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FULLY INTEGRATING INDUSTRIAL DESIGN INTO ENGINEERING EDUCATION

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ABSTRACT

Industrial design is an inseparable component of a product's quality. Industrial design's content, organisation and personnel must be integrated into product development in order to achieve an ideal product. In this process, designers and engineers share a common goal, an ideal product. Their differing tasks and interests frequently cause problems, usually resulting from miscommunication and lack of knowledge about the other party's discipline.

An opportunity to improve this relationship can be found in the education of product developers: in this paper an integrated major for industrial design engineers.

This internationally common interdisciplinary education exists at only a few German universities. The Technische Universitaet Dresden has been one of them for almost 50 years.

Particularly in light of the introduction of consecutive degrees to German universities, we have investigated international academic design education within engineering. There are many different educational models for industrial design within engineering education, in different countries. An array of positive and less positive trends can be observed. These insights should be considered in the upcoming changes to education programmes at the TU Dresden.

Keywords: Industrial Design Engineering, Industrial Design Education

1 NECESSITY OF CONNECTING INDUSTRIAL DESIGN AND ENGINEERING

Industrial Design is an inseparable component of a product's quality and indispensable in a product development aimed at attaining the best possible result. Because the user experiences the product holistically, industrial design must treat it in a holistic manner and must incorporate all qualitative criteria in its form. Aside from aspects that can be evaluated objectively ("correctness"), e.g. human interface or human factors design, the product experience always encompasses subjective evaluation ("appeal") of the design object.

Per definition, it is design's domain to positively influence the holistic user experience when he uses technical objects to solve tasks and problems [1, p. 187].

A product is not only a carrier of function, it equally carries meaning, and offers its owner or user much more than mere practical value. "'Form follows function' is no longer sufficient. Products must capture the user's imagination" [2, p. 387].

Industrial design's content, personnel and organisation must be incorporated in the process of an integrated product development early on – in the planning and conception phase. Should the designer be introduced after the concept phase or, worse still, at the completion of mechanical design, it is hardly possible to arrive at an optimal product. It is this very goal, however, that unites industrial designers and engineers in an interdisciplinary product development process. Naturally, both parties have their respective tasks and interests. This is the reason why they often represent distinct points of view and have different methods of working, means of expressing themselves and different strategies.

Carulli and Reidsema compare the goals and roles of the two partners in an interdisciplinary team: "the engineer's goal is directed to solving technical problems, while the designer's goal is directed towards identifying new product solutions" [3, p. 3].

The necessarily more rational and objective engineer's point of view appears to be incompatible with the much more subjective and emotional view of the designer, which encompasses the entirety of the product. When working together, problems stemming from miscommunication and lack of knowledge about the other party's discipline often arise [4].

This conflict can be solved either by the cooperation between designers and engineers or by the transfer of necessary knowledge between the two disciplines. Ideally, the activities of designers and engineers should not take place alongside one another, but with each other. Of course each has his own area of responsibility – the engineer for technical solutions and the designer for holistic product design.

But knowledge alone is no guarantee. Ehrlenspiel [5, p. 188] even warns against "overemphasising specialisation in a self-realisation mentality at the expense of collective, cooperative and integrative action" within integrated product development. It is not the single-field specialist who is needed, but the generalist for the collective product development process, one who knows the detailed engineering processes and the holistic design from within. This starts with an educational integration of both fields [6].

An opportunity to improve the relationship between engineers and designers can be found in the education of product developers: engineering education, industrial design education and – the topic of this paper – particularly with regard to overcoming disciplinary boundaries, an integrated major for industrial design engineers.

2 INDUSTRIAL DESIGN IN ENGINEERING EDUCATION IN GERMANY

In Germany, the division of the two disciplines, industrial design and engineering, is prevalent. This becomes apparent in the academic education of those significantly involved in product development. The strict separation between the academic disciplines is an important source for the separation of engineers and designers in the industry. Engineers are taught at technical colleges and universities and as a general rule, have no contact with designers and receive no knowledge of industrial design. Designers learn their trade at art and design academies and experience very little about technology and natural sciences.

In contrast, the academic field internationally known as Industrial Design Engineering, or IDE, has established itself worldwide as an integrative programme together with or within Mechanical Engineering. There are only very few universities in Germany at which industrial design content is integrated into the engineering curriculum – the Technische Universitaet Dresden hast been one of them for nearly fifty years.

The education of design engineers at TU Dresden is based on two years of prerequisite mechanical engineering courses, in which students are taught scientific and technological fundamentals. During this time, only one optional course in design drawing, offered to all engineering students, prepares students for their specialisation. In the three years following, industrial design and engineering courses are combined in an interdisciplinary major. These courses are meant to equip students with both design aptitude and mechanical design skill. Practical design projects with increasing demands are included. Graduates receive an engineering degree, but consider themselves industrial designers with additional engineering competence, which their subsequent employments show.
The necessity to restructure curricula at TU Dresden for consecutive majors is an opportunity to take international experience and developments in IDE into consideration. The positive experiences of the current educational system must also be incorporated into new course offerings.

3 INDUSTRIAL DESIGN ENGINEERING WORLDWIDE

Our investigation of the current state of and developmental tendencies in teaching industrial design within engineering at institutions of higher education in various countries has resulted in the following insights [7]:

1. There are many different educational models for IDE (under different names), summarised in Table 1.

Table 1 Educational models for Industrial Design in Engineering

	Industrial design courses are existent	Examples
A	throughout the entire course of studies until graduation …	
A1	as consecutive Bachelor’s and Master’s programmes	Delft, Swinburne, Strathclyde and others
A2	as continuous 5-year Master’s programmes or equivalent	Trondheim, Glasgow and others
A3	as non-consecutive Bachelor and Master programmes	Stanford, Sussex and others
B	only in a Bachelor’s programme	Sheffield, Bradford, Portsmouth and others
C	only in a Master’s programme	Dresden, Stuttgart, Compiègne, Pittsburgh
D	only in single courses	Belfort-Montbéliard, Budapest, Zürich, Ilmenau, Wuppertal and others

2. There is a trend towards integrating industrial design into mechanical engineering programmes as well as towards the creation of such programmes. Some examples include the Master’s course in IDE at Chalmers University Göteborg [8] founded in 2006, the founding of the Graduate School of Art and Technology at Hosei University in Tokyo in 2005 with its integrated major Industrial Design (Concept and Design) [9] or the creation of the Design & Engineering Master’s programme at Politecnico Milano

for students of different faculties (mechanical engineers, designers, economy students) in 2004 [10].

3. Interdisciplinary projects serve as an important part of course offerings. In most engineering programmes integrating industrial design, project work is an essential component of the education. At Delft University of Technology, six projects on different topics belong to the core of the curriculum [11], [12]. It is the chief goal of these integrated programmes to prepare students for their future career and for the complete, interdisciplinary, product development process. This takes place consciously in contrast to industrial design programmes at art schools and universities. “In fact, most ID programs do not focus on the complete product development process; they tend to concentrate on form-giving and aesthetics.” [13] It is not the absolute concentration on formal and aesthetic problems, but on conceptual abilities and on a holistic approach to the problem at hand that is important to the IDE programmes mentioned in this article. Lawson writes in 2006, “conceptually the studio is a process of learning by doing, in which students are set a series of design problems to solve. They thus learn how to design largely by doing it, rather than by studying it or analysing it. It seems almost impossible to learn design without actually doing it” [14, p. 7].

4. The scientific environment surrounding design education at a university provides the opportunity for scientific engagement and research. According to Jonas, referring to Frayling (1993), one must differentiate between

- ‘research about design’, i.e. research of other scientific fields about design (e.g. design history, design philosophy)
- ‘research for design’, i.e. scientific work conducted by fields whose results partially support the design process (e.g. market research, product semantics)
- ‘research through design’, i.e. design-internal research and creative conduct directly involving researchers [15],

While the first two kinds of design research are offered at most universities, they represent the research interests of other fields ‘about’ or ‘for’ design and are therefore less interesting for the designer who conducts research. Design research often occurs in such tangential subjects as human factors, marketing, ecological design and other subjects belonging to the first two above-mentioned categories.

5. Due to the subdivision of the course of studies into Bachelor’s and Master’s programmes, students are becoming more mobile. The non-consecutive programmes allow a cross-connection between engineering and industrial design curricula at one university, and beyond academic and national borders as well.

Unfortunately, there are, from the author’s point of view, also some negative tendencies.

6. Industrial design fundamentals qualifying graduates for design tasks are receiving less attention. The new integrated academic programmes can often be found in non-consecutive Master’s programmes (e.g. Milan, Göteborg) and are an option not only for those with a Bachelor’s degree in design. It cannot however be assumed that all students possess fundamental design skills, which apparently cannot be made up for [10].

7. The observed flexibility that the change of universities between Bachelor’s and Master’s degrees offers, in combination with time limits, makes it more difficult to consistently equip students with a desired level of aptitude in the manner that a stricter curriculum affords.

4 CONSEQUENCES FOR A CONSECUTIVE ACADEMIC PROGRAMME FOR INDUSTRIAL DESIGN ENGINEERS AT TU DRESDEN

Insights based on the experience at TU Dresden should contribute to the restructured consecutive programme for design engineers. Because only one B.Sc. and one M.Sc. programme in Mechanical Engineering are planned, there are but a few liberties left for the specialisation.

- The uniform Bachelor's programme in mechanical engineering should provide students with the opportunity to qualify themselves for a subsequent specialisation in IDE.
- In order to teach students design aptitude, courses in elementary design basics, contrary to the current trend, cannot be neglected. Endowing students with an ability to design on their own is essential and cannot be left out.
- The IDE specialisation occurs in an optional module within the Master's programme. In addition to design coursework, students complete courses in mechanical design. It is assumed that the prerequisite courses have been completed in the Bachelor's programme.
- In order to guarantee post-graduate flexibility, students with a Bachelor's degree in mechanical engineering from other universities can join the IDE specialisation after completion of one semester of preparatory coursework.
- The course offerings are not only directed at IDE students. Some courses afford students specialising in mechanical design the opportunity to learn about design and to attain design skills, and later to participate in interdisciplinary projects.
- 'Research through design' – i.e. regarding the design process in the early stages of the development cycle or about the importance of specific design knowledge and the use of visual instruments in design – should be conducted with industrial design engineers as insiders. This research should be expanded and should use the possibilities the wide thematic spectrum offered at a university.

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