Furniture Design Education with 3D Printing Technology

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Abstract Three-dimensional printing technology has an important place in furniture and interior design, a strong global sector that responds rapidly to the changing needs and expectations of the individual and society. The main objective of design education should be to equip us to imagine new models of life. Among the most attractive benefits of 3D printing technology that make it a boon to designers working in the building and furniture sector are that it enables them to seek original forms that cannot be produced in molds, it generates less waste, and is accessible to all. Today, innovation in the profession, innovative materials, and knowledge of innovative production technologies that feed creative thinking have become ever important features of design education. This knowledge will allow us to imagine, discuss and pioneer design production ideas for new life models. This paper discusses 3D printing technology, the furniture design studio method and its contribution to design education in the Production Techniques courses of the Interior Architecture Department of Marmara University's Faculty of Fine Arts led by Professor Meltem Eti Proto, Instructor Can Onart, Lecturer T. Emre Eke, and Research Assistant Ceren Koç Sağlam.

Keywords 3D printer · Furniture design education · Innovation · Production · Design training · Prototype

1   Introduction

Three-dimensional printing technology has an important place in furniture and interior design, a strong global sector that responds rapidly to the changing needs and expectations of the individual and society. The main objectives of design education should be to equip us to imagine new models of life and to respond to the rapidly changing needs and expectations of the individual and society. Today, innovation in the profession, knowledge of innovative materials, and the ability to recognize innovative production technologies that feed creative thinking have become ever

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important features of design education. Indeed, as Achille Castiglioni [1] would say, "If you are not curious, forget it." This knowledge will enable us to imagine new ideas for life models, and will encourage discussion and inspire design production.

"In every design or engineering exercise, we as creatives are looking to innovate, to do more with less, and to always do something better than what came before us. Parallel to this we are expected to produce faster, more efficiently, and cheaper, with less time than ever. The demand from consumers, as well as investors has created a world where design exploration is under immense pressure." These words by Paul Sohi [2], leader of Autodesk's iconic projects program, describe the dilemmas of today's design production. Among the most attractive benefits of 3D printing technology that make it a boon to designers working in the building and furniture sector are that it enables them to seek original forms that cannot be produced in molds, it generates less waste, and is accessible to all. As the technology has developed and different forms of it have emerged, the applications of 3D printing have multiplied to cover fields as diverse as medicine, the automotive industry, consumer products, architecture, construction, textiles, mold applications and the food sector.

1.1 Design with 3D Printing Technology

In recent years, 3D printing technology has shaken up many of the world's industries, from the food sector to the construction industry, the automotive industry and the health sector; in fact, few sectors have been left untouched by it. This technology is also changing the world of furniture. Made from melted parts of an old refrigerator, designer Dirk Vander Kooij's "Endless Pulse Chair" is a good example of the possibilities of 3D printing [3]. The result is a durable, strong and lightweight design. The chair is environmentally friendly and recyclable. Another environmentally friendly project is "Print Your City" by The New Raw design team, who recycle household plastic waste into raw materials for 3D-printed street furniture [4] (Figs. 1 and 2).

3D printing simplifies and reduces the cost of furniture design. The ability to quickly and cheaply produce furniture prototypes through 3D printing provides designers with more scope to test their creations and maximize the useful properties of the finished product. This technology enables furniture companies to design forms that cannot be produced by conventional methods, while consuming less energy and fewer resources in the manufacturing process. 3D printing is not only more cost-effective for companies than traditional furniture creation processes, but is also more environmentally friendly and sustainable.

The benefits of 3D printing for the consumer. While custom-design furniture is traditionally not cost-effective, because of the related operating expenses, 3D printing reduces the cost of customization. Changing the color, design, and other customized options adds no costs to the printing process. Although 3D printing will drastically change the furniture industry, it will not completely replace traditional manufacturing. The designer and manufacturer will continue to combine 3D printing with traditional production capabilities. As shown in the diagram in Fig. 3, the speed

Fig. 1 Endless pulse chair, by Dirk Vander Kooij (credit: Dirk Vander Kooij, 2011) [3]

Fig. 2 Print your city, XXX Bench in Amsterdam by The New Raw (credit: The New Raw, 2017) [4]

of production will have a big impact on the habits of designers, manufacturers and consumers, and will also change the way we shop for furniture. It will not be long before consumers will be able to have chairs, tables and fittings printed at their local 3D printing shop (see Fig. 3).
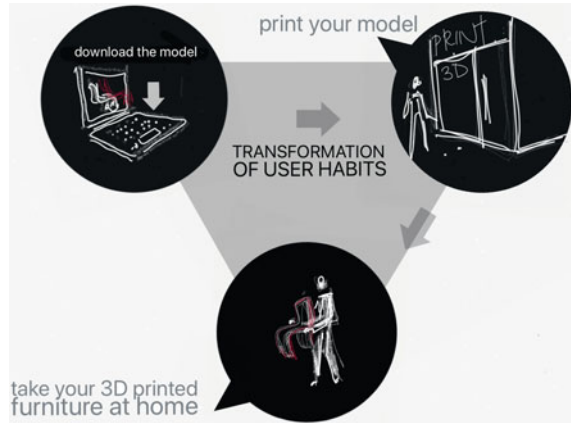
2   Furniture Design Studio with 3D Printing Technology

The aim of the course is to bring awareness to students regarding the global economic, social and political factors that give rise to change in furniture manufacturing methods and the introduction of new technologies. This will help students become part of the solution. The furniture designed during the course offers solutions to the transportation, assembly, production, raw materials, sustainability and cost issues common to many manufacturing industries. These designs are inspired by the democratic design philosophy, which emphasizes the need to provide functional and quality design for all [6]. Democratic design means affordability, environmental protection, sustainability and manufacturing efficiency.

The study was conducted with the participation of third-year students within the framework of the Free Furniture Design course of the Department of Interior Architecture, Marmara University. The Free Furniture Design—Production Techniques courses are led by Professor Meltem Eti Proto, Instructor Can Onart, Lecturer T. Emre Eke, and Research Assistant Ceren Koç Sağlam. The project also emphasizes that such values as originality, flexibility, communication/interaction, and inter-disciplinarity, which inspire art and design, should be featured in furniture design courses.

In the first phase of this study, a modular furniture project was developed according to democratic design principles. The interlocking parts that connect and lock together the functional plywood parts of the furniture are produced using FDM 3D printing technology (see Fig. 4). The furniture designed and produced by the students has a variety of functions. For example, a table that can be used for educational purposes with children, or a modular shelf for display, storage, a hanger, a home-play area for pets, or a seating element.

An entirely different method was employed in the second phase of the study to develop experimental techniques that lead to creativity. The idea was to establish
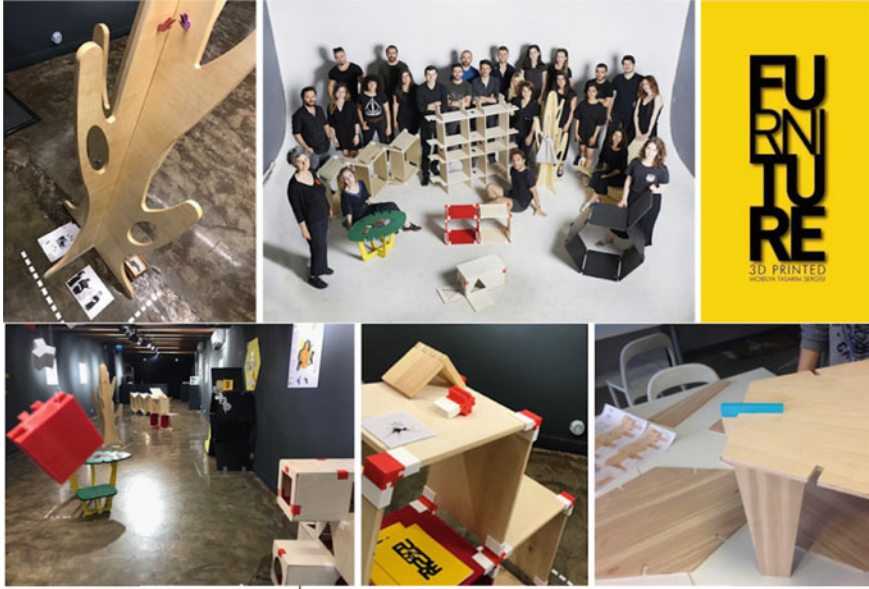
Fig. 4 Exhibition of 3D-printed furniture, Kadıköy youth and art center, İstanbul, 2018
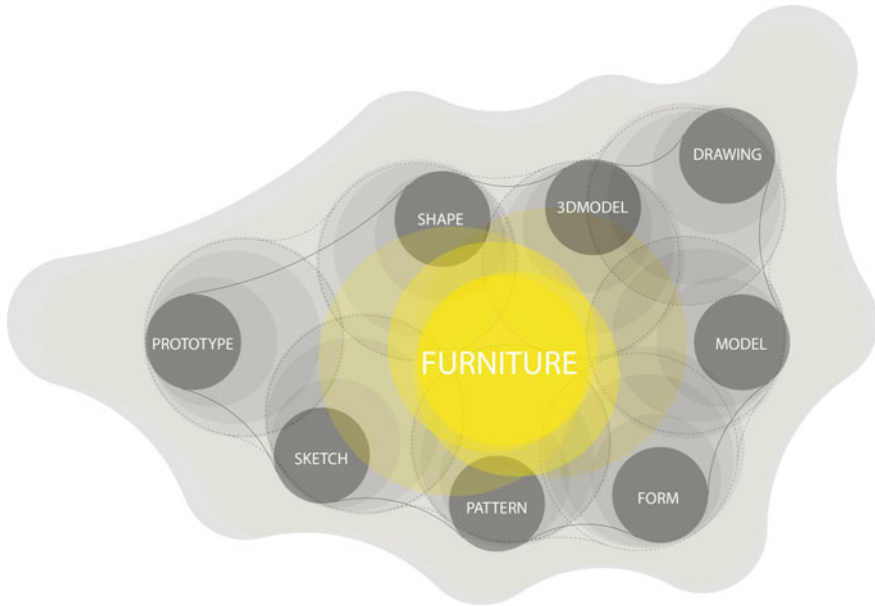
Fig. 5 Flexible relationship between the stages in the furniture design process, (Koc Saglam, 2019)

interconnected stages of furniture design and production, which included 3D drawings, visualization and manufacturing technologies. Rather than being sequential, the stages in this process are cyclical and merge with each other (see Fig. 5). The designer moves around the borders drawn by the stages in the process. However, furniture is defined as an alternative consequence of the multiple alternative combinations that come into existence between these stages. In this research project, students produced 1:1 scale prototypes and tested the design solutions they developed. This project can thus be defined as action research.

The students were also asked to bring alternative patterns they could draw inspiration from and to produce a new design by abstracting the alternative patterns. They were expected to transform their new design into a 3D form using any method they preferred; the form would be functionalized as a seating unit with appropriate size and ergonomics (see Fig. 6). In the study, the designer could move in and out of the stages in the process any way she pleased, and the outcomes were optimized in terms of function, ergonomics and durability. Although the students were free to move between the stages, priority was given to developing the products through drawing and then 3D modeling. The students experienced the production stages and the design stages simultaneously, including technical drawing, modeling, visualization, and presentation of 1:5 and 1:1 scale prototypes which they printed on FDM 3D printers. They were able to perform unique actions within a free framework that highlighted the design process and 3D printing technologies (see Fig. 6).
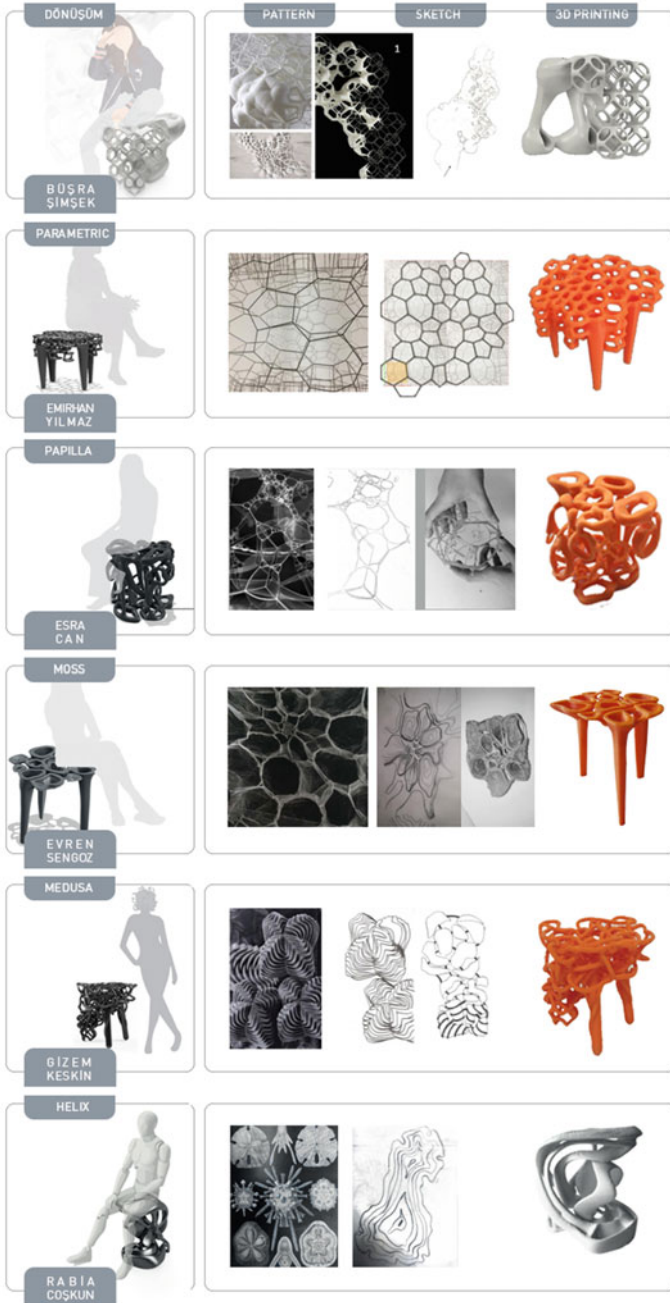
Fig. 6 Images of the stages, creating the design process, and 3D prototypes (Eti Proto, Koc Saglam, 2019)

Fig. 7 A prototype printed on a 1:1 scale using FDM 3D printing technology

With the support of 3D printers, students can develop their designs and build different-scale prototypes of their models. In this way, students can produce 1:1 models of their designs for inspection, without having to go through the process of producing them physically. The prototypes, 3D-printed on a 1:1 scale by FDM technology, are produced under the trademark *Istanbul Technical University* in cooperation with "*Tiridi Atölye*" managed by *Magnet Fab* (see Fig. 7).

3 Conclusion

Advances in technology-based modern design and production techniques have made positive impacts on furniture design practices. The boundaries of design have been expanded thanks to both traditional and digital design tools. In the context of this experience-based method for furniture design training, the flexible feedback introduced by 3D design and production technology enables students to create unique ideas, rapidly visualize these ideas and experience them by producing simultaneously. Such experiences in 3D production technology can be a useful method to use in design studios on furniture design courses for exploring such skills as creativity, abstract thinking, and 1:1 scale production.

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