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DESIGN AS A SOCIAL ACTIVITY AND STUDENTS' CONCEPT OF DESIGN

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ABSTRACT
A design and product realization program was started at KTH in Stockholm in the second semester of 2003 and more than 100 students enrolled for the course. This paper presents the experience gained from the first semester of the program-specific course "Perspectives on design and product realization."
The planning and realization of the course drew on the general view that design engineering is a social activity, and so focused on teamwork, collaboration, openness, and interest. The students' project involved a high degree of synthesis, and produced very good results.
A study of the students' concept of design revealed that they regard it as mainly concerned with aesthetics. It also revealed that a majority of them accept and embrace the idea of becoming a design engineer. However, they want a substantial part of their education to deal with aesthetics, art fundamentals, sketching, and the like.

Keywords: collaboration, design, education, social activity, definition of design

1 DESIGN AND PRODUCT REALIZATION AT KTH

In September 2003, a new Master of Science program in Design and Product Realization (DoP) was introduced at the Royal Institute of Technology (KTH) in Stockholm, Sweden. The program attracted a large number of applicants, from which 250 chose DoP as a first preference. It ranked as the third most popular of the 15 engineering programs offered at KTH, and for the first year 106 students were accepted
The DoP program is offered within the KTH School of Mechanical and Materials Engineering by the departments of Machine Design and Industrial Production [1]. The 106 students were divided into four classes, with a maximum of 28 students in one class. All modules, except for occasional lectures, were taught in parallel in the four classes.
The curriculum for the first semester of the program comprised a basic course in mathematics, a basic course in physics, and the course Perspective on Design and Product Realization, hereafter referred to as the first DoP course.
In this paper we present some experiences from the course in Design and Product Realization and some results from a study of the students' conception of design.

1.1 The course Perspective in Design and Product Realization

The general goal of the first DoP course was to give the students some perspective on design and product realization and on how engineers in that area are working in different companies. Some basic design activities were carried out, as well as some

more rigorous tasks such as learning to use CAD software. The activities in the course were presented in the following order:

1. **Sketching and visual thinking:** The course began with an intensive module involving drawing from live nude models, study of anatomy, rapid sketching, portrait work, and sculpting in Styrofoam, plaster, etc.
2. **Analysis project:** For the analysis project, the students were divided into teams of three. Each team was assigned a company and a product or system to analyze. Each team undertook an intensive study of their product/system and visited the assigned company to analyze its design process. This project took one month to complete.
3. **CAD:** Students were introduced to computer-aided design using Solid Edge, with which the students practiced 3D modeling, assembly, animation, and rendering.
4. **Synthesis project:** This creative project will be described later in this paper. All the other modules in the introductory course were seen as supporting this project, which took two months to complete.
5. **Matlab:** An introduction to Matlab is a required component of all introductory courses at this faculty.

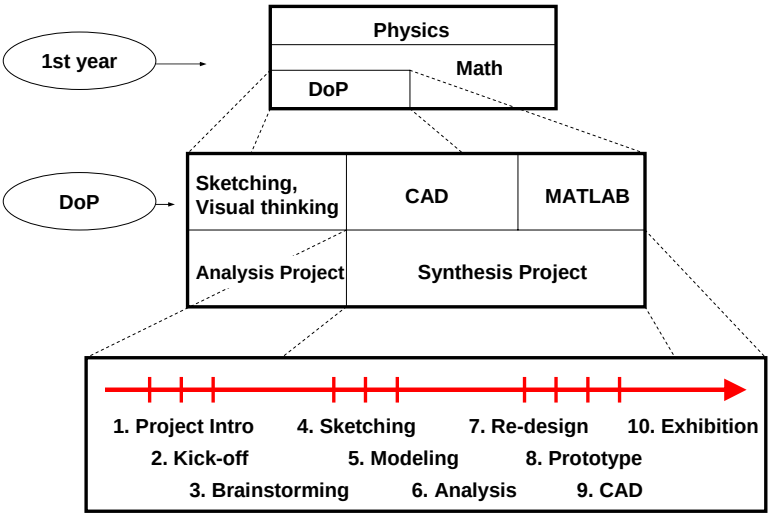

Figure 1. The first year of the DoP program

2 DESIGN AS A SOCIAL ACTIVITY

2.1 The DoP Synthesis project

The purpose of the synthesis project was to introduce the students to their future professional role as design engineers. The project spanned two months, corresponding to 15% of the entire curriculum during the first semester. The primary aim was to teach design methodology and to enable the students to practice and improve teamwork skills. The four classes were each divided into four teams with six to seven students. Each class was assigned one faculty member. The students were assigned individual roles such as project leader, student responsible for external contacts, student responsible for

documentation, etc. Each team was assigned the task of designing an innovative product that satisfied a particular need specified by the faculty.
The synthesis project was divided into three phases:

Phase 1 – Kick-off and brainstorming: The synthesis project was introduced to the students with a 36-hour kick-off activity. Each class traveled by bus to the town of Falun 225 km away. There they visited industries and formed project teams. Each team was assigned a project and team-building activities were conducted. During the rest of this phase, the students performed brainstorming activities, information searches, background studies, etc. The team spaces were also organized, with each team being assigned a workplace in one of the four DoP labs.

Phase 2 – Concept and detailed design: During the second phase, the students worked simultaneously on three different concepts, each derived from the brainstorming sessions. Each concept was designed in detail, taking into account both shape and functionality. At the end of this phase, the three concepts were presented in the form of sketches, drawings, Styrofoam models, and functional prototypes in wood, metal, paper, and the like. Each team presented their three concepts to the other three teams and the faculty member, who assisted in the selection of one final concept.

Phase 3 – Final design, documentation, and presentation: In the third phase, the students simultaneously produced the final design of the chosen concept, created a functional prototype, modeled the solution in a 3D-CAD tool and created detailed drawings, specified the manufacturing process, and prepared the final presentation in the form of a written report, a presentation, a poster, and a display to be placed in the exhibition hall.

Each individual student was at some point responsible for the team or for a sub-team. All responsibilities were assigned by the faculty member.

2.2 The Design Labs

Each class was assigned a design lab with facilities for studying, socializing spaces, cooking facilities, equipment for prototype manufacturing, etc. The setup of the design lab varied according to the activity, but the default setup had four team areas, a social area, a mini-kitchen and a teaching area.
The labs were used by students approximately from 8 am to 10 pm each day, Monday to Friday, as well as every weekend for the last month of the course. The activities in the labs were related both to the concurrent basic courses in mathematics and physics and to the synthesis project. A considerable amount of time was, however, spent socializing: lunches were prepared in the labs, parties were held there, and basically all breaks were spent there. The faculty had originally intended the labs to be primarily educational spaces, but they responded positively to the actual use being made of them by the students.
Throughout the entire course, and in particular during the synthesis project, the students spent the majority of their time at KTH in the design labs. Consequently they were constantly exposed to the design environment and in close contact with the other team members and the faculty members.

2.3 The synthesis project as a social activity

Teaching design as a social activity implies a need for collaboration. This collaboration manifests itself in three ways: 1) teamwork between students and faculty, and between the university and industry or society; 2) openness toward other students, the university, and society; and 3) interest from all participants [2, 3, 4].

In the synthesis project, these three aspects were approached in the following ways (the number in parentheses indicates which particular aspect is being addressed):

a. The student teams consisted of six to seven students, which is highly unusual for a first-year course (1).
b. The students had constant access to individual work places, socializing spaces, and a team space (1).
c. During the introductory weeks at KTH, senior students helped to create a homogenous group within each class. All students were part of this social group at the start of the course (1).
d. All students visited several industries during the course (1, 2).
e. The teaching staff was highly motivated (1, 3).
f. At the end of the synthesis project, all teams presented their results in the form of an exhibition that was visited by parents, KTH staff, students from outside the DoP program, and the media. Photos and articles later appeared in two of Sweden's largest newspapers (2, 3).

2.4 Summarizing design as a social activity

During the course, the students produced impressive work, particularly in the synthesis project, despite most of them having no previous experience of design activities and limited technical knowledge. It appears that these results were positively influenced by the social activities within each class and lab, as well as by the approach to teaching design as a social activity.

3 STUDENTS' CONCEPT OF DESIGN

3.1 Design in Sweden

In Swedish, the term *design* (written and pronounced as in English) is most commonly understood solely in terms of aesthetic values such as shape and appearance. It is not used when referring to functionality. Thus industrial design, both as programs at universities and as a profession, relates primarily to an aesthetic education, even if it does encompass areas such as ergonomics and aerodynamics. Education for industrial design in Sweden is normally not an education in engineering. This is also apparent from the fact that the Swedish translation of 'engineering design' is *produktutveckling* or *konstruktion*, with no reference to the word 'design'.

However, in recent years the concept of *design* has been introduced in an engineering context in Sweden in the form of new engineering programs such as the DoP program. Similar programs are offered at other technical universities. The intention is to introduce this area as Design Engineering, not to be confused with Engineering Design.

In this paper, we are not setting out to define the concept of design engineering, either in terms of how it is envisaged by KTH or by the faculty. Our intention is only to investigate the students' concept of design. All references to design in what follows should therefore be seen as the students' own definitions of the concept.

3.2 The students' definition of the concept of design

During the first semester a reference group of 26 students were interviewed, primarily to identify their definition of the concept of design and the reasoning behind their choice of educational program.

All students were asked to define design. The statements made by four randomly chosen students are presented below.

1. Design is about aesthetic pleasure. Design has nothing to do with functionality.
2. Design is about appearance. At KTH, however, they also define design as product development.
3. Design is shape, appearance, color, etc.
4. Design at KTH is similar to industrial design, with aesthetics and product development.

3.3 Relation between engineering and design based on the students' definition of the concept of design

The students were next asked to quantify how much of their own education they would like to focus on design as they had defined it. This choice was presented in a questionnaire on which students were asked to identify their preference on a scale between two extremes, defined as follows:

1. Engineering, defined as mathematics, physics, mechanics, mechanical engineering, industrial production, environmental protection, etc.
2. Design, defined as sketching, visual thinking, theoretical and applied aesthetics, interaction of color, perception, etc.

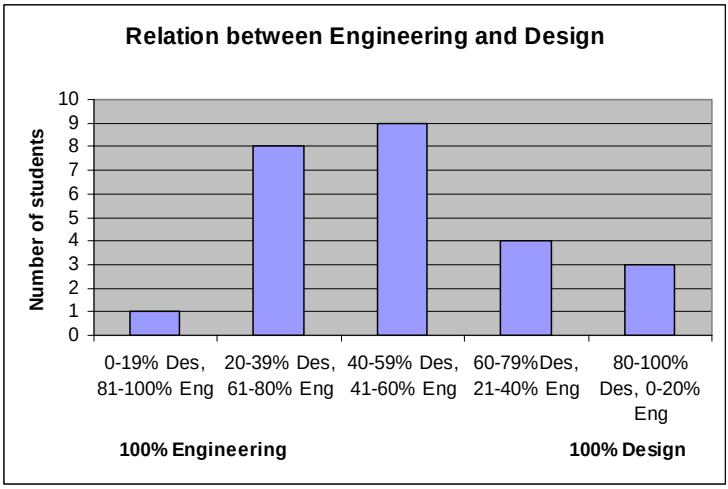

Figure 2. Students' preferred division between engineering-related areas of study and design-related areas (according to the students' own definitions of design)

The students' answers are shown in Figure 2. From this data, it can be concluded that 96% of the students would prefer at least 20% of their education to focus on design-

related areas as defined above, and that 56% of them would prefer at least 50% of their education to be design-related.

3.4 Relation between engineering and design based on the students' definition of the educational program

On the basis of the results from the previous questionnaire, a different approach was adopted. The students were asked to choose which of the following three professional titles they would prefer to hold after completing their education:

1. Mechanical Engineer, that is, someone who is as competent in engineering as a graduate from a mechanical engineering or similar program, but who has taken 2 or 3 courses in design-related areas.
2. Design Engineer. A person who has taken some courses in mechanical engineering, production, mathematics, and physics, but who primarily is a design engineer.
3. Industrial Designer.

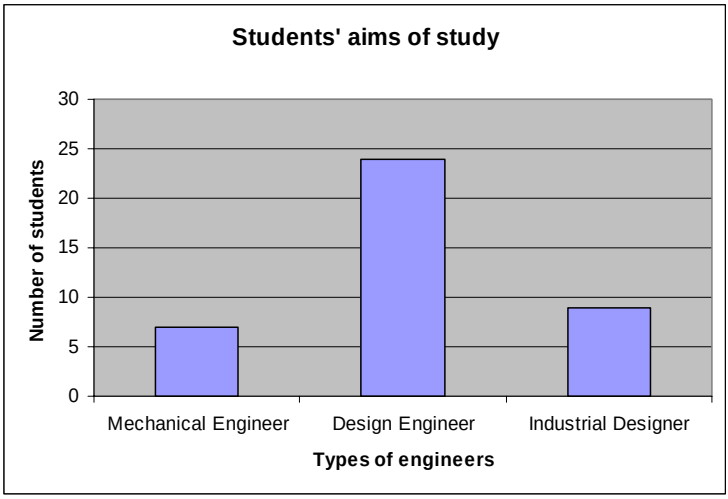

Figure 3. Students' preferred choice of professional title as graduates

According to Figure 3, the majority of students preferred the idea of becoming a design engineer, even though the questionnaire implied that such an engineer would have fewer courses in traditional engineering subjects than a typical mechanical engineer. The students preferred to decrease the number of traditional subjects in favor of design-related courses.

3.5 Relation between Engineering and Design based on the students' preliminary choice of master's programs

A third study was undertaken to further illustrate the relation between design and engineering. The students were asked on two different occasions to make a preliminary choice between four possible master's programs related to the DoP program. The first preliminary choice was taken on the first day of the first semester, before any

information had been given about the master's programs. The second choice was made ten days later, after a brief introduction to the four possible master's programs.

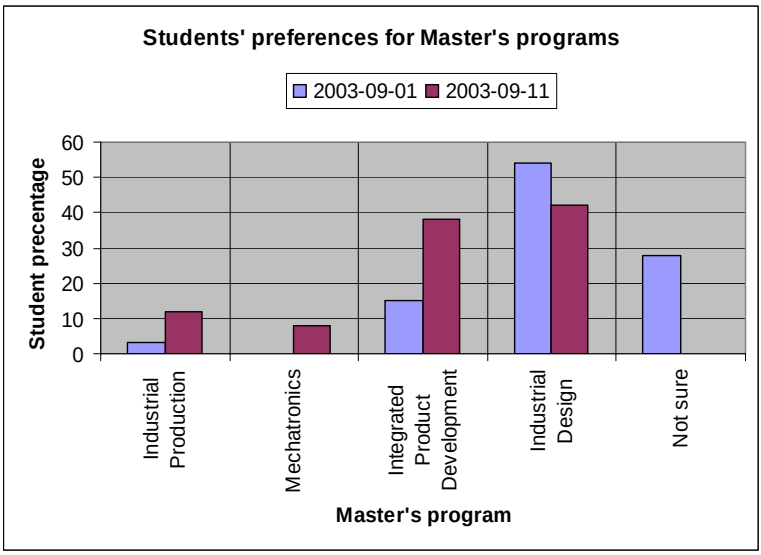

Figure 4. Students' preliminary choices of master's programs

Of the four master's programs, Industrial Production and Mechatronics do not include any courses or aspects that relate to the areas defined as design by the students. Only a minority of the students chose these two programs (5 out of the 26 in the second questionnaire).

3.6 Summarizing students' concept of design

Twenty-six of the 106 students accepted for the program have a definition of design that is not directly compatible with the internationally established disciplines of either engineering design or design engineering. Most students define industrial design as involving theoretical and applied aesthetics, and 56% of the students would have preferred that at least 50% of the program cover aesthetic areas. In the second study, however, the majority of the students did not want to become industrial designers but rather design engineers, which rather contradicts the findings of the first study. However, it can be concluded that the students would prefer to study more design-related areas, but have decided to become design engineers for other reasons. When choosing a master's program, the majority of the students are equally divided between an industrial design master's program and a master's program in integrated product development, which further points toward the students' reluctance to choose between design and engineering. They want to study both, and are willing to reduce their study of engineering areas in favor of aesthetic subjects.

4 CONCLUSIONS

This paper presents the results from two studies undertaken during the first year of teaching design and product realization at KTH. These studies focused on design as a social activity and on students' understanding of the concept of design.

The projects presented by the students at the end of the course were impressive. Although, most students had no experience of design activities and limited technical knowledge, the results were nearly as good as would have been expected from students who had spent several years in an engineering program. Our analysis indicates that the results were positively influenced by the social activities within each class and within the labs. We therefore strongly believe that treating design as a social activity is an important success factor, in combination with education in a professional practice.
The following conclusions were drawn regarding the students' concept of design. The majority of them considered design and product realization as a combination of industrial design, product development, and production. Generally, they liked the idea of being design engineers, the title which we believe will become the accepted one for engineers who have studied Design and Product Realization at KTH. However, not all students saw the program in this way. A minority of them would have preferred an education in industrial design. These students described themselves primarily as wanting to become designers, and not necessarily engineers. This group seems to define design as industrial design and has some difficulty in seeing the potential of combining design and product realization.

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