CoDesign Spaces

Experiences of EBD research at an industrial design makerspace

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During the last years, insertion of technology accelerates its incursion both in the design process and in the teaching-learning process. Design education has gone through different visions: Some hold the vision of education in design with a look at professional training. Others, have chosen to study the roots and problems of the training process, the ultimate goal is to generate experts in future designers. An element that - consistently - is often absent from such discussions is the role played by prototypes in the teaching-learning process. This research reviews the role that the prototype has played, as a central element, in the process of collecting evidence, with a view to informing the decision making during the development of Project Design. The paper discusses the role that prototypes - from the standpoint of CoDesign, Evidence Design, and evolutionary design - have played in the teaching experiences of the last four semesters within a Computer Lab for students of Industrial Design. The systematization of information extracted from the research experiences has evolved from the Lab model to the Maker-space experience.

Keywords: *Prototype, FSB Framework, Makerspace, Industrial Design*

INTRODUCTION

This paper reports an educational experience carried out with Industrial Design students - junior and senior levels - at the University of Chile. The paper summarizes our experience after three years running a seminar in design computing. Such an experience has evolved from the Lab model to the Maker-space experience. In this paper we revise the overall experience and discuss the integration of three frameworks that have driven the navigation of the course. Further, lessons learned at sight of the integration of these models and its implications for design education are discussed at the end of the article.

BACKGROUND

AT university of Chile, industrial design students' work in the seminar in Design Computing, which last 38 weeks and is divided in two semesters of eighteen weeks each, in their junior and senior years.

This seminar establishes student's first approach to the use of research methods. The goal of the seminar is to build a link between design formulation, design problem solving, and digital fabrication with special focus on two topics. First, research methods that provide students with empirical evidence to guide their decision-making processes and second, the role that the prototype play in the collaborative process of framing their proposals.

The concept of prototype, for Sanders and Steppers, emerged historically as a "means to give life to ideas before they are built or manufactured". However, just as current design frontiers are undergoing radical changes, so are the prototypes and activities carried out with prototypes (Sanders, 2013). This change lies in the fact that prototypes nowadays become a participatory element which allows engagement of designers and community. Further, Sanders and Steppers claim that design happens in communities made up of users. These communities trigger the emergence of creative activities for non-designers, and the interest in Design Thinking by people linked to business and with the obsession of -create / co-design by various actors. We put students under this precedent, and impulse them to interact with real case users, gather evidence about their users experiences, and reflect on the role that the prototype plays in such processes.

THREE FRAMEWORKS

In this experience we have overlapped three different frameworks. One for triggering thinking on the role played by the prototype, other used to frame the design problem and track their own design process. Lastly, we introduce an approach to gather - and reflect on the role that - evidence plays in their design processes. These three models are presented below.

Make-Tell-Enact: the role of the Prototype in the participatory prototyping cycle (PPC)

The prototype, under the traditional model of education in design, was usually a model of representation, of high visual fidelity and low level of functionality, present in final stages of design processes with the aim of transmitting to the client the final appearance of the product.

Thus, the "traditional" prototype allows, according to Sanders (2013), Dorst (2015) and Stappers (2013):

- Experiment or explore ideas
- Identify problems
- Understand and communicate form or structure
- Overcome the limitations of two-dimensional representations
- Support the testing and refining of ideas (concepts and principles)
- Communicate with others and
- Finally, we sell the idea to another.

These functions, Sanders clarifies, work according to the iterations in the design stage in which is the opera prototype. Starting from these ideas, Sanders proposed a change in the role that prototypes ought to play, shifting the focus of attention to the experience, the people, the revision, and the learning process. Thus, new roles that the prototype can play emerge. Such roles gather "research with new functions" (Dorst, 2015; Sanders and Stappers, 2014; Stappers, 2010). Consequently, the prototypes serve to:

- Evoke focused discussions in the research team.
- Test hypothesis
- Confront theories given their ability to force the superposition of different perspectives/theories and frames of reference and
- Allow people to live a situation that did not exist before.

Sanders establishes three key states that guide collaborative design processes; make, tell, and enact. Make refers to the fabrication process of working models as well as the final model. The devices made by students when framing their research focuses on describing user experiences and the final models seek to represent the final design along with all its details. Tell enhance gathering preliminary information and testing out hypothetic scenarios, which triggers the exploration of more research questions. Enact refers to interacting with the prototype in such a way that students obtain the user experience information; achievements, difficulties, and background information that allow users to participate in the co-design process.

According to Sanders, the participatory prototyping cycle can be entered at any of the states described above, which does not follow a linear order. Thus, participation of team members as well as interaction with real user are documented in the search for relevant and empirical information looking for “helping students gain critical problem-solving and inquiry skills in the context of relevant, real-world, interdisciplinary problems.” (Honey & Kanter, 2013).

Framework FBS (Function - Behavior - Structure):

The Function-Behavior-Structure framework introduced by Chandrasekaran () and expanded by several scholars (), particularly Gero in design (), conceptualizes design in three ontological categories: function (F), behavior (B), and structure (S). The ontology models design processes a set of activities which in turn are related to any of the categories. In the ontology, function captures the purpose that the design goal must accomplish. The behavior gathers the set of attributes derived from the design structure. The structure, on the other hand, represent the components of the design object itself and its relationships. Figure 1, below, present the FBS diagram made by a group of students after accomplishing the first task of the course, which is to succeed at the “egg challenge game”. Students must design and fabricate a structure to drop off and egg from 12-meter-high and the egg must “survive”. The diagram renders the FBS model of their designs.

Afterwards, students are asked to present an FBS diagram of the design problem that emerges from interviewing real users and real problems, which are the base of the semester design project.

Evidence Based Design (EBD)

Evidence-based design, (EBD) is defined as the process of basing decisions about the built environment on credible research to achieve the best possible outcomes. The current definition spans numerous disciplines, including architecture, interior design, landscape design, facilities management, education, medicine, and nursing. We use this definition to enhance student to base their design decisions process on the evidence they collect along their interactions with the users of their prototype. Students must present in posters or presentations the links they made between the evidence collected and the information provided by the users. Such posters and presentation must have graphical depictions and photographs as the constituent elements of their evidence.

The makerspace

This research reviews the role that the prototype has played, as a key feature, in the process of collecting evidence, while interacting with team members and real users. Students use such an evidence to inform their design decision making processes.

The systematization of information extracted from the research products developed by the students, that is, posters, presentations, reports based

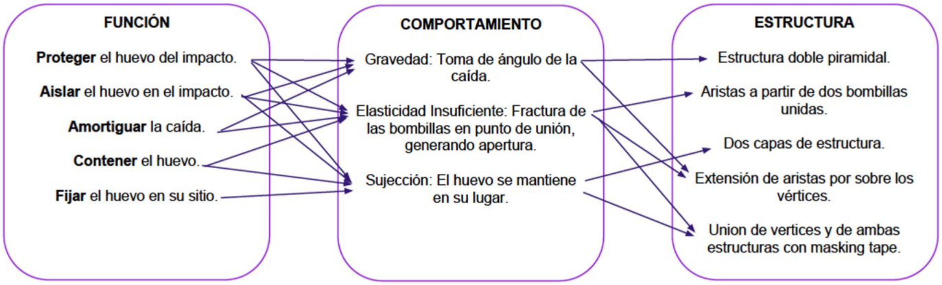

Figure 1
Example of the FSB Ontology applied by students to the “egg challenge” design problem.

on a research problem and the design of their prototypes, is considered the main input for the development of this work.

To carry out this study, we analyze 19 design projects produced in 4 iterations of a class in our undergraduate design program.

Thus, the class has become a laboratory to look at the evolution of the role that the prototype has played in students understanding of its nature.

To carry out the evaluation, we followed the model proposed by Sanders & Stappers (2014), which includes the crossing of five dimensions and three analysis units, focusing on the role that the prototype acquires in the stages of pre-design, generation, evaluation, and post-design.

Additionally, our analysis contemplates the comparative review of the results obtained from the Sanders & Stappers model, with the methodological tactics informed by the participants of the group course in the posters and academic articles produced with the prototypes.

Tactics used by students in their research and design processes

1. The first key step that students face is the formulation of their "design research problem"
2. Several students, in the initial stage of their projects, seek relevant information

Not all approaches to the determination of this instance should be charged or expressed of the negativity that the word problem seems to imply.

Many of the students, in the initial stages of their projects, look for a lack, problem or difficulty and often see superficially, speculatively and lacking relevant background approaches to the design problem (which should be thought of as an opportunity, improvement).

In this way, it is important to understand and clarify ways in which prototypes deliver relevant information even for the discovery of a possible problem.

This makerspace implements initial stages of prototype development with a view to developing research with strong information backup.

DISCUSSION AND LESSONS LEARNED

We envision four main lessons so far:

1.- The change in the role that the prototype play in students design processes. As the students were involved in their projects, they reaffirmed that prototyping does not refer exclusively to the final stages of Design. An important part of the results was favored by the high functionality of the prototypes that, as the investigations iterated, each team found strengths that developed autonomy, confidence, and validation with respect to the information that the different prototypes, the interaction with the users and the participation of contexts and actors gave them.

2.- Moving from a Laboratory to a Makerspace: The demands of implementing methodologies such as this not only generate changes in the teaching-learning process, but also change the appropriate spaces for the realization of each of the projects. During the experiences lived these four semesters, have been more favorable for each project to have training spaces where you can manufacture, experiment and submit to evaluation each of their prototypes. The initial semesters, when it was decided to use laboratories exclusively with computers, limited these approaches, making the design and development of the projects difficult, as well as the meeting spaces between the teaching team and the students.

3.- The integration of methodologies for the development and evaluation of prototypes such as PPC and FBS which are powerful tools that together allow evaluating, validating and improving the degree of decision making in prototypes developed by students. As a recursive and iterative process, Evidence-Based Design is not based exclusively on one of these models, it is when they interact with each other that each of the stages of the investigations can be explored in greater detail, generating reflective spaces in the students through action. and experimentation: The validation of techniques for the development of new technological spaces.

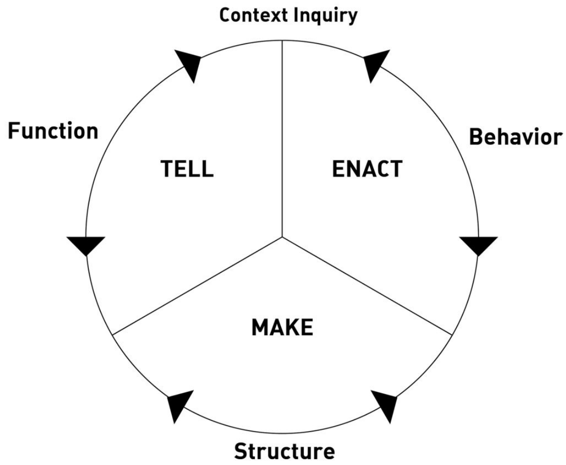

Figure 2
Render the overlap structure of the Make - Tell - Enact and Function - Behavior - Structure frameworks.

4.- For the instructors team, this type of changes poses new challenges from the point of view of implementing multidisciplinary training spaces to effectively generate a co-design environment where other disciplines can bring themes, provide different approaches and understand the design processes; we do not rule out opening this type of instances to training spaces interacting with Computer Engineers, Architects and Designers.

The motto of the class is that digital technologies are a mean to develop and evaluate both design products and user experiences. In particular, the course focuses on exploring the insertion of technology in design research.

This experience, we expect, should facilitate the irruption of the new role that Sanders envision for the prototype. Hence, we expect - and move towards - a change in student´s world view and favor their interest in exploring design decision making based on the use of evidence.

So far, we have observed an increase in the development of autonomy and collaborative work of the working groups based on the design of prototypes and the information extracted for the iterations during the development of the project. Thus, students respond to real-world problems in the context of the ethos of the class and by using the selected frameworks. Figure 2 show how such frameworks overlap. Further, they go through hands-on learning experience even though they are not accustomed to it. Moreover, they discuss the role of the prototype in their design process as well as the use of the evidence collected by them and their users.

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