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'CREATE THE FUTURE': AN ENVIRONMENT FOR EXCELLENCE IN TEACHING FUTURE-ORIENTED INDUSTRIAL DESIGN ENGINEERING

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ABSTRACT

In 2001, the University of Twente started a new course on Industrial Design Engineering. This paper describes the insights that have been employed in developing the curriculum, and in developing the environment in which the educational activities are facilitated.

The University of Twente has a broad experience with project-oriented education [1], and because one of the goals of the curriculum is to get the students acquainted with working methods as employed in e.g. design bureaus, this project-oriented approach has been used as the basis for the new course. In everyday practice, this implies a number of prerequisites to be imposed on the learning environment: instead of focusing on the sheer transfer of information, this environment must allow the students to imbibe the knowledge and competences that make them better designers. Consequently, a much more flexible environment has to be created, in which working as a team becomes habitual, and where cutting-edge technologies are available to facilitate the process. This can be realized because every student owns a laptop, with all relevant software and a full-grown course management system within reach. Moreover, the learning environment provides the fastest possible wireless network and Internet access available [2].

This obviously has its repercussions on the way the education is organized. On the one hand, e.g. virtual reality tools, CAD software and 3D printing are addressed in the curriculum, whereas on the other hand more traditional techniques (like sketching and model making) are conveyed explicitly as well. Together with a sound footing in basic disciplines ranging from mathematics to design history, this course offers the students a profound education in Industrial Design Engineering.

The paper describes in more detail the curriculum and the education environment, based on which it is assessed if the course on Industrial Design Engineering can live up to its motto: 'Create the future', and what can be done to further enable the students to acquire the full denotation of that motto.

Keywords: project oriented education, digital learning environment, future studies

1 INTRODUCTION

The first educational programs on industrial design in the Netherlands were either offsprings from the architecture departments of existing (polytechnic) academies or from art academies. Their primal focus was mainly on the aesthetic aspects of design.

Over the years the scope has changed to product design in general, as a result of which the curriculum became more technical. Now Dutch design is internationally renowned and many students feel attracted to the design profession. However, most schools teaching industrial design were, until a few years ago, of sub-academic level. There is a change in the character of Dutch industry – simpler manufacturing activities are increasingly being outsourced to low wage countries and are gradually replaced by high-tech products. The need for engineers who are capable of designing high-tech products and of managing product processes is growing. Therefore, in 2001 the University of Twente started with a new course on Industrial Design Engineering. The curriculum contains elements stemming from different technical disciplines such as mechanical engineering, electrical engineering and software design, as well as from social and commercial sciences like marketing, ergonomics and psychology [3]. It contains an academic basis for the acquisition of knowledge that is required to solve specific design problems; and it contains tools for trend extrapolation and the development of future scenarios. The industrial design engineer that has finished his studies at the University of Twente is able to 'Create the Future', either as an employee within a company or as a consultant from outside the company. He is capable of creating – in the sense of developing, designing and engineering – future products that go far beyond the re-styling of existing products.

2 THE INDUSTRIAL DESIGN ENGINEERING CURRICULUM

2.1 Project-oriented education in engineering

In 1994 the Department of Mechanical Engineering of the University of Twente changed its education concept by introducing a project-oriented curriculum for the basic part of the program. Where the focus of conventional education programs was on the delivery of theory, project-oriented education focused more explicitly on the development of the students and their competencies by placing the students in a realistic engineering environment. Moreover, it was expected that this approach would contribute to the motivation and the learning attitude of the students. Research in education science [4] shows that the number of drop-outs who discontinue their studies due to lack of effort and motivation exceed the number of drop-outs who lack the capabilities. So a teaching and learning concept that stimulates the engagement, self-activity, self-confidence and self-knowledge and through this the motivation of the students, is highly important. The goals of the project-oriented education in Twente can be summarized as follows:

- To make the relationship between the several fundamental science and engineering disciplines, as well as the coherence between the various parts of the study program, more transparent;
- To stimulate the motivation, engagement, self-activity, self-awareness and the team spirit of the students;
- To train the students in an early stage of the education program in project management skills like team work, allocation of tasks and time, communication and negotiation skills, the scheduling of control of a project, the oral and written presentation of results, etc.

2.2 Evaluation of the curriculum in 2001

After the introduction of the project-oriented curriculum the new program was evaluated extensively over a couple of years and compared with the old traditional education program before 1994. The most important results can be summarized as follows [5]:

- The students were enthusiastic and well-motivated; they work harder: the average numbers of study hours weekly spend increased from 32 hours to over 40 hours in the project-oriented curriculum;
- The improvement of student progression and learning results after one year of study time in the new curriculum was evident, but had a big variance. In 1993/94 (the last year of the old curriculum) 17% of the starting students did finish the first year exactly in the nominal tempo (obtaining all the necessary study points) and in the project-oriented program it varied between 25% en 40%.
- The improvement of student progression over a three year term of the program was even more significant. After the introduction of the project-oriented education program the percentage of the students that obtained at least 80% of the total number of study points had more than doubled;
- Drop-outs were leaving the university considerably earlier than in the past; so the selection mechanism of the new program was more effective.
- A project-oriented block-wise structured curriculum proved to be somewhat inflexible, for instance if a student is becoming ill or makes a conscious choice for a part time study load.

2.3 One room concept

The Twente educational concept on Industrial Design Engineering is based on the experiences with this project-oriented concept. However there are two major differences.

Firstly the students of an educational year spend most of their study time in one large room instead of in the much smaller project rooms that are used for Mechanical Engineering. These rooms can accommodate up to 100 students. The concept is to create a multi-functional facility that can be reconfigured from classroom to project room to exposition facility and vice versa. Tables that can easily be moved accommodate groups of eight students; movable partitions can be used to separate groups. With project work or exercises, such as concept drawing, sketching, product presentation drawing or elementary composition, the group is split up. Sometimes these courses are given simultaneously in separate rooms, sometimes in sequence in their own room. Even within the large groups – when the group is not split up – interaction between students and teachers can be maintained. All Industrial Design Engineering students use laptop computers connected to a wireless network. Lecturers can employ projections on a big screen, computer presentations can be combined with annotations using a stylus on a graphics tablet, and students can answer questions from the lecturer via their laptop. The correct answer can be projected on the screen as well as e.g. the percentage of students that gave the correct answer, or the range of the answers that were handed in. Because it is important that Industrial Design Engineering students learn to develop both their manual skills and their computer skills, they have to do their project partially by hand (e.g. sketching and elementary composition) and partially using computer tools. For the first type of skill they can use a studio with e.g. foam

cutting devices and hand tools. For metalworking, or the building of large physical prototypes, they can use the workshops of the Faculty of Engineering Technology that hosts a.o. the Industrial Design Engineering course. Students can use their laptops, in combination with a 3D printer for the creation of small physical models. For virtual prototyping, a lab with advanced virtual reality equipment like haptic devices and large immersive stereo displays is available.
Secondly the staff members act more as clients – and the student groups as design bureaus – than as teachers. The student groups have to search their own information sources, although a considerable part of the needed information is brought to them by 'just in time teaching'. The advantage of these changes in comparison to the curriculum of Mechanical Engineering is that the students tend to become more professional, more active and more future oriented.

2.4 The bachelors program

The Twente curriculum consists of a mix of project work, lectures and exercises. The traditional scheme of lectures in the morning and practical work in the afternoon has been abandoned. In principle all activities take place on the Industrial Design Engineering floor. However, scheduled courses that are shared with students from other educational programs (like mathematics), are given at other locations. Typical for Industrial Design Engineering is the mix of short lectures and project work. The students can just turn their chairs to the screen and some 20 or 30 minutes later they are working on their project again, while the teachers are giving detailed explanations to groups or individuals. Project results are assessed both on a group result as well on an individual basis. For the theoretical subjects, students take traditional examinations.

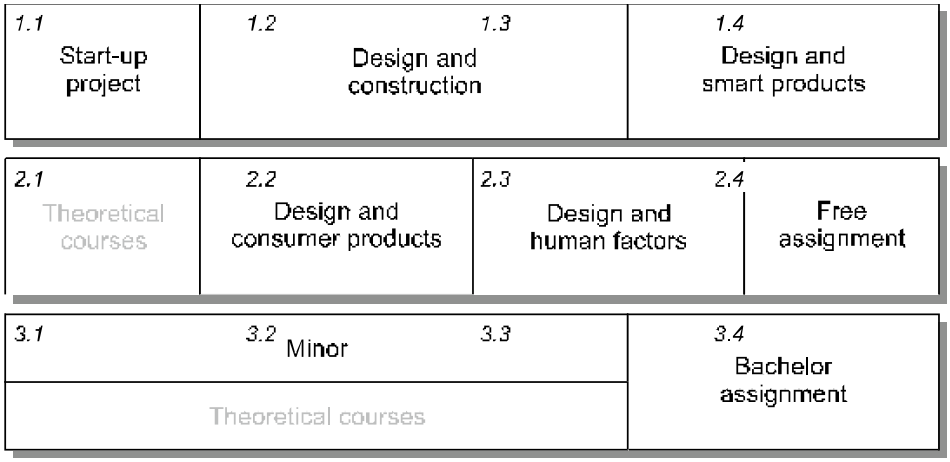

Figure 1: Outline of the bachelors program

In the first year of the bachelors program the students start with a short project of five weeks to get acquainted with the profession of industrial designer. They design and produce a product like a small stove for backpackers or a pizza oven for use on a camp site. A product presentation, including the motivations for the design decisions and a functional test at the end of the project are part of the assessment. It is remarkable that already in this first project several of the available software packages are used by the students without them being given any formal instructions [3].

The next project is aimed at construction and the use of materials. This 20-week project covers the design and manufacturing of a prototype in much detail. Nearly every aspect of industrial design is introduced and explained. Ample time is spent on practicing drawing techniques and on supporting theoretical subjects like statics, strength and stiffness, choice of materials and production techniques.
The third project is addressing smart products. Many products contain sensors, actuators and control units. It is not sensible to require that all theoretical knowledge like complex function theory, differential equations and control theory should be studied in depth before the students can be confronted with mechatronics. Therefore, the approach is actually opposite. By investigating a quite complicated consumer product students get insight in the layered architecture of the software and the use of sensors and servo systems. Based on this experience they will practice building controlled devices with simple toolkits like Lego Mindstorms and computer based measuring equipment like Labview.
The paradigm of this approach is that decomposition of apparently complex systems must be done in such a way that students experience the need for fundamental understanding of the underlying principles, not the other way around.
The second year of the bachelors curriculum starts with a period dealing with design methods and principles, physical principles and with the relation between art and industrial design. Then two fourteen weeks periods follow in which two projects are carried out. One in the field of a typical mass produced consumer project with injection molded parts and the other dealing with the design of a product for a specific target group. The projects are supported by courses in statistics, marketing, legal aspects, styling, human factors and CAD/CAM. The second year ends with a free individual assignment. In this assignment the students formulate, plan and execute their own project. The only limitation is that the project has to be approved by the staff of the Industrial Design Engineering course.
In the third year the program is more individual. The University of Twente uses a major-minor concept, which allows the students to follow a second line of interest during the first half year. In parallel to the minor the students follow courses on topics like philosophy of technology, psychology, business economics, systems engineering and dynamics. In the last trimester the students have to do a bachelors assignment and an accompanying course on research methodology. They may choose to do this in a company.

2.5 The masters program

After the bachelors program students can decide to continue their studies in one of the four masters tracks at the University of Twente:

- Design and Styling
- Management of Product Development
- Biomedical Product Development
- Smart Environment

In figure 2 the masters program for the track Design and Styling is depicted. The year is divided into four quarts. As an example, if a student chooses the track Design and Styling he has seven or eight obligatory courses in the first year. The rest he can choose in consultation with the responsible professor. In the first quart of the second year he has one obligatory course - in the case of Design and Styling this is 'Create the

future/Future studies' - and he can choose one course. Usually this course is related to his subject for the MSc. Assignment. The rest of the second year of the masters program is completely dedicated to the MSc. Assignment, which can be done either in a company or at the University.

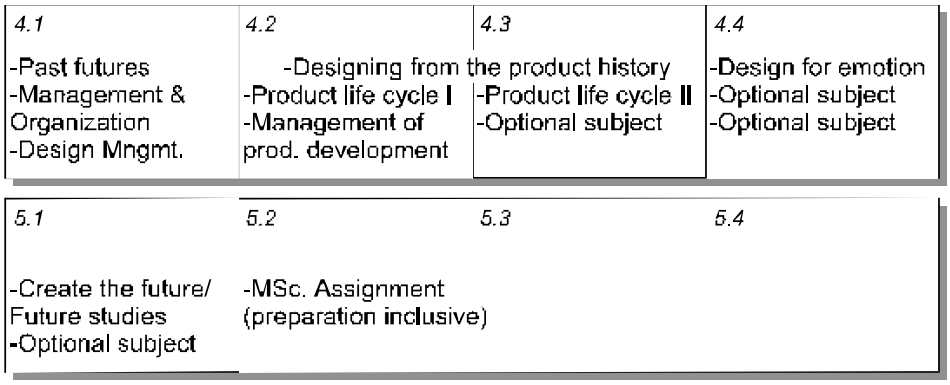

Figure 2: Outline of the masters-track 'Design & Styling'

3. CREATE THE FUTURE

As mentioned before, the industrial design engineer from Twente should be able to create the future. The aim is to confront the students with intriguing and realistic problems for which they need to acquire additional knowledge. Within the Twente curriculum several aspects are incorporated that should make the students extra critical on the formulation of projects, stimulate them to go 'one step beyond'. Create the future means that the industrial design engineer from Twente is able to formulate a new, innovative product strategy for a company. This means that he:

- thinks about projects in a critical manner and does not take the supplied problems for granted;
- is capable of formulating, planning and executing a project on his own;
- is capable of developing new ideas and bringing these to realization.

Throughout the course in Twente the students are challenged to develop these skills. Below a few examples are described.
In the second year of the bachelors program the students were confronted with the question to combine a remote control with a mobile phone. Nearly all groups discovered the conflict between the mobile phone, which is a personal product and the remote control, being a kind of group product. Only a few groups went to their tutor to ask for reformulation of the assignment. A request that was granted. After this project most students became a lot more critical with respect to the formulation of an assignment.
At the end of the second year (still of the bachelors program) the students have to formulate their own 'free individual assignment'. For some students this was a nearly impossible task. Others were very creative and came up with such interesting projects that the Dutch design magazine Product was willing to publish them. Two examples: one student designed five coffee machines based on the styling of science fiction movies. She analyzed the styling in the movie and, using the style elements, designed a

coffee machine that would fit in that particular movie [6]. Another student studied the phenomena of Dutch Wax. A Dutch company designs, produces and exports with very much success fabric to Ghana under the brand name Dutch Wax [7].
In the third year, about twenty students took an optional course in design and styling: designing for the label 'do'. Do is a brand that offers an antidote to the one-way world we live in. Do starts with a simple proposition: change the conventions of brands. Most brands start by creating products or services, they much later develop a brand personality. Do turns this around by creating the brand mentality first. After do explains its mentality, it can make products that fit within this mentality. Do believes it's more interesting to engage a user in a multiple-way relationship with a brand. A do-er, quite simply, has to do something to make a do-product work. By adding her or his own interpretation, a do-er is an integral part of a product, and therefore of the brand [8]. The students had to develop a new product that suited this label 'do'. Part of the course were workshops to get to know the label (the workshop 'do together'), a workshop on creativity (Synectics) and workshops on the design of concepts and story boards and on the building of prototypes. The students came up with very innovative ideas that suit the label well. One group created a flexible lamp (do knead) that the owner can form to his own taste. Another group studied ceramics and developed a cup that can be personalized (do grab) by putting one's fingerprints in it.
In the masters program (figure 2) there are some courses that concentrate more directly on the subject of 'creating the future'. ‘Past futures’ tells about past ideas on the future of industrial design. 'Designing from the product history' aims at teaching the students how to use the history of a product to design a new innovative product concept. In 'future studies' the students learn how to write scenarios for the future.

4 CONCLUDING REMARKS

As mentioned, the curriculum in Industrial Design Engineering started in 2001. Although the experiences with this course are therefore not very extensive, some first conclusions for the program can already be drawn.
The format of the curriculum and the educational facilities can be considered to be successful; the students are motivated by the challenges imposed by the project oriented way of working. Both students and teaching staff are very enthusiastic in the execution and accompanying of the projects. The high content of project (related) work and the fact that other courses are – where possible – related to the project, stimulates the students to spend much time on their study.

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