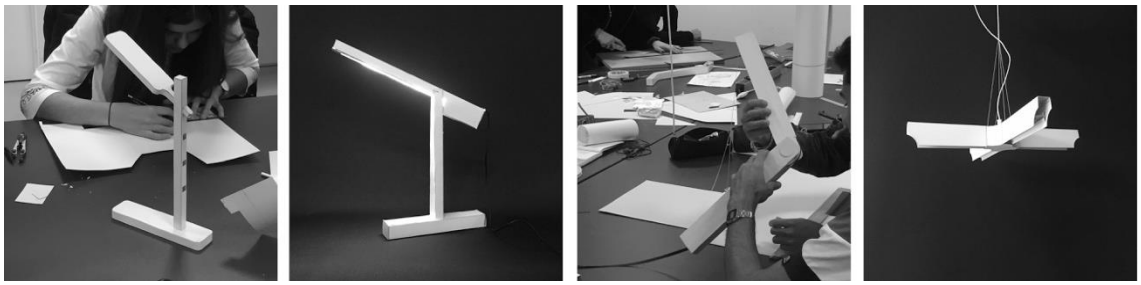
The transformation of a theme/concept that is represented on a mood board (Figure 2) and that in itself is something abstract, to be transformed into a product idea, in this case an LED lamp, was the stage where the students showed the most difficulty, either because they have difficulty with the techniques of representation and manual drawing, or because they are unable to make this transition from something that has no form, such as a theme, to a physical object that bears form and a function.

Figure 3. Illustrative drawings of the functional and formal exploration phase.



After each group had a formal two-dimensional representation of their luminaire, the next step consisted of building real-scale card models (Figure 4), this step is when the idea of the product leaves the paper, in a two-dimensional way, and finds three-dimensional reality, that is, it passes from the phase where everything is possible to the phase where the first constraints begin to appear, whether volumetric and formal, or aesthetic and functional. With the construction of these models in full scale it is possible to validate dimensions, proportions, and balance and even some functional details, such as fittings, light location, where the electric wire leaves the luminaire, light simulation, among others. In many cases problems are found and the process goes backwards to a previous stage for reformulation and correction.

Figure 4. Some examples of low-fi cardboard models at real scale.



After the formal and functional validation of the cardboard models, the project moves on to its last phase called the final model, a phase of greater detail and dimensional rigor using digital 3D modelling through CAD software, in this phase all components are modelled and assembled on site, such as: the LED strip, the electrical connections, the internal channels for cables, unions of parts, articulations, diffuser, bases, etc. After the 3D modelling is finalized and validated by the teacher and the product development laboratory technician, the model is divided into parts and components. These parts are isolated in dxf or stl files for later digital fabrication, either through laser cutting, 3D printing, or CNC machining. Using these digital fabrication technologies, all the parts that make up each luminaire are produced to proceed with its assembly, in this assembly phase the students had to make the electrical connection of the LED strip, which provided them with an extra learning experience on basic principles

of electricity, soldering with tin, positive and negative poles, type of electric current, current transformers, among others. The assembly of prototypes is a meticulous task where assembly errors are avoided in order not to compromise the result and avoid having to produce new parts, which entails additional costs to the process. At the end of the assembly, a photographic session of the prototype is carried out (Figure 5) so that the students have a record of the work that is as close as possible to a professional work, which in our opinion substantially reinforces the quality of the portfolio.

Figure 5. Some examples of final models in acrylic.

4. Conclusions

The fact that a lot of importance and responsibility is given to the creation of the prototype, as if it were a final product, means that, at the time of portfolio elaboration, students show preference and greater confidence in the prototype elaborated in the discipline. The project briefing is adjusted to the laboratory conditions existing in the course, which allows the realization of the prototype within the foreseen objectives and the required quality standards. Research is carried out throughout the project and with the appearance of needs. The prototype also works as a measurable element of results between groups of students and encourages healthy competition between groups, which makes the result of higher quality. It is important when preparing a course of this kind that teachers and technicians simulate all the stages to adapt the project requirements to the real conditions of each educational institution.

Acknowledgments

This work is funded by national funds through FCT – Fundação para a Ciência e Tecnologia, I.P., under the project UIDB/04057/2020.
To the technician of the product development laboratory of the Polytechnic Institute of Cávado and Ave, Mário Fonseca, for the unconditional support given to all stages of the process.

References

Chow, G. K. (2022). *Keys to successful studio projects: A graduate industrial design studio case study*. Retrieved March 6, 2023 from https://www.idsa.org/wp-content/uploads/2023/01/Keys-to-Successful-Studio-Projects.pdf

Cline, T. (2019). *Looking Back: The Foundations of Design Education*. Retrieved March 6, 2023 from https://www.idsa.org/wp-content/uploads/2022/09/Looking-Back-by-Thomas-Cline.pdf

Garner, S. (2005). Revealing design complexity: Lessons from the Open University. *CoDesign, 1*(4), 267-276.

Industrial Designers Society of America (2010). *Industrial Design: Defined* [online]. Available at: http://www.idsa.org/content/ content1/industrial-design-defined [accessed 10 July 2010].

Oxman, R. (2006). Special issue of Design Studies on digital design [editorial]. *Design Studies, 27*(3), 225-227.

Sener, B., & Wormald, P. (2001). The future of computer use in product design. In R. Shaw, & J. Mckay (Eds.), *The 4th CADE Conference: Computers in Art and Design Education: Digital Creativity Crossing the Border, Glasgow School of Art, Glasgow, 9–12 April 2001* (pp. 358–363). Glasgow: The Glasgow School of Art Press.

Unver, E. (2006). Strategies for the transition to CAD based 3D design education. *Computer-Aided Design and Applications, 3*(1-4), 323-330.