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# RESEARCH THROUGH DESIGN & RESEARCH THROUGH EDUCATION

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**ABSTRACT**
The very definition of a university is a place where research and education are intertwined. When there is no research, a university will look like a place for vocational training, and when there are no students to teach, the university is no more than a research institution. This convention of research and education is firstly explained as a practice where research (as in the generation of new knowledge) informs education. So that education develops constantly and is ensured of the latest insights in the discipline. In a more sophisticated integration of research and education, the two pillars of university practice mutually support each other. In this paper we want to shed light on this mutual support alongside nine years of experience with design research in education, going beyond the mere practices of using students as simple test subjects filling in questionnaires, and proposing different levels of design research results instead.

*Keywords: Research through design, research through education, project based education, design process, design curriculum.*

## 1 INTRODUCTION

A university can be defined as a place where the search for new knowledge (research) and the dissemination of that knowledge through the raising of new professional talent (education) meet. The definition of academic teaching is mostly referred to as an educational practice that is informed by new knowledge, derived from the research that is undertaken at the university. We argue for a more sophisticated interplay between research and education for two reasons; a principle one and a more practical one. The principle argument states that both research and education can benefit from each other; the learning experience of the students can be enhanced by involving them in research activities and vice versa. Comparable to the principles of Project Based education, that advocates better results by mimicking real-life problems and a real-life engineering environment in design education [1], the student will learn more about research when he or she has been part of a real research environment. The more practical argument is that research targets and educational budgets are ever becoming more demanding, forcing us to organize both activities more efficiently. One way to do this is to reduce the time that is needed for proper education [2], in order to be able to spend more time for research. A more fruitful way is to organize proper education in a way that it is at the same time suitable for proper research. This can of course be done in multiple ways.
In this paper we will describe some possibilities of such design research and education combinations from nine years of research experience and educational practice. Our main goal is to inspire other researchers and to give them a general overview of possibilities to incorporate research in education.

## 2 RESEARCH AND DESIGN

Research in design is different from the more classical empirical science [3] because, like the other engineering disciplines, design is a ‘making’ discipline. By designing and making, you alter the world you are researching. So the concept of finding whether something is true is not very valuable, because you ‘can make it true’. We therefore better concentrate on finding whether things ‘work’ or ‘do not work’. In other words, whether the act of designing really adds something or not [4].
To tackle this, the design research classification by Frayling [5], based on the earlier work of Read [6] is more and more adopted. Frayling discerns three types of design research: (1) research into design, (2) research for design and (3) research through design. The first two emphasize on the process of designing itself, where research into design focuses on the end results (the designed objects or

artefacts) and research for design is the process of gaining knowledge that is needed to be able to make the design anyhow. Research through design however, can be characterized as a process where the act of designing itself is explicitly used as a method to research a general problem. The research question in this case being typically broader than the design question itself [7]. Glanville argues on top of that [8], that we should rather be interested in knowledge *to* design, rather than knowledge *of* design. In other words, using design research to understand how we can support the act of designing, instead of knowing more about design(s) itself.

## 3 RESEARCH AND EDUCATION

When building combinations of design research and design education, it is of course too simple to just use design students as cheap research capacity by designing research experiments and execute them in an educational setting. This approach raises ethical questions, and is doubtful to lead to the best educational experience. Better is to see the analogy between the search for new knowledge and the search for better education. By constantly developing your education and incorporating new insights and perspectives you are constantly improving. The educational experience of the students substitutes for the experiment and the educational outcomes (designs, design reports, written reflections, course evaluations) are the equivalent of data. By analysing and reflecting on these data, one can come to new insights and generalise the outcomes into new theories. From there, an improved set-up of the course can be developed. This can then in turn be evaluated with the next student cohort. A practice that is similar to the alternating prescriptive- and descriptive research phases in the design research methodology of Blessing and Chakrabarti [9]. In this way both students and researchers benefit from combining research and education.

In the following paragraphs we will describe our experiences with such a research through design approach in education -in short; research through education. The different approaches are categorized in a scheme on different levels of aggregation (figure 1). The circles refer to the level of aggregation; from a simple course set-up, up to development of the design discipline. The rectangle shows the research result possibilities; from (course) descriptions to general insights.

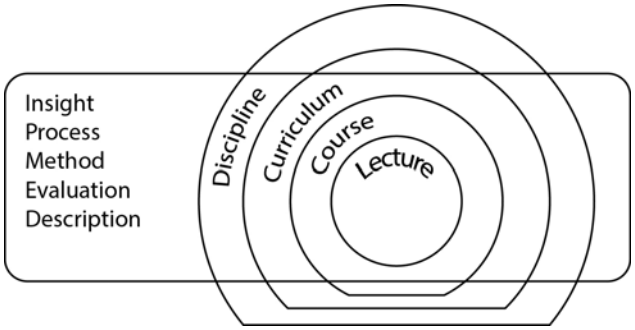


*Figure 1. Research results can be derived from different levels of design education practice.*

### 3.1 New course setup (with evaluation)

The most straightforward way of getting research out of education, one could say, is publishing about new educational developments. For instance when a new theory or methodology is used to teach novice designers a certain perspective on design. When one designs and implements a successful new course set-up, one can describe and evaluate the course and the associated methodology to inspire others [10]. The rigorousness of the publication can then be improved by repeating the course and comparing subsequent results [11]. A valuable side-effect of such publishing practice is that by writing systematically about the new developments, one is also forced to systematically rethink one's own course and its outcomes. The research result level can be classified as 'description' (figure 1).

### 3.2 New method/technique developed within course (with evaluation)

The development of new course set-ups can also be a resource for new perspectives on design. When we started a new multidisciplinary course on human product relations, we sat together with a group of teachers from different backgrounds. The wish to incorporate our different approaches to design in the new course in a comprehensive way led to a combined framework to guide the students design work. The proposed new method was then evaluated by assessing the students design outcomes and

experiences after the course [12] (see also figure 2). An advantage of developing new methodology in such a way is that students, as novice designers, are not yet fully framed in their 'own' methodology of doing design [13]. In our experience, they are therefore easily able to adopt the proposed way of working. When successfully implemented the research result level as mentioned in figure 1 is 'method'.

| | A human as "user" | A human as "aesthetic" | A human as "consumer" |
|---|---|---|---|
| Individual | Ergonomics<br>Interaction design<br>Dynamic use | Aesthetic preferences<br>- | Mediation<br>- |
| Social | Rich interaction<br>Dynamic use | Identity<br>Status<br>- | Mediation<br>Morality<br>- |
| Society | Future use scenarios<br>- | Culture<br>History<br>- | Influence of behaviour<br>Ethics |


*Figure 2. (left) Human Product Relations framework [14], (right) an example of a course result; 'Tetris' adaptable street furniture for engineering students.*

### 3.3 Comparison of methods/techniques throughout one course

A possibility for evaluating methods systematically is through a course platform that incorporates different methods. We came across such a possibility in the Industrial Design Engineering masters course *Sources of Innovation*. This is a project-led education based course where students have to develop an enticing product design, based on (a given) innovative technology. In our case the participants had to choose from product integrated sustainable energy technology like solar cells, hydrogen batteries or concentrating photovoltaic modules. The complete course is built around a standard design process, however, this is complemented by a set of nine different innovation techniques that can be applied in several stages of the project (figure 3). These range from Innovation Journey to Constructive Technology Assessment (CTA) [15].

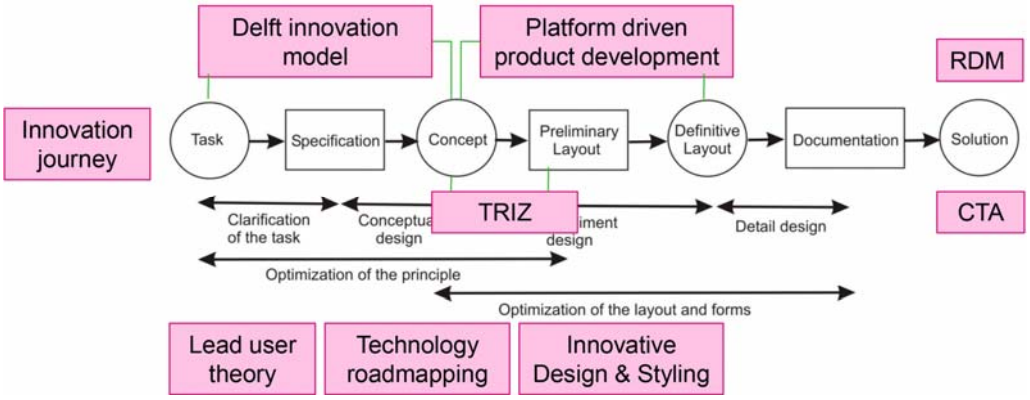


*Figure 3. Overview of the Innovation methods in the Sources of Innovation course platform [15].*

In the course, all the innovation methods are explained and practiced by the students in a series of workshops, however they only have to apply a minimum of four explicitly in their main design project. This means that one can evaluate the results of the design projects in terms of the applied methods and see whether the designs are better if a method is applied or when not [16].

Difficulty in this context is the large number of possible combinations of methods applied, which makes it hard to isolate the influence of a single method. The results of the comparison of methods are however rather promising, and the principle is scalable. In order to optimize for research outcomes one can design a course with less different options to maximize the differences between the used methods and to increase the number of instances of comparable design results (i.e. the design results that are derived with the same design method).

The major advantage of this course set-up however, is that students will practise all methods in the workshops and can choose to apply the methods they prefer, so there is no risk of an unethical situation of retaining knowledge from students. The evaluation of the design outcomes itself is

however still difficult. Lacking better resources, we based our research on the grades that the students received for their designs, which were assigned by our colleagues and therefore naturally subject to bias and subjectivity. The research result level is both 'method' and 'evaluation' (figure 1).

### 3.4 Evaluation of Course educational Methods

Still another way of making research out of education is by evaluating the educational methods itself. Like for example the grading method or the common practice of course evaluation questionnaires. This can be seen as research in education, but it can also inform the design practice or design research practice. In order to shed light on the subjectivity problem mentioned in the previous paragraph, we decided to evaluate some of our grading methods. In this way adding to our design education practice, but also to our own design research practice by improving our evaluation method. We set up an experiment where five of our colleagues independently graded the same set of design results. And although the feedback of the participants revealed that the reasoning behind the grades was sometimes very different, the absolute values of the grades were conveniently within the margin of plus/minus one point out of ten [2]. The advantage of this method is thus not only that it enhances the justification and clearness of the learning targets of the course and the actual feedback to the students, but also justified our research method of comparing design results by student scores from the example in paragraph 3.3. The research result level here is 'evaluation' (figure 1).

### 3.5 New curriculum developments

An even higher level of aggregation is reached when one combines developments throughout different parts of the curriculum. An example of our education and research practice is the development of a design process for Creative Technology, a design curriculum based on electrical engineering and information and computer technology. The Creative Technology design curriculum was built on a combination of technology-, human factors-, business-, and art and design subjects. Integration of the subjects is done in design projects, culminating in an individual graduation project. The diversity of the graduation projects that were executed in the time that we ran the curriculum (since 2009), needed for an adaptable and versatile design process. Based on the analysis of the projects we adapted a combination of a linear and a spiral design process, in which three different types of projects could be placed (see figure 4 for a cut-out of the process).

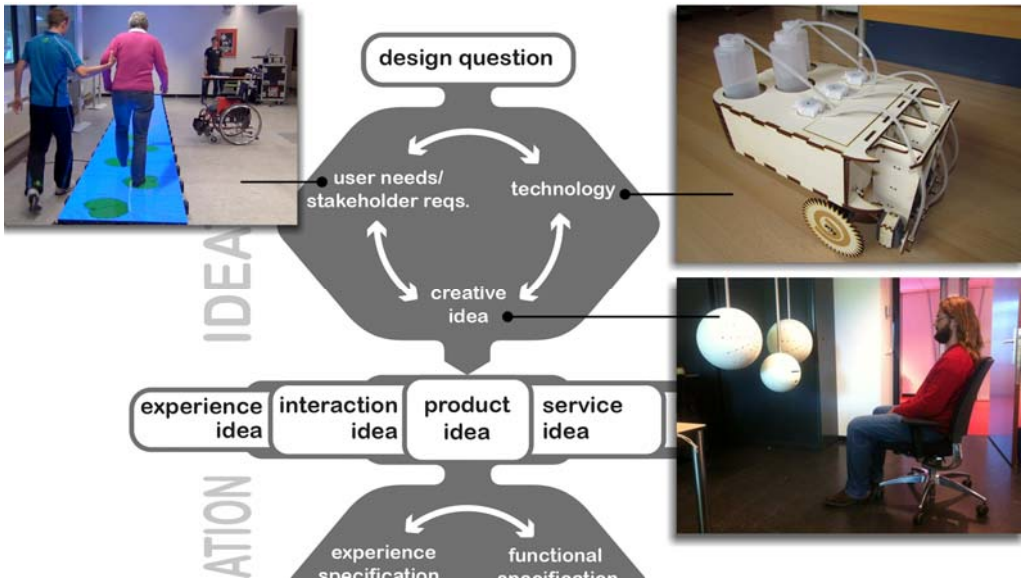


*Figure 4. Creative Technology Design process (partial) and three of the graduation projects that inspired it (a user driven-, a technology driven- and an idea-driven project) [17].*

The difference is the start of the process, that can be either from user needs (like the revalidation process of stroke patients, pictured in the upper-left corner of figure 4), from technology developments (like the automated decoration of concrete floors, pictured upper-right) or from a creative idea (like the adaption of the slow-food movement perspective for music, that led to a music device that invites the user to listen actively to an entire cd-album) [17].

The nicest aspect of this combination of education development and research on this level was that it had a sort of amplification effect. The analysis of the projects taught us, both as teachers and as researchers, a lot about the design problems and challenges of the Creative Technology discipline. On the other hand, the concretization of the design process in itself helped to guide new graduation projects in a 'Creative Technology manner' and supported us in turn in understanding the design projects better. The research result level in this case can be described as 'process' (figure 1).

### 3.6 New discipline development

The experiences from the Creative Technology process and our earlier Human Product Relations course confirmed us that in every design process that is targeted on products for people, both knowledge of technology and knowledge about humans are needed. At the same time our University was advertising the slogan 'high tech – human touch', to advocate this relation and emphasize the importance of design. The latter caused every department within the University to emphasize that they were also designing, claiming their importance within the new strategy. This forced us, as design driven disciplines, to explain our unique position in the shaping of human technology relations [18], in order to take centre stage in the new developments. This eventually led to what we call the *human technology relations funnel* (figure 5). In our own scheme on the research result level of 'insight'. The funnel shows that indeed every department can be involved in design, like when the nanophysics department designs a new lab-on-a-chip or the clinical psychology department designs a new therapy intervention. However only the combination of high tech and human touch will lead to artefacts that have a direct meaning for people. Just as only the combination of research and education will render a meaningful University.

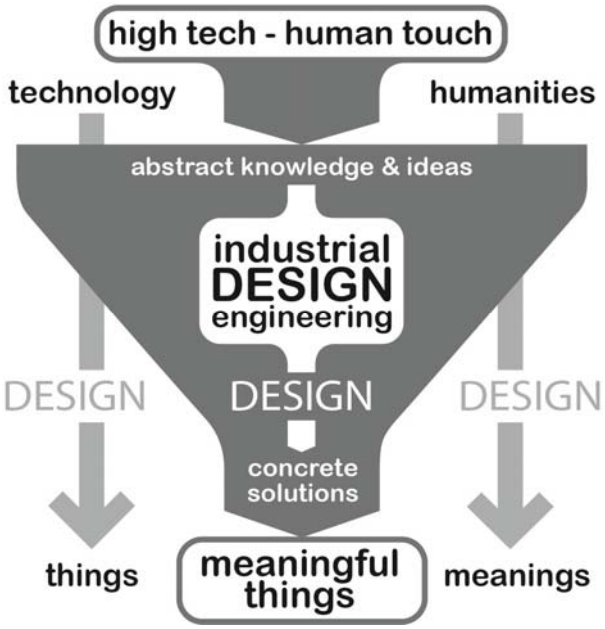


*Figure 5. The Industrial Design Engineering Funnel: design is everywhere, however only the combination of Technology and Humanities leads to meaningful artefacts.*

## 4 DISCUSSION

Having seen all the different approaches, the disadvantage of research through education is of course that one works with novice designers that have little experience. Besides that there is the possibility that the results of the new method or approach are not as good as one expected. To avoid the 'loss' of a full cohort of students it is recommended to perform a small pilot or to implement drastic new approaches only in elective courses first, so students have the opportunity to 'opt-out'. The advantage of the use of electives is also that students are normally better motivated and are more inclined to participate in additional evaluations and fill in questionnaires. A major issue with this kind of research stays however that it is difficult to compare results systematically [4]. It is also hard to organize a 'control group' as it is deemed unethical to teach groups of students differently, or to withhold some of them from the newest insights and theory [19]. The benefit however, is first of all that a large population of students can be utilized for making a lot of different design results. Researching a

particular phenomenon in a design course therefore could render better research rigor than working with expensive professionals. In our opinion this can weigh against the lack of experience of student designers. Another benefit of the research through education practice is that one can proceed to fine tune approaches with every instance of a design course, optimizing the results of both education and design methodology every year.

## 5 CONCLUSION

With this paper we want to give researchers an extensive overview of the possibilities of incorporating design research in education from a low level of aggregation to a high level of aggregation. And we hope to inspire fellow researchers to think about combining both worlds (education and research) in a more efficient, but first of all in a more pleasurable way.

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