EMERGING TECHNOLOGY DESIGN

A new master course aimed at bringing emerging technologies its break through applications

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ABSTRACT

In 2001 the University of Twente started a course on Industrial Design Engineering. In 2004 the first group of students obtained their bachelor degree and started with one of the two then available subsequent master courses:

- Design & Styling
- Management of Product Development

This paper describes the insights that have been employed in developing the curriculum of a third course that will start in 2005, and that is called 'Emerging Technology Design'. Many new products are the result of what is often called 'technology push', the result of new techniques, new materials or new methods. Within the University of Twente a lot of research, both fundamental and applied, is carried out. Too often it happens that the results of this research remain in a theoretical phase and don't find their way to the industry because they lack a "break through application". The master course Emerging Technology Design teaches students of Industrial Design Engineering to introduce in the market of consumer products a new technology that was developed in one of the faculties of the University of Twente in a two years course. In the first year they study – next to a program of industrial design subjects – methods of innovation research and market research, and the new technology they have chosen. In the second year, after they have succeeded in tracing a possible break through, they finish the course with the design and engineering of a new product. The intention is that they finish the course within a company that is interested in the new product. The paper describes in more detail the curriculum and the education environment.

Keywords: design curriculum development, new materials and new technologies in design, interdisciplinarity, industrial collaboration and working with industry.

1 INTRODUCTION

The Twente curriculum Industrial Design Engineering 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. 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 [1].

2 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. 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. The software packages are installed on the laptop each student has to buy (for a reduced price) at the start of the curriculum. Thanks to the wireless network the students can use the laptop and communicate with colleagues at any location on the campus of the University Twente. 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. The third project is addressing smart products.

The second year of the bachelor's 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 second year ends with a free individual assignment. In this assignment the students formulate, plan and execute their own project.

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 the bachelor assignment in a company.

3 THE MASTERS PROGRAM

After the bachelor program students can decide to continue their study in one of the three master tracks at the University of Twente:

- Design & Styling
- Management of Product Development
- Emerging Technology Design

Design & Styling and Management of Product Development are well known specializations in Industrial Design Engineering. In this paper we will further explore the different approach we use in the track Emerging Technology Design. In the next two paragraphs we will first explain why this specialization was chosen.

3.1 Competences of designers

In 1995 a study was carried out with regards to the question how industrial design engineers fared after graduation [2]. One of the questions that was researched and answered in this thesis was: by whom and how have the competences of industrial design engineers been put into use. From the interviewed designers that considered themselves to be working in product development, 32% claimed to work as industrial design engineer, 30% said to work as manager of product development and 38% either as consultant or in R&D.

3.2 Core features

Nigel Cross [3] describes eight core features of design ability. Designers:

- produce novel, unexpected solutions,
- tolerate uncertainty, working with incomplete information,
- apply imagination and constructive forethought in practical problems,
- use drawings and other modeling media as means of problem solving,
- resolve ill-defined problems,
- adopt solution-focusing strategies,
- employ abductive/productive/appositional thinking,
- use non-verbal, graphic/spatial modeling media.

Most of these abilities appear to be closer to inventing than to industrial design engineering or styling. The activities of some industrial design engineers in the research from De Wilde [2] seem to be closer to inventing as well. It is therefore that, besides the two more traditional master tracks "Design & Styling" and "Management of Product Development" a third master track was developed at the University of Twente: "Emerging Technology Design".

3.3 Emerging Technology Design

The students that choose the master track Emerging Technology Design like to:

- understand applicability and constraints of new technologies,
- explore applicability of (new) technologies on markets of existing products,
- explore applicability of (new) technologies on markets for new products,
- design for new technologies; modify technology for new design,
- define product and/or technology requirements,
- communicate with researchers, manufacturers and customers.

Table 1. Outline of the master track Emerging Technology Design

4.1 • Past Futures • Design management • Innovation methodology	4.2 • Product life cycle 1 • ETD 1 • Optional subject	4.3 • Product life cycle 2 • ETD 2 • Optional subject	4.4 • Scenario Based Product Design • ETD 3 • Optional subject
5.1 • Create the future/ Future studies • ETD 4	5.2 MSc. Assignment	5.3 MSc. Assignment	5.4 MSc. Assignment

The students share about 30% (35EC) of their courses with the other two master tracks. One course - Innovation methodology - was especially developed for this track. In this course the students learn how to search for new markets or how to use a SWOT analysis for new opportunities. They have to learn that in looking for opportunities, weaknesses of a product or material can create new opportunities. To give an example: when looking for new possibilities for a heat resistant ceramic material the porosity of the material was considered to be a weakness. During a brainstorm session a member of the innovation group suggested to consider it as strength. This lead to research in sewage plants where the material could be used for bacterial growth (to clean the water). Four courses, Emerging Technology Design 1, 2, 3 and 4, offer the student the opportunity to further investigate the materials and techniques that he (or she) will develop in his master assignment in the second year of his master studies. Table 1 gives an outline of the program of the master track Emerging Technology Design.

3.4 Examples of master assignments

3.4.1 Hydroforming in consumer products

In the automotive industry, hydroforming of tube metal has been introduced over the last decade. With this technique it is possible to achieve tubular shapes that can not be made with ordinary bending techniques. Lightweight, yet stiff and strong, space frames as presented in Figure 1 were developed. The freedom in shape is well demonstrated in

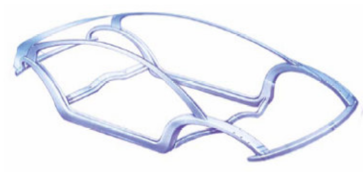

Figure 1: Hydroformed automotive space frame

Figure 2. By axial compression and internal pressure a bulge can be formed, of which the shape depends on an external die. The flexibility of the manufacturing method is also used for creating table legs of modern office furniture.

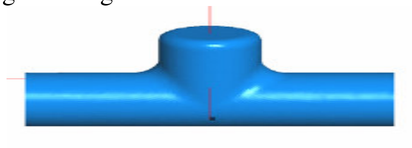

Figure 2. Hydroformed T-piece

The assignment consists of an investigation into the applicability of hydroforming in other products. New applications can be found by substituting existing parts by hydroformed parts, reducing costs, or by creating new parts that can not be made economically at all without this process.

3.4.2 Design for Friction Stir Welding

Recently, a new welding process has been discovered, that facilitates welding of aluminum and other materials in the solid state instead of in the liquid state: Friction Stir Welding. The FSW process has several advantages over traditional arc welding processes. With a minimum of preparation a sound weld with less distortion and residual stresses is made that shows prolonged fatigue life. Moreover, strong alloys traditionally considered unweldable can be welded easily. A rotating tool moves between the surfaces to be welded and creates sufficient heat to deform and mix the materials to a homogeneous weld. A sketch of the process is shown in figure 3. The Friction Stir Welding process has mainly been applied in various areas of transportation. One of the earliest industrial examples is the catamaran built by Kvaerner in the mid nineties. Other examples are floor parts in the fast Japanese Shinkansen train and Space Shuttle rocket fuel tanks. A recent application is in the Eclipse airplane where up to 60 % of the rivets are eliminated through FSW welded panels. The advantageous of the FSW-technique should allow its use in a wider range of applications than transportation and aluminum alloys. The objective of the assignment is to investigate possibilities to apply this technique in consumer products.

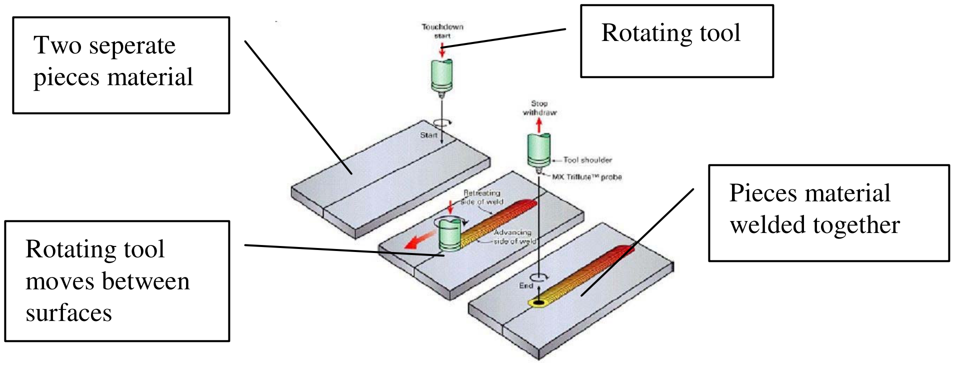

Figure 3. Principle of Friction Stir Welding

3.4.3 Integration of fuel and solar cells in products

A growing number of portable consumer products consume electricity. Batteries continue to be the main source of power, not only in audiovisual, communication and information products, in which the electronics provide the main functionality, but also in an increasing number of products that deliver mechanical work as their output. With the current battery systems it will become more and more difficult to fulfill the requirements of energy density and life time. Promising alternatives are fuel cells such as Direct Methanol Fuel Cells (DMFC) (see figure 4) and Photovoltaic (PV) solar cells.

Figure 4. Prototype of a laptop with Direct Methanol Fuel Cells (DMFC) of Casio

The defined assignments concern investigations on the application of PV solar and fuel cells in consumer products. Several kinds of investigations can be considered such as an inventory of possible products in which fuel and solar cells can be used on the one hand or the implication of the integration of the cells in the design. For instance the non-flatness of the product causes an intrinsically non-uniform radiation on the solar cells. To be able to apply the solar cells on curved geometries this problem should be solved.

3.4.3 Noise reduction

A lot of electronic equipment contains fans e.g. in computers for cooling and in hair dryers for forcing a heat flow. Tonal noise at the rotational frequency of the fan is important in fan noise. A well known solution to reduce sound at a specific frequency is the application of so called resonators. These are tube like air cavities which can reduce the noise at a certain frequency having the proper dimensions. At the University Twente fundamental research is carried out to understand this mechanism of sound reduction and analysis tools for determining the right tube dimensions have been developed. With these tools a pilot study has been carried out to reduce the noise of a hair dryer. The basic design as depicted in figure 4 (left) is not suitable and 'user friendly' from a consumer point of view. Therefore the Industrial Designer asked the researchers whether the theory is also valid for tubes that are 90^0 bend. This lead to a new concept namely an axial cylindrical resonator as depicted in figure 4 (right).

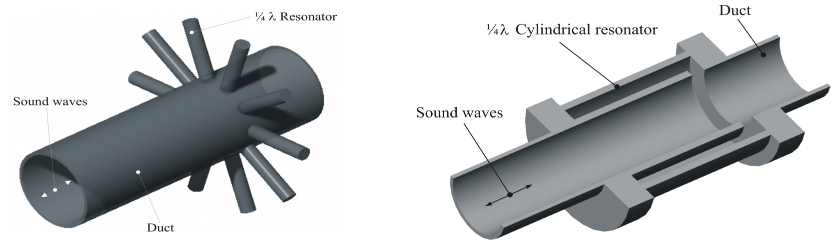

Figure 4. Fan duct with tube like resonators (left) and cylindrical resonator (right)

4 CONCLUDING REMARKS

The master track Emerging Technology Design educates students how to introduce new technology on the market instead of searching a technology for a certain product. In this way technology that is expensive because of its limited field of applicability can become cheap because it is adapted for mass production. On the other hand consumer products can be modified and or new products can be brought to market because new technologies make it possible to produce new shapes (hydroforming) or cheaper (less parts due to friction stir welding) or more advanced (fuel cells, reduced sound). Another goal of this track is to decrease the distance from the research environment to the industry and market. It happens too often that new advanced findings are only used to solve one particular problem and disappear in the garbage bin after that.

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