PROCEEDINGS

DRS LEARN X DESIGN 2019

insider knowledge

Fifth International Conference for
Design Education Researchers
9-12 July 2019
Middle East Technical University
Ankara, TURKEY

Editors
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ISBN 978-1-912294-00-8

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Cover and conference identity design

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Publisher

METU Department of Industrial Design
Middle East Technical University
Faculty of Architecture
Department of Industrial Design
Universiteler Mahallesi
Dumlupınar Bulvarı No:1
06800 Çankaya, Ankara, Turkey
<http://id.metu.edu.tr/>

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A Gestalt Approach to Teaching and Learning by Prototyping

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doi: 10.21606/learnxdesign.2019.14066

Abstract: This paper describes a teaching approach used at both Politecnico di Milano, Department of Design and the University of Cincinnati, College of Design, Architecture, Art, and Planning. In this teaching approach, students learn about furniture and product design by prototyping a full-size working prototype, in tandem and with the integration of other design methods, in order to better see and learn - underscoring the Gestalt idea: The whole is greater than the sum of its parts. Different kinds of prototypes are used throughout the design process to verify, as touchstones, every step of the product's development, providing feedback and suggestions according to shape, function and usability. The paper intends to underline the importance of the prototype in the process of creating artifacts as a practical feasibility of the concept, along with a palette of designers' tools including sketching, drawing, 3D modelling and 3D printing.

Keywords: *learning by prototyping; furniture design; product design; design method; making*

1 Introduction

Practice is, first and foremost, a process by which we can experience the world and our engagement with it as meaningful. (Wenger, 1998, p. 51)

Since ancient times, we get to know things surrounding us through engaged actions and practical experiences that bond us together. As Heidegger pointed out, these interactions cause the uncovering of meaning in the world (Dourish, 2001, pp. 129, 177). Then, it can be stated that human sense-making, understanding and learning are not ideal processes based on self-contained structures –the Platonic *Hyperuranion*– yet, they are defined in a strict relationship with actional contexts (Hanks, 1991, p. 15). As a matter of fact, from a gnoseological point of view, physicality is fundamental in our lives. Through our body we touch, feel, and ultimately know objects and spaces in the physical world (Hornecker, 2011, p. 21). Moreover, referring to bodily experiences does not imply focusing only on sight. On the contrary, we are made of “eyes in the head on the shoulders of a body that gets about” (Gibson, 1979, p. 222), which means that we perceive our surroundings through all of our senses that, in turn, trigger multiple insights.

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For instance, “touching something fires a whole battery of sensors and nerves; we feel resistance, temperature, surface quality, softness, weight, and more” (Hornecker, 2011, p. 21) and all the pieces of information deriving from our different senses finally merge into the whole, providing meaning, awareness, experience, performance, pleasure, affect, emotion, persuasion, etc. (Kaptelinin & Nardi, 2009, p. 253).

In the contemporary scenario, action and embodiment seem to lead Human-Centered Design and UX research in a holistic way (Forlizzi & Battarbee, 2004; Hassenzahl & Tractinsky, 2006; Väänänen-Vainio-Mattila, Roto, & Hassenzahl, 2008; Hassenzahl, 2008, 2011). Therefore, education should be informed by these notions and students need to acquire their skills by actually engaging in a concrete process, no more being provided with exclusively abstract knowledge, for them to reapply in later and also intangible contexts (Hanks, 1991, p. 14). As Dourish outlined in the context of HCI – but in a way that can be transposed to any field of design – building active representations can induce learning, facilitating the exploration of abstract ideas and relationships through a physical procedure (Dourish, 2001, p. 163), which, in design disciplines, is represented by prototyping, here intended as the activity of building physical full-size models throughout the design process.

The on-line Merriam-Webster Dictionary defines the word prototype as: “a first full-scale and usually functional form of a new type or design of a construction” and, additionally, “a prototype is something that serves as a model or inspiration for those that come later” (“Prototype | Definition of Prototype by Merriam-Webster,” n.d.). Thus, making a prototype is a way to foresee, to perceive, to study, and to learn about an object or space (typically at full size). But also, as a verb, it implies the idea of *projecting* (hurling forward) concepts and enabling discourse by seeing, experiencing, and reflecting – enhancing one’s understanding about interaction, presence, characteristics, and quality of the object and/or space. According to Scaletsky et al., (2014) the act of designing represents a projection *in time*, throwing the designer forward, to build something that did not exist. It is a way of generating knowledge through a process of learning by experiencing and by doing. From prototyping, designers can get information to “empathize with the people and their living conditions” (Scaletsky et al., 2014, p. 3084).

Then, prototyping allows one to uncover issues in the design (Dourish, 2001, p. 145), as it happens directly in the physical world (Dourish, 2001, p. 153). Consequently, it is central to design, and learning to work within this venue, early in the process, is critically important to a design-based education, as it may serve well as a pedagogical tool. During the iterative process that characterizes prototyping, it is already possible to assess the final design qualities, thus problematic issues can be exploited to explore new paths towards new solution directions. In particular, with its incompleteness, prototypes reveal parts of the final ideas and, therefore, only parts of their qualities. For this reason, the competence involved in prototyping is the skill to build prototypes that are able to filter the qualities the designer wants to examine and explore. (Lim, Stolterman & Tenenberg, 2008)

Nonetheless, currently, if students in studios, labs or seminars are called to design a furniture piece (or system), they typically spend a great amount of time in drawing and digital modelling, while they often prototype their ideas at full-size only at the end of the creative process, to affirm and present solutions rather than explore or refine design-inquiry. Usually, that happens because of the efforts, related costs, and time involved.

The advent of computer graphics, 3D software, and rapid prototyping has completely changed the concept of modelling. In professional practice, models used to be made in wood or resin with a long and very difficult process, they were finished by hand, or redone when the result was not satisfying. Nowadays, the whole process has taken a different path, making the waste-time and the discontinuity in the design process disappear. The possibility of personally managing the entire process eliminates the pause-time between the realization of the design and the delivery of the prototype to the companies: that mandatory suspension and sedimentation of the idea is now spread in the flow of a non-stop design process, which proceeds for continuous revisions, corrections, and adjustments. Certainly today, having the possibility to send files directly to the prototyping laboratory, time is better managed and there is little downtime. Moreover, with modelling software, every slightest variation can be assessed, which was actually impossible in the traditional resin or wooden model method. Three-dimensional digital forms lead to a reversed working approach: designers now see, evaluate, discuss, compare, and choose defining and subsequently refining the result. Undoubtedly, there is less room for questions and explorations – that the obligatory time of waiting entailed – and it seems that answers almost come before questions.

Yet, real and correct perception begins with what is experienced, and not just expected (Dourish, 2001, p. 21), may it be from a drawing or digital 3D model. As the Compasso d’Oro-awarded Makio Hasuike affirms, most of his work as a designer is defined out of this (Cecconello, 2015, p. 60) and, in general, it is only through a direct interaction with artifacts that one can create, manipulate, and share meaning (Dourish, 2001, p. 126). As categorized by Lim et al.

(2008), the reasons why prototypes are used cover: (i) evaluation and testing; (ii) the understanding of user experience, needs, and values; (iii) idea generation; and (iv) communication among designers.

Starting from these premises, the contribution aims at proposing a Gestalt, phenomenology-based approach for furniture design, to be applied in an academic context. In particular, it refers to the course of Furniture Design (Prototyping Furniture Seminar) ARCH7036-004, University of Cincinnati (2018-19), which shares the same principles of Final Synthesis Design Studio, Product Design, Politecnico di Milano (2017-2018) and Smart and Interaction Design Seminar, Politecnico di Milano (2017-2018). According to Gestalt principles, learning is efficiently encouraged when the instruction is related to real life experiences (David, 2015), therefore, the purpose of the courses is to introduce prototyping from the beginning of the design process, then integrating a study-through-making approach with complementary activities (such as sketching, drawing, detailing, and analysing). The process results in a broad spectrum of linear and integrated assignments designed to nurture and strengthen the output. Such a teaching method, more often than not, results in *whole* project solutions that, on a number of levels, are greater than the sum of their *parts*. Students firstly need to manage the project in its entirety, rather than broken up into parts (Ehrenfels, 1937, p. 521). The alignment of specific design assignments, occurring in tandem with making an array of prototypes, results in clarification and refinement of the design intent through the process of integrating theory, utility, aesthetics, materiality, careful detailing, fabrication methods, resource allocation, human use and interaction, text descriptions, the delineation of plan, elevation and section, computer modelling, social and spatial context definition, etc.

A broad range of ideas will fuel the process of designing and fabricating a working prototype of a furniture or product. Initial studies that generally involve sketching, might also involve the study-through-making process (i.e., a model or fabricating a rough full-size working-prototype of a furniture piece or furniture system) in order to explore and test initial design ideas. Following efforts can involve developing a set of drawings for the project, in order to see and understand details of the design.

2 Methodology

It is often too great a challenge to begin with a complete and comprehensive picture of a resolved design idea already set in mind. Rather, a better approach is to begin with a partial view and work inductively to generate an integrated *whole* out of the sum of the *parts*. Yet, in the proposed approach, a series of working prototypes is the preferred pedagogy to the course, and specific assignments give focus and resolution to the different *parts* of the entire project.

In order to introduce a hands-on approach as a common design practice that helps furniture or product design students to always have a contact with an integrated *whole* –comprehending more information than the same object divided into separated pieces– an academic methodology has been developed. The Furniture Design Seminar at the University of Cincinnati, in fact, presents a prototype-based learning approach, which focus is to make students understand the value of physical experimentations on the entirety of their projected items, instead of considering them in a multi-faceted way, e.g. through sketches. It develops on a 15-week semester and its final result is the design of a piece of furniture or product, as stated, utilizing a phenomenological approach. Throughout the design process, students are free in decisional aspects and time management, while they are guided in following a precise methodology –highlighting the importance of early building of prototypes– through precise indications and assignments, as well as with a theoretical support.

Firstly, students are asked to define the object of their design exploration. They have no constraints in that, and they can get inspiration from anywhere: precedents, life-style uses, trend forecasting, or personal intuition. As the initial stages of the design process can be daunting and dispersive, students are supported by readings and lecture presentations, introducing a wide-ranging body of knowledge on the subject of furniture design. This body of knowledge helps them to open their minds and comprehend a broad range of furniture designers' works and working methods; processes for designing furniture; taxonomies and typologies; anthropometries and ergonomic theories; interrelations between disciplines and companies; regional and global trends; professional practice considerations, marketing, branding, and promotion; materials and fabrication procedures involved in making (manufacturing and production); regional, national and international venues for furniture design, including, exhibits, tradeshow and museums. Moreover, since students tend to point at general-use situations, leaving their field of enquiry too wide, some activities are planned in this phase to help them find a direction towards a more punctual specificity of their projects. For instance, they are introduced to theories and practical examples in class as well as through field trips. At the beginning, the course is intended to encourage the limitation of the scope of the initial concept to something relatively simple, so that later students can (i) keep the design, material palette, and fabrication effort focused as they

develop complexity into the furniture design, and (ii) concentrate on *prototyping* as a central part of the design process and the final outcome.

As a matter of fact, what is fundamental in this educational method, is to rapidly build upon ideas, focusing on pre-production prototyping. On that purpose, five assignments are subsequently required. In the first assignment, the prototype is akin to a thought-experiment, an idea-generator, or a vehicle for testing design-ideas. Only after an initial and rough prototype is made –usually by the third week of class– a full-size, working prototype of the furniture design piece has to be fabricated (assignment B) working closely with one another, faculty and staff in the workshop and prototype lab. Throughout those phases, students must make important early decisions, considering utility, social-use and spatial context, along with performance, and fabrication of the furniture or product, until they get to a few carefully articulated ideas that should govern the project development to its completion. Then, to increasingly implement their reasoning about the items, they also have to take in consideration the bodily dimension (assignment C). Finally, students begin to work through simultaneous phased assignments, including sketching, drawing, writing and defining specifics about the furniture project, to return, at the end, to the finalization of their prototype (assignments D-E). From these assignments, which are better defined in the following paragraphs, it emerges that the direct embodiment of concepts into prototypes denotes a form of participative status for students in the design process. In fact, things are embedded in the world and reality depends on their being embedded (Dourish, 2001, p. 18).

3 Assignments & Descriptions

As previously explained, full scale or scaled model studies, made early in the process, should serve to explore and test design ideas rather than solely presenting design solutions. That is the reason why students are supported in their practical investigation by a series of assignments that, at once, give perspective and enrich designing operations.

3.1 Assignment A: Prototyping

Simultaneous with clarifying the design intent and considering issues of utility, social, and spatial context, students are invited to build rough prototypes, in order to initially explore size and form parameters for their project. This initial work should be made using a limited material palette (i.e., wood, cardboard, foam, metal, fabric, plastic, etc.). Then, through a series of follow-up assignments and in-class lessons, students should develop and resolve the design, the material palette, functionality, joinery, and workmanship to a schematic-level resolution. At the end of this initial phase, the first-pass prototype (Figure 1) will be presented to the class for discussion, encouraging others to see it, experience it, and critique it. At this stage, students have to understand the importance of seeking inputs and reactions from everyone.

Figure 1. Prototype as ideas tester and generator (Fourth year student in the Furniture Program, DIS, 2005).

3.2 Assignment B: Modelling the Idea at Scale

Following the initial effort to develop a rough working prototype, students will increase their effort by completing a second prototype iteration (Figure 2), improving the initial working-prototype at every level possible. They will focus on a particular aspect of the piece (detail inquiry) or may consider making a scaled model to further their investigation and design direction (scale 1:4). This phase is particularly important to experiment with materials and intentionally

integrate the materials into the piece to affect its performance, durability, or interactive qualities. Material suggestions may include lumber, veneer or ply material, metal rod, tube or sheet, plastic, or anything else.

Figure 2. Second prototype iteration: testing the plasticity of an edge profile - Furniture Seminar, University of Miami (Dickerson, 2009).

3.3 Assignment C: Anthropometric Studies

Our body affects our experience of things, changing our viewpoint on them, in terms of what they allow, suggest or prohibit (Hornecker, 2011, p. 22). This is the main topic of the assignment C. Assignment C is designed to guide efforts in observing and documenting people's interactions and use of furniture/products at full scale, underlining that material objects are often described by the enactment of a particular human activity (Kaptelinin & Nardi, 2009, pp. 240-241). Using white Kraft, corrugated cardboard, or bond paper taped together and any media to draw with, students shall produce a drawing of their product: plan and elevation –aligned and composed on one sheet, with appropriate line quality and weight– integrating as many body postures as they can think about, to provide a wide scenario of possible utilizations of their project (Figure 3). The aim is to communicate spatial and physical dimensions, behaviours and use in 1:1 scale reconstruction. For further realism, the plan shall be viewed directly on the floor and the elevation on a vertical surface, so that the sheet has to be folded along the seam where the floor meets the vertical partition.

This phase is particularly important, since we are accustomed to interpret spatial qualities in relation to our own body, and that attains psychological meaning (Hornecker, 2011, p. 21). Therefore, evaluating one's project in relationship with human body and behaviours also informs the product sense-making.

Figure 3. Human body integrated in an object plan and elevation - Anthropometric Study (Sambuco, 2017).

3.4 Assignment D: Design Documentation – Drawings and Text

While students are working on fabricating a final working-prototype outside of class-time, they are asked to produce a finely delineated set of materials to document their design graphically (Figure 4). Indeed, design is about communication, it has to persuade audiences of its utility and social value. From this, the designer's argumentative ability is measured (Buchanan, 1989, p. 111; Kolko, 2011, p. 53). Additionally, describing a piece can have enormous benefit in a generative perspective. For instance, giving a title can serve to bind and underscore the content within the piece. It is also the case that most furniture pieces, like books, have titles.

Assignment D is composed of –at least– a five-sheet document including: the title of the furniture design and other basic information; a reference image (this may be a sketch or photograph); a text describing the general background description, functional information of the design, its intended purpose, cultural considerations and context – which is indeed essential as artifacts are the product of cultural needs and they are transformed by culture and society providing incentives, guidance and constraints (Kaptelinin & Nardi, 2009, pp. 61, 248); technical information (weight, material(s), finish, production process, dimensions, cost, and formal description); a constructive critique; measured scaled drawings in plan, elevation, and section carefully rendered (by either hand or computer); one exploded axonometric showing all significant components of the furniture; and a final rendering of the situated furniture piece showing both use and spatial context. The idea is to create a single image that communicates the spatial context (time and place), use, purpose, and design qualities of the piece: we are spatial beings, therefore, while presenting a design, we cannot escape spatiality (Hornecker, 2011, p. 21).

Figure 4. Design Documentation, Assignment D (Knipscher, 2016).

Following assignments A to D, each student is responsible for completing his/her working prototype (E) (Figure 5), which has to be ready for the presentation at the end of the 15-week course. The working prototype serves as the primary tool to present one's furniture design, while drawings and texts, as well as the initial studies are helpful to flush out and support the design efforts.

Figure 5. Final prototype - Hairpin Chair (Miller, 2017).

4 Results

The most tangible outcome of the presented approach is that the idea immediately acquires a physical dimension. This path highlights several aspects that cannot be seen on paper, thus requiring an early 3D, physical materialization

is not only a constraint, but also a stimulus for the design process. In addition, early materialization enables one to better consider weight, lateral forces, and human scale relations in the design process.

Then, directly working with the prototype forces students to keep the design *simple* versus *simplistic* and strive to make the design *complex* rather than *complicated*, focusing the inquiry on one primary idea, or point of departure, as a place to begin and refer to during the project development. Subsequently, some considerations may follow. What components and variables should be present in the next iteration? And how might the organization of the parts contribute to the understanding of the whole? What ideas can result when considering use, comfort, surfaces, construction specifications, materials, finishes, and details? These are only some examples of the natural questioning approach that affect students dealing with direct prototyping in person, hence stimulating their reasoning and problem-solving skills. In addition, interesting conclusions or correlations can become relatively easy to detect when design ideas are experienced. But, in order to result in something that others can experience, students will need to focus and work within strict limitations of their resources, knowledge of various technologies, and time.

Below, results more strictly related to each assignment are highlighted.

4.1 Assignment A

In assignment A, students begin designing and fabricating a rough furniture prototype, and explore initial design ideas at full scale. Making a full-size working prototype helps students consider form, size, scale, structure, use, and the *reality* of their design. They can rapidly visualize ways a person can sit, ways things can be displayed or organized, ways activities can be supported, or ways materials can be joined. Requiring a rough, working prototypes throws students into the practice of furniture design, to engage theory, fabrication, workmanship issues, structure, and utility. The process generates a body of knowledge that designers need to consider in designing furniture. In addition, as initial fabrication efforts need not be of high craft or workmanship, but rather produced out of a relatively simple and easy-to-work media (corrugated cardboard, reclaimed wood or scrap metal) from which, the results can be useful in provoking further development or individual inquiry and class discussion on several aspects of furniture design. In this way, assignment A stimulates a formal direction of inquiry for the furniture piece.

4.2 Assignment B

In order to create a worthwhile *working prototype*, several factors must be taken in consideration. This is the utmost relevance of this assignment. While developing their prototype, students strongly increase their awareness and skills about different design issues. For instance: if the product has to support the human body, one can think about ways to sit in or on it, or rather, lean into it. If it is to organize or display things, those things should be included with the prototype. If the piece is to support an activity or use – then the necessary equipment or components – such as a chair with a desk or a place setting with a dining table might be included within the prototype. At the same time, issues of durability, comfort, sustainability, fabrication, joinery, and many more aspects should be considered in the early stages of the design process as well.

4.3 Assignment C

Forcing students to confront their product with the human body quite in the middle of the design process has double consequences. On the one hand, they can set their design up, free from common practices and expectations –a risk that Norman and Verganti (2014) warn about in the field of User Centred Interaction, as it can get designers stuck into present solutions– on the other hand, it does not bring them too far from physical reality, in a parallel dimension only made of aesthetics and abstract functions. Furthermore, 1:1 scaled drawings and –especially– prototypes facilitate the reasoning and elaboration of alternatives in human behaviour, as students do not have to make almost any effort of imagination.

4.4 Assignment D

This assignment, which demands the most usual materials of design documentation, is the proof that the physical model serves to better understand the drawing. Prototypes in cardboard or polystyrene or other materials, support better comprehension and reflections on a product, and this has a significant impact on the quality of drawings. Moreover, the three-dimensionality of objects may foster additional characteristics that 2-dimensional design methods may ignore, like shadows and perspectives. Finally, it highlights the importance of products communication: an object can provide information about sitting behaviours, modalities, movements and at the same time it can be considered for its colour, shape, line weight, material deflection, support, joinery and more, along with other design elements that will affect the experience and degree of success of the design.

5 Discussion

Seeing, touching and making mistakes are the fundamental components of a *correct design practice*, as Isao Hosoe stated, and they all are experienced in design by prototyping. (Ceconello, 2015, p. 57).

Prototypes are intricately intertwined with the evolution of design ideas throughout the design process. [They are useful for the designer to] evaluate and reflect on the values of what they design—if those designs are socially responsible, economically viable, experientially pleasing, culturally sound, operationally usable, technologically compatible, and functionally error-free. These are some of the important values that designers try to satisfy. Throughout the design process, prototypes are what manifest the design thinking process to reach such design outcomes (Lim et al., 2008, p. 8).

A designer obviously has a strong propensity to experiment with the project, contemplating aspects that go beyond its dimensions (which are always, and in any case, infused by the drawing) letting himself be guided by a sensory nature. Touch, textures, smells, etc. enrich his/her work and this type of sensory response only increases the number of elements at stake when (s)he has to grasp the right moment and the right way to connect them together. In addition, prototypes (especially in Product Design) communicate several perceptual aspects, like *size, weight, shape, texture*, etc. In this way, also functions can be envisioned. Thus, taking into account also the context of use of the future product, “nearly every feature related to embodiment” (Scaletsky et al., 2014, p. 3089). Yet, just referring to a bidimensional or virtual reality – as common practices (based on sketches and 3D models) require – may be deceiving, while dealing with something physical and situated in the same dimension actually facilitate the creative process as a pedagogical tool. The use of scaled or full-size study models help in an immediate and unmediated way in the understanding of the formal and visual characteristics of an object or space, training the mind to be in connection with the hands and verifying through the prototype the sensitivity to shape and proportions. The continuous comparison between the two dimensions and the three dimensions enriches the awareness and sharpens the receptivity on objects and spaces (Piardi, 2011, p. 8).

Common within one’s design teaching experience, the model is primarily a tool for the final presentation of the project while, during the design and concept development phase, students use only 3D sketches or computer modelling software. Yet, the use of the model is fundamental –though often overlooked– and it is a powerful and, at the same time, pleasant tool in a design approach. It can generate points of departure and verification, but also stimulate creativity. Hands are often the basis of the first formal elaborations of a design product: hands can gesture, hands can draw and hands can model. Despite the introduction of digital technologies and virtual mock-ups, physical modelling remains an irreplaceable tool for the dimensional definition of the project and for the immediate verification of hypotheses. On the other side, as pointed out by Lim et al. (2008), designing and constructing prototypes is a time and resources consuming process, which makes it difficult for students to really evaluate the importance of this tool in relation to the efforts it requires.

Though, collectively, the assignments, and the constraints built into each of them, enable students to learn core-content and knowledge about furniture design and fabrication methods. In designing and realizing a furniture prototype, students gain a substantial level of understanding about design, production, and physical implications. Through the furniture assignments, students learn about ergonomics, part-to-whole relationships, human use, structure, detail, and materials. While, through traditional representational assignments, they acquire awareness of the role that each method has in relationship with the product itself, and of the importance of different means of communication.

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