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THE CHANGING FACE OF DESIGN PROJECT EDUCATION IN THE DELFT INDUSTRIAL DESIGN ENGINEERING CURRICULUM

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ABSTRACT
This paper gives an overview of the design projects within the Delft Industrial Design Engineering curriculum. Attention is given to the structure of the curriculum as a whole as well as to the individual projects. Recent developments within the design projects are addressed and discussed. The paper concludes with some thoughts on the role of design project education for staff development within a multi-disciplinary curriculum.

Keywords: Industrial design engineering, design projects, experiential learning

1 INTRODUCTION

The Delft School of Industrial Design Engineering (IDE) is a large school for design education, with approximately 240 new students each year, and is multidisciplinary in nature. Six design projects form the much-needed integrating backbone of the curriculum. Theoretical knowledge from different disciplines represented in the School, such as engineering, aesthetics, ergonomics, and business, is applied within the design projects. The practical design education is also the one place in the School where staff members from the different research groups cooperate. In that sense design education has a central function in providing the staff-members coming from a variety of disciplines -ranging from aeronautics to psychology and applied arts- with a basic understanding of each other's trades and their contributions to the industrial design engineering domain.
In this paper we describe the nature of the design projects in the IDE curriculum. Regarding the changing face we report some of the main trends that can be found in the recent curriculum changes. We also discuss some issues that are still under debate within the staff. Finally, we address the functioning of the design project education as a learning laboratory for staff as well as students.

2 DESIGN PROJECTS IN THE DELFT IDE CURRICULUM

An important objective of the IDE curriculum is to develop the student's ability to design and develop consumer- and professional products. A professional designer must have a sound knowledge of form giving, engineering, manufacturing, ergonomics, consumer behavior, etc., yet integrating this array of knowledge into designs for new products, can only be learned by doing. Therefore, from the first year on, IDE students take part in a series of design projects. This series forms the backbone of the IDE curriculum; theoretical and practical courses are grouped around the design exercises, providing the students with disciplinary knowledge, methods and skills.

The basic teaching philosophy of IDE Delft has always been that of experiential learning. Students learn to design by working on a series of realistic design problems. Initially the students follow a largely predefined design process, but gradually they are left free to make their own decisions on, tasks to perform, steps to be taken and methods and tools to apply. The design projects are concentrically structured, i.e. in principle every project addresses all major aspects of designing a product, yet projects increase in scope, depth and complexity over the years. Table 1 shows an overview of the present series of design projects in the curriculum.

Table 1: The principal characteristics of the six IDE design projects

Project	Phases	Focus	Work mode	Design task	Example
Design 1 Year 1 (240 hrs.)	All	Introduction to product design	Individual	Static, low complexity	Lamp, Display, Communication device
Design 2 Year 2 (180 hrs.)	Conceptual design, embodiment design	Understanding and practicing design methods	Individual	Mechanical, dynamic	Home trainer, Water play mobile
Design 3 Year 2 (180 hrs.)	Conceptual design, embodiment design	Ergonomics, semantics, sketching and modeling	Individual	Hand-held electronic tools or devices	Digital wallet, hand-held navigation system
Design 4 Year 3 (280 hrs.)	Detail design	Manufacturing and cost, working models, user testing	Individual - team	Electronic or pneumatic appliances	Button maker, toaster, foam cutter
Design 5 Year 3 (120 hrs.)	Product planning	New business development, sustainability, teamwork and communication	Team (role play)	Business case: Company with strategic gap in product portfolio	Bicycle appliance company, Food packaging and dispenser company, etc.
Design 6 Year 4 (400 hrs.)	Comprehensive, all phases	New business development through design for an actual company	Team	As in 5, but this time for a real company.	Shopping display, bicycles, strollers, etc.

Together the six design projects amount to 1400 hours. If we include the final degree project (1040 hrs.), the main body of IDE students spends some 35% of their total study time in practical design projects. This is less than in art-based architectural and industrial design education, but considerably more than in typical university level engineering design programs. Below, short descriptions of the six design projects are provided.

2.1 Design 1

The first year design project is an introduction into product design by means of a series of four assignments in which time and depth gradually increase. The first year design program has the following principal learning objectives: 1) Develop design ability; 2) Intensify the grip on the design process; and 3) Develop an individual design vision. The main teaching approaches are to integrate design methods into the project, and to supply the student with individual feedback/ assessment.

Supplying and practicing a broad array of design tools, such as creative problem solving, evaluation techniques, various types of models, visualizing, etc. provides the student with a sound base for developing a personal vision on design. Students examine design methods in theory, as well as attending weekly instructions and workshops. They

apply the methods in their design projects and get feedback right away. At the end of each project there is a plenary presentation.
Students start with a design problem that can be solved with skills and knowledge gathered from high school. For instance, the first assignment is to design a barbecue, to be built in our workplace and to be used by the designers themselves on a summer night. The final assignment requires much more integration of knowledge from related domains. One example is the design of a multi-media terminal, in which students need to consider issues like form, production, electronics, and ergonomics.

2.2 Design 2

The objectives of the course are to teach the students how to generate ideas, identify solution principles, generate concepts, and develop and elaborate concepts into a final design, with an emphasis on form, construction, ergonomics, usage and functionality. Additionally, Design 2 addresses the application and integration of methodological knowledge. Students are asked to reflect on their approach in conjunction with the studied and lectured design methods. Work is done primarily on an individual basis.
The project starts with asking the student to define an early design direction, by identifying the users, the environment the product is used in, and the product's key functions. This design direction is then formalized as a solid problem description, a collage and a set of design criteria. In this phase students use methods for structuring their thoughts, such as brainstorming and mind maps. Idea generation is supported by morphological analysis, and idea selection methods, leading to a first design concept. Each time a particular method is used students are asked to reflect immediately how they have experienced the method.
In the second phase a comprehensive list of requirements is set up through life cycle analysis. From this point on, students are urged to find their own strategy in further developing the product. Some design strategies -such as the ones identified by Dorst [1]- are pointed out in lectures, but the students have to find his own way through, and they are asked to reflect on their behavior.

2.3 Design 3

Design 3 focuses on elements like setting a design direction (product vision for a specific user group in a specific user environment or context), generating ideas, developing concepts and elaborating these into design proposals that can be produced. Students themselves are free to choose a user group and a context of product use. This freedom is provided in the exercise in order to help the students to develop their individual styles and preferences. An additional objective in Design 3 is to provide the students with experience in making 1:1 models.
The supporting method for the whole process in Design 3 is Muller's [2] 'Fish trap model', a step-by-step approach to form giving of products. The model starts with characterizing the product to be designed in terms of its desired semantic characteristics, like businesslike, fun, macho, and impressive. Then, semantic characteristics are translated into form characteristics, like type of geometry, colour, textures, and materials. Design alternatives are first generated on a 'topological' level (that results in structural concepts). The final step in the model is the development of alternatives on a 'typological' level (that results in concrete, material concepts).
In Design 3 mass-produced or series-produced handheld/portable device (wearable) are developed. An assignment always includes designing a plastic casing that contains electronic and electrical components. This type of products ideally suits the objective of making 1:1 models. An example is a 'Geocam' device for rescue workers (see figure 1)

-user group- in the mountains –environment of use-. As a special requirement, use with one gloved hand should be possible.

Figure 1: Model of a 'Geocam' device. Design: Stefan van Cleef, 2003.

2.4 Design 4

In this project students go through the length of a complete design process: they start with problem analysis and finish by producing a prototype and conducting user tests with that prototype. The way we organize the design process is strongly influenced by having this prototype at the end of the design course. User testing consists of interviewing users and monitoring their actual use of the prototype. The user response is monitored on video, see [3].

In this project we emphasize the phases of embodiment design and detail design, which means that students rapidly go through the early phases of the design process. During the conceptual phase students work primarily individually. In the second phase, students work in groups of approximately 5 students. Each group selects one conceptual design to further develop.

The assignment in this course concerns electrical powered products. An example assignment is a hot-wire foam cutter with a moving wire (see figure 2). To help students to manage the short time span, we prepare a detailed assignment and an almost ready-to-use design brief. Developing good assignments is critical: students need to be challenged to design new principles and new features, rather than to copy the mechatronics of a competing product, and merely design a new shape.

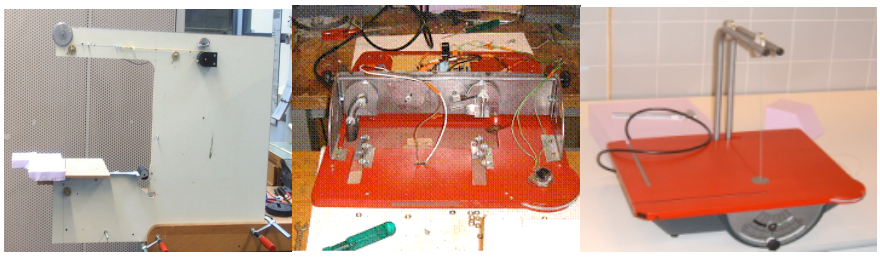

Figure 2: Left to right: Test model, Building the interior, Prototype ready to be tested

2.5 Design 5

Design 5 is aimed at the fuzzy front end of the product development process, with an additional focus on sustainable product development. In addition to design related objectives, explicit attention is given to teamwork issues, project management, presentation skills, and other aspects regarding product development within a business

context. Design 5 is the first time that students work in-depth on issues relating to strategic product design.
The project is part of a third-year cluster on business aspects in product development, together with a course on business aspects of product development and a course on marketing & consumer research. In close coordination, these courses provide the students with just-in-time knowledge on the aspects that are dealt with in the design project, see [4].
In Design 5 students and staff engage in a role-play activity. Using a case based on an existing company, students work as a design agency for a client. Teams consist of five students. One design teacher performs the role of client, while second design teacher functions as a coach. In a short trajectory, student teams start with building a long-term vision of the context of product use and end with a concrete new product business plan, based on a preliminary product design.
Rather than defining a specific product range, the exercise is built on cases from real companies with a need for innovation. An example of ca case dealt with is a bicycle accessory company In the cases, these companies share a gap in their product portfolios. It is up to the design teams to discover the gaps, to convince the client, and to search for substantial solutions.

2.6 Design 6

The project is intended to confront the students with daily practice in industry. It is a complete innovative product development process carried out in cooperation with an industrial company, starting with a strategic product plan for the company, resulting in a design assignment. The project groups have to develop their own ideas about which product they are going to design for the company. The design project concludes with making a prototype of the designed product and a plan for market introduction.
The students work in teams of 4 to 6 people. Each project team has two teachers: a ‘coach’ (the teacher personally involved) and a ‘detached critic’. The project groups have access to a studio with essential facilities.
In earlier design projects, the activity of new product development is trained within a given context. In contrast, at the start of Design 6, the context and the product (function) are unknown. Students must find a relation between a context and a product to design in that context. The students have to cope with this ‘fuzzy front end’ of product development, and with all related problems.
Unlike the first five design projects, in Design 6 no specific design methods are incorporated in the learning objectives. The presumption is that the students -at this point in their education- know the different models of the design process and can apply the regular design methods and techniques. The challenge for the students is to select the most fruitful method for the situation at hand.

3 THE CHANGING FACE

In the 40 years of product design education at the faculty of Industrial Design Engineering the curriculum has gone through many developments. Courses are never static; they are influenced by new knowledge on theory and teaching, and by operational and environmental influences.
We will first discuss some of the main trends that can be discerned in the changes in the design projects over the past decade. Then we will focus on some of the key issues that tend to dominate the discussion on design education. Rather than pretending that we fully agree as a staff, we think it is more interesting to show the issues that are under debate, the levels of agreement, and the various viewpoints that can be found.

When reflecting on the changes in the studio work, we can see the following trends, some of which may have causal relationships, or may even be conflicting:

3.1 Enhanced attention to developing a personal approach to design

As the Delft program has its roots in a technical university, a lot of focus has been put on teaching students to design in a structured manner, using clear methods and models of the design process. Delft has the reputation of delivering designers who are skilled, knowledgeable and thorough, but also tend to lack identity in their designing. Visionary new product ideas tend to come from art academy graduates rather than IDE graduates. An issue that needs to be mentioned in this regard is that Delft does not have special entry requirements for students beyond a certain level of secondary school education, especially in the sciences (which is a standard entry level for all technical universities in the Netherlands). This means that the school does not require the students to have a personal design philosophy or design vision at the outset of their education, unlike many other schools that have portfolio-based selection procedures. This makes it especially important to put emphasis on stimulating students to develop their personal identities as designers. As we realize once again, solely structured processes [5] do not produce good design. At least as important are the personal characteristics of the designer. Both in the academic staff [6] and in the student community there is renewed acknowledgement of the impact on the design results of the designer's personal qualities.

3.2 Shift from design as problem solving to design as reflective practice

Following the developments in design thinking research, also in design education we have moved from the more traditional problem solving [7] and 'systems engineering' approaches to describing design [8], to less procedural approaches, such as conjecture analysis [9] and reflective practice [10]. These alternative views on the design process do not replace the knowledge from the earlier models; rather, by highlighting different aspects of designing, they provide valuable additions for teaching design.

3.3 Emphasis on design as a social process, rather than an individual process

In Delft, after the second year, design education becomes largely team-oriented. In addition to rational issues of project-planning and –management, 'softer' issues, like team development and 'shared understanding' [11] become more important to address in order to make progress in designing. As a teaching staff, we spend more and more time dealing with teamwork related issues.

4 DISCUSSION

We consider design methodology as an indispensable and fruitful ingredient of a complex product development process. Design methods have to be taught, and need to be integrated in the design courses. The discussion is about the question when and how design theories are introduced in the courses.

One of the principal discussion topics for the Delft design teaching staff: is whether students should be provided with design methods within the context of the design exercise, or in a separate methods training activity, in which students go through the methods' procedures in isolation from a later design exercise. Different approaches can be found within the design projects. In the second year, two ends of the spectrum are represented. Once a course in training design methods, Design 2 has evolved into an integrated design exercise, where methods are applied and taught within a larger design project:

"In our experience, students appear to adapt theories and methods better when these methods help to solve what they see as their main problem: the design of a particular product. Lectures only do not create the insight, practicing in combination with reflecting does" (coordinator Design 2 project).

The other second-year course, Design 3, is much more focused on developing a personal approach to design, and indicates that design methods should be taught outside the context of the actual design exercise:

"In our opinion, the design project should be as free as possible, in order for students to learn to choose design tools and methods that work for them. In an ideal situation the methods applied in the courses are practiced in isolated assignments. In practice, however, there is too little time and space to work in that way" (co-coordinator Design 3 project).

We do not claim that there is a single 'best' approach to conducting a design education project. Different requirements based on learning objectives and pragmatic reasons provide strong differences in the design education curriculum. However, we do need to have some basic agreement on the learning model that underpins the design education curriculum. It can be fruitful to revisit Kolb's loop model of experiential learning [12], containing activities of reflecting on practical experience, theorizing, experimenting, and applying the new knowledge in new practical experience. If we strictly follow the experiential learning model, students should be provided with theory after they reflected on their design activity. Students experiment with this new outside of – and/or in parallel with- the context of the design exercise. In their practical design activity, students can then take more liberties in applying the new knowledge. Design 5 has largely relied on this model to integrate knowledge from theoretical courses and the design project [4]. The students' evaluations of this type of approach to design education are promising.

A second issue is whether one can teach methods without having previous design experience, or whether it is useful to ask students to design something without any knowledge of design methods. A shared opinion in this matter among the Delft staff is that when learning to design, it is essential for students to engage in an ongoing experimental learning cycle. Then it does not matter so much which activity the student commences with as a first entry point into the experiential learning cycle, be it practical experience (designing), abstract conceptualization (method learning), or experimenting (training methods outside of the context of the design project). Starting by reflecting is perhaps a less obvious entrance point into the design experiential learning cycle. However, even examples of this can be found in the Delft curriculum. For instance, at the very beginning of their studies, Delft students are asked to reflect on earlier experiences that may be considered analogies to design, such as, decorating a room planning a party, or preparing a fancy dinner.

5 FINAL REMARKS: THE CHANGING FACE OF DESIGN PROJECT EDUCATION FOR THE DESIGN TEACHER.

For the design teacher, the design projects provide a rich learning environment. For the staff members, especially mono-disciplinary research staff, teaching design projects provides opportunities to learn about different approaches to design from the other disciplines found in the faculty. The design projects also provide opportunities for development of our understanding of design education and didactics. In order to support this, we need to regard design education not only in terms of the experiential learning activities for the students, but also to regard design education as experiential learning activities for the staff. The design staff needs to be encouraged to reflect on their

practice and to think up new approaches of teaching and designing, and to actively experiment based on these new insights.
This would imply a change of the face of design education, from a designer production facility, towards a learning laboratory, in which both students and teachers actively pursue their experiential learning. We believe that this is the next step to take, in order to enhance the quality of design education, both for the students and the staff. In future research we will explore such a learning laboratory approach to design education.

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