

DESIGN FOR SUSTAINABLE BEHAVIOUR IN DESIGN EDUCATION

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ABSTRACT

This paper reports on how Design for Sustainable Behaviour has been integrated in a design course. Based on a teaching philosophy aiming to provide students with a holistic view on design, and encouraging them to use user-centred investigative and analysis tools, it is discussed to what extent 3rd year design students are able to use such tools, in a context that is largely unfamiliar to them. Experience and reflection tells that most students find it challenging to combine behavioural and sustainability aspects in combination with an analysis oriented and open-problem course approach. But eventually, with a course-customised guide and intensive supervision this teaching philosophy does appear to result in an understanding and consequent enthusiasm about the topic studied, unleashing a spur of creativity and an appreciation for research and analysis as a complementary activity in the design process.

Keywords: Design education, design for sustainable behaviour

1 INTRODUCTION

Sustainable product design should be no different from regular product design; it entails the identification and consequent consideration of all factors deemed relevant to the life cycle of a product, although individuals may have, and contexts may dictate different ideas about what is relevant. For sustainable product design, these are generally understood to be of a functional, economic, environmental, social or ethical nature. Sustainable product design education should therefore be taught holistically; rather than ‘merely’ developing concepts for environmentally superior products. Students should be trained to genuinely consider all relevant design parameters to allow for identifying design dilemmas when searching for opportunities to avoid avoidable impacts on the environment. Only by understanding how environmentally preferred design solutions affect other relevant design parameters, realistic improvements can be realized. In practice, this approach boils down to questions like “is it worth to sacrifice aesthetics for environmental impact?”, “how to maintain convenience and user-friendliness using a dematerialization strategy?”, or “will lowering energy consumption still result in a product that is cool to use?” To answer such questions, designers need to be able to make design dilemmas explicit and solvable, requiring use of appropriate methods for quantitatively and qualitatively measuring and assessing design parameters, and an evaluation scheme that can make trade-offs visible (and thus decisions possible) between parameters that are usually measured in completely different dimensions.

This teaching philosophy has been the core of the sustainable product design course series at the Norwegian University of Science and Technology (NTNU)’s Department of Product Design (IPD) since 2007, and has gradually become more explicit in the requirements for student assignments. Although justifiable from a holistic perspective, it does however provide the course with a number of challenges. By lack of a text book method, these include how to explain students this general philosophy in a comprehensible way, and how to translate this in practical design tasks in terms of measuring design parameters, identifying dilemmas and trade-offs, and how to solve them.

The emergence of design for sustainable behaviour as a research topic, and the consequent desire to incorporate this into the course, makes the story even more complicated. Insights from this new research area advocate a much stronger focus on studying user behaviour, including habits, norms, values, real and perceived affordances, attitudes, beliefs and intentions, in order to identify opportunities for improving the sustainability of products. This adds a palette of additional parameters to consider, and requires a more user-centred approach rather than a product-focused one. As literature

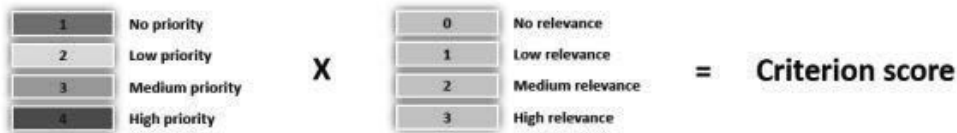
so far provides little or no experience with addressing these topics in sustainable design education, this paper aims to discuss how the course and course assignments are shaped to accommodate the teaching philosophy stated in the introduction. It aims to explore to what extent students are able to develop a sense of interdependency between behaviour related, sustainability and conventional product requirements, and if they are able to choose or develop approaches to achieve this understanding in case using existing sustainable design methodologies do not provide this.

2 COURSE SET-UP IN PREVIOUS YEARS

At IPD, sustainable product design education is concentrated in the 6th semester of the 5 year Masters programme. Apart from a brief introduction in the first semester, the 7.5 ECTS Sustainable Product Design course taught in this semester is the first course in the design curriculum where sustainability issues are the explicit focus of a course. The course typically hosts 25 IPD design students and 15 other students, mostly from NTNU's Industrial Ecology international master program or exchange students with various backgrounds. This allows creating groups of 4-5 students with mixed background and expertise. Over the years, the course has experimented with different course set-ups and focal perspectives. In 2007 and 2008, courses were mainly inspired by more traditional ecodesign approaches, based on product comparison and redesign. In 2009 and 2010, partly inspired by how sustainable design had been taught at the Technical University Denmark, the main course deliverables included a product analysis report and a playable board game inspired by eco-design methodology. The purpose of the game was to educate a chosen audience, for example a group of product developers in a company; on aspects of sustainability, on a general level or in the context of a certain product [1]. Throughout these four years, and in an effort to embed sustainability in product design education rather than just teaching it as a separate theme, students were challenged to explicitly consider a wide range of relevant design parameters in their group assignments. Rather than 'merely' developing concepts for environmentally superior products, students were required to genuinely consider all relevant design parameters on an equal basis, including aspects of an economical, aesthetical, ergonomic, convenience, and sustainable nature. Given that such a holistic approach often poses designers for various design dilemmas, the aim of the courses has been to make these dilemmas as explicit as possible. Whereas more traditional approaches of addressing sustainability aspects in a design curriculum aim at the inclusion of various design requirements in a design brief without much background research, this new approach has over the years increasingly focused on the composition of a realistic design brief by prior analysis of design dilemmas. This has been done by using quantitative and qualitative studies to map mutual relations between the various aspects, arriving at a detailed list of requirements including 'musts, shoulds and could's'. For most students, this proved to be a difficult but interesting challenge, as "measuring" dilemmas such as convenience and aesthetics versus environmental impact is not something they are used to, nor do text books and other literature provide much guidance. With a focus more on formulating and motivating design briefs and specification requirements rather than developing conceptual and detailed designs, it has been a journey into the unknown both for the students and the teachers. Even though the course requirements were very explicitly stated, the assignments were not only open-ended but also "open-beginning". The supervision of the student groups needed therefore to be very intensive.

2.1 Group performance in 2007-2010

Since 2007, student assignments have become gradually more extensive and have been showing a greater variety of tools and methods used. Earlier assignments were principally based on straightforward benchmarking of products, identifying stages in the life cycle and components in the product with potential for improvement, combining good solutions in the product analysed, and using creativity to develop alternative product concepts with superior environmental improvement. In the 2009 and 2010 courses, more attention was given the additional inclusion of non-technical/physical aspects of the product, and on assessing these. Groups mostly used their own 'expert evaluation', giving their own opinion on aspects such as aesthetics, functionality, cost of ownership and user friendliness (instead of attempting to measure these in some way, apart from environmental impact which was mostly done with Eco-it software). Commonly, groups used 1-5 scales to grade the various aspects, and used a similar weighting scheme to arrive at final scores for each product analysed. Figure 1 shows a typical example of such an analysis, in this case for flashlights.



Categories	Eco friendly Wight factor	Maglite	Light sticks	Dynamo torch Led	Varta Dy-namo light	Induction torch	Krypton light						
Price/cost of ownership													
The price should be low	1	1	1	3	3	4	4	2	2	3	3	4	4
A high price reflects high quality	2	4	8	3	6	1	2	2	4	2	4	1	2
A low price reflects low quality	0	1	0	1	0	3	0	3	0	3	0	4	0
The price should be so low that you would buy it on impulse	0	2	0	3	0	3	0	2	0	1	0	3	0
Value proposition													
The product should reflect high quality	1	4	4	2	2	1	1	3	3	2	2	2	2
The product should reflect eco-friendliness	2	2	4	2	4	3	6	4	8	4	8	1	2
The product matches the image of the people buying it	0	4	0	3	0	3	0	3	0	2	0	1	0
Eco-friendliness													
Energy efficiency													
The product should be eco-friendly in use	3	3	9	2	6	4	12	4	12	3		1	3
The product should be eco-friendly to produce	3	2	6	2	6	4	12	4	12	3	9	1	3
Aesthetics and Image													
The product should look masculine	0	4	0	2	0	2	0	3	0	2	0	3	0
The product should look feminine	0	2	0	2	0	2	0	2	0	3	0	1	0
The product should look like its meant for active use	0	2	0	4	0	3	0	3	0	1	0	2	0
The product should appear to be eco-friendly	1	1	1	3	3	4	4	4	4	3	3	1	1
The product should look cheap	0	1	0	3	0	3	0	2	0	2	0	3	0
The product should be intuitive and have good affordance	1	4	4	4	4	3	3	2	2	4	4	3	3
The product should look like it is part of a brand and product series	0	4	0	3	0	1	0	4	0	1	0	1	0
Total score			70		58		73		77		59		44

Figure 1: A 2009 example of how students measure and weigh product aspects

Though insightful for students in terms of understanding the broad spectrum of variables to be considered in good product design, students seldomly showed initiative to exploit such matrices to formulate explicit design dilemmas. Experience tells that they need to be explicitly challenged to identify the single or combined product features or design solutions that cause a product to score well on one aspect, and worse on another, and to formulate this as a dilemma to be solved. And even then, most groups did not succeed in doing this. That said, many did arrive at interesting redesigned or sometimes even novel product concepts, opening up for a discussion to what extent creativity and gut feeling can replace prior analysis. However, the teaching philosophy for this course has remained with the assumption that both gut feeling and analysis work synergistically, and that students are served with gaining experience of context and user analysis before entering ideation phases; partly also because the focus in many courses is in fact on ideation rather than analysis.

3 DESIGN FOR SUSTAINABLE BEHAVIOUR

Since the early 1990s, ecodesign research and education has developed from an activity mostly targeting redesign to more sophisticated levels of incorporating sustainability principles in product design. Boks and McAlone [2] identified a number transitions; from a product to a systems perspective, from an environmental to a sustainability context, and from a concept development to technology transfer and commercialization perspective. Research focusing on the use phase of products has throughout these transitions mostly focused on technological solutions to achieve resource use (mostly energy use) efficiency. But more recently, technical efficiency gains are no longer seen as the sole panacea in achieving environmental impact reductions in the use phase. Through understanding user behaviour, and applying that knowledge in design solutions that may inform, guide, persuade or force users to behave in environmentally preferred ways, for example using shapes, colours, affordances, or other 'nudges', significant additional energy consumption reduction may be achieved. Design researchers increasingly understand their role in investigating opportunities to influence users to alter their behaviour into more sustainable behaviour and consumption patterns [3]. As a result, we can now observe a young area of research emerging, mostly referred to as Design

for Sustainable Behaviour. Research into Design for Sustainable Behaviour strategies aims at exploring design strategies for reducing behaviour-related environmental impacts of product and systems, although they have also been proposed for more general applications to persuade users into more socially desirable behavioural patterns [4]. This research incorporates insights from scientific fields including social psychology, persuasive technology, sustainable consumption, stakeholder analysis and interaction design. It attempts to conceptualize, frame and structure research constructs taken from these fields with the ultimate aim to design solutions that inform, persuade or force sustainable behaviour. The current state of the art is one of exploring case studies, identifying design principles and developing guidelines to choose appropriate principles for specific design challenges.

3.1 Design for sustainable research at NTNU

IPD hosts a research group that also has adopted Design for Sustainable Behaviour as a key research area. One of the ongoing PhD projects aims at providing designers with a means to make informed decisions about which design principles to apply. In the first stages of this project, preliminary guidelines for selecting principles have been proposed [5]. These guidelines propose a way of translating information about human behaviour and insight from social psychology literature to recommendations for design principles. However, these preliminary guidelines have been derived from literature and theory, and have not yet extensively been tested in practical design projects. The preliminary result of this research is a booklet, attempting to communicate the guidelines in a user-friendly manner. The development of the booklet is partly inspired by the first evaluation of the guidelines; which was done in a master project focusing on oral healthcare [6]. This project was primarily used to improve the usability of the guide. One of the conclusions was that, considering the amount of information and diversity of topics, a small booklet might be a suitable format, including both the guide, explanation to the process, instructions of how to use the guide, examples of design principles and introductions to other methods the guide could be combined with. This guide is further discussed in section 3.4 below.

3.2 Design for sustainable behaviour in education

The 2011 edition of the course embraced “design for sustainable behaviour” as an additional explicit component of the course. The motivations for doing so were partly because of a demand for research-based education, and partly because working with students on this topic provided a way to test preliminary research results in practical projects. In addition to the challenge posed upon them in previous courses, students were this time also challenged to identify potentially unsustainable practices and behaviour and use these as a point of departure. In other words, instead of conducting research that eventually should lead to redesigning appliances from a traditional eco-design perspective, students have been challenged to collect and analyse data aiming at redesigning practices rather than products. To give the students an understanding of the reasons for why behaviour change can be relevant from an environmental perspective and an overview over the insight that the research had brought forward, a number of lectures on design for sustainable behaviour were given in the beginning of the course. The course was also informed by NTNU research on addressing ethical aspects in forging design for sustainable behaviour solutions [7], and on addressing behavioural aspects related to the design and use of clothing [8]. In addition, to further stress the focus on behaviour change, the topic was clearly stated in the course description and instructions for the assignments. For instance, the first sentence of the course description was: “...students are to work on a group assignment during the course, focusing on understanding both material and behavioural aspects of a particular ‘consumer practice’”. The student assignment was introduced by stating that the main goal for course was to “...develop an understanding of how products related to certain activities impact the environment, and in particular on how behaviour affects this.”

3.3 Group performance in 2011

As a result of this substantial focus on user behaviour, all groups did investigate the behaviour of the users and some of the groups even applied a well justified triangulation of different methods. However, when analysing the reports from the project, it became apparent that most of the groups ended up with a more traditional redesign project and not particularly focused on behaviour change. Even though some groups did identify behavioural problems, their process and solutions focused on reducing environmental impact from a technical point of view rather than making users behave more

sustainably. Nevertheless, the best assignments successfully combined both approaches, such as:

- Development of a hybrid diaper with an estimated 30% reduction in diaper waste, based on understanding parents' need for easy-of-use and flexibility in choosing inlays depending on the time of day. This group used consecutively benchmarking of existing diaper solutions, Life Cycle Assessment (using Eco-it) and MET matrix, interviews with kindergarten employees, parents and specialised shops, an absorption test, and concept testing with the original interviewees.
- Development of a bathroom cleaning brush based on a squeeze dispenser avoiding excessive soap use. In this project the group used a survey explicitly addressing habits and norms related to bathroom cleaning, a descriptive statistics analysis and correlations analysis, an immersive story telling workshop (Figure 2), ethnography (cleaning practice observations and interviews), benchmarking of existing cleaning solutions and Life Cycle Assessment. This group also managed to produce a working prototype (Figure 3).

Although students did try to affect user behaviour, in most cases however their choices of behaviour changing design principles did not appear to result from conscious deliberation and evaluation.

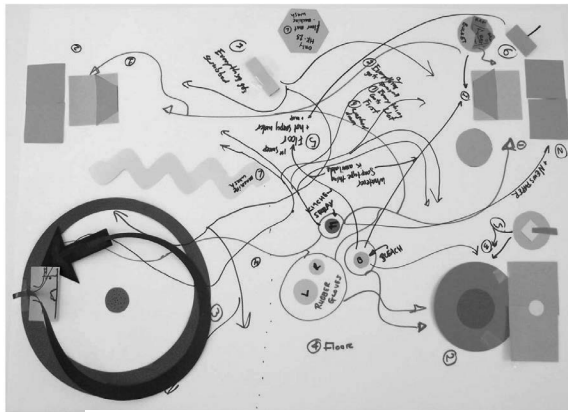


Figure 2. Storytelling workshop



Figure 3. Bathroom cleaning brush

3.4 Additions for 2012

Based on 2011 experiences and the focus on design for sustainable behaviour research at IPD, it was decided to increase focus on behaviour change even further in the 2012 edition of the course. Whereas design for sustainable behaviour was one of the topics in the sustainable design course of 2011, it became the main topic for the 2012 course, meaning less focus on some topics that previously were taken up in the course. Several of the lectures during the first weeks centred around what design for sustainable behaviour is, and on choosing and using user-centred methods such as surveys, interviews, probes, observations, using personas and focus groups in design projects, as previous experience told that students are relatively unfamiliar with using these methods appropriately. It was also decided to develop and print a first version of the guide mentioned in section 3.1 and recommend the students to use it, in order to strengthen the design for sustainable behaviour focus in the course and help the students to structure their behaviour changing design projects. The booklet is structured according to a suggested design process, specifically designed to support a focus on behaviour change. It was made sure that the assignments for the interim reports were in accordance with the steps in the booklet. Another motivation for using the booklet in the course was to obtain research input, gaining further knowledge about how the guide should be presented to support a design process in the best possible manner - also strengthening research-based education.

The focus of the course is per 2012 strongly directed towards design for sustainable behaviour. However, even though the aim of the student projects is to identify unsustainable behaviour through user research, the students still have to consider both the problems and the potential solutions from a holistic perspective and identify occurring design dilemmas. A consequence of the chosen focus is however less attention for product level environmental analysis, such as through disassembly and benchmarking. Whereas these activities so far always had been a starting point for most assignments, this year the starting point was explicitly 'practices' and 'behaviour'. Students' choices included ambient temperatures while sleeping (finding solutions for reducing energy consumption for heating sleeping rooms), laundry practices (avoiding washing clothes that do not need washing), dishwashing practices and preventing food waste, neither of which take a clear product-level starting point.

At the time of writing this paper, the students are half way through the course and have delivered the second interim report. They have decided upon a topic, studied literature on the topic, identified relevant directions and the need for further information. To identify the main reasons why people do not behave sustainably, the groups used a broader variety of investigative tools than in 2011 (indicating that the dedicated lecture on this topic clearly paid off) and have in addition used a number of customised measuring approaches of factors like temperatures and cleanliness. These empirical data have further been translated into design dilemmas, a design brief and a list of requirements, and the groups are ready to start identifying the most promising design principles for their target group by using the guidelines, and generate ideas for how these may be applied to change their target behaviours. The booklet, together with the direct connection between the lectures, the topics in booklet and the student projects, seems to have provided them with a sense of direction for the project. However, it does not seem like the booklet and the lectures gives enough guidance yet, as has become clear after several rounds of supervision meetings. Whether this is due to the booklet itself, the amount of attention the students have given the booklet or because of the students' inexperience with this type of project (where the focus is largely on analysis rather than starting to sketch solutions from very early on in an assignment) remains to be analysed.

4 CONCLUSIONS

Based on the above-described experiences with transitioning from a more traditionally focused eco-design project to a sustainable behaviour focused project description, a number of reflections can be made. First, we found that most 3rd year design students have problems with identifying and selecting appropriate user research tools without close supervision; this is even so for relatively familiar tools such as surveys and interviews. Quantifying product aspects, especially behaviour related ones, is challenging. The same holds for approaches to evaluate, summarise and prioritise both qualitative and quantitative analysis results. When newly introduced to both 1) a behavioural (rather than product) focus and 2) a research and analysis (rather than just ideation) focus, also in combination with 3) the sustainability context which also requires new tools and ways of thinking to learn, and 4) an open problem formulation, students become (at first) puzzled and either feel as if they are on thin ice or resort to approaches they are familiar with. However, feedback from the students suggests that explicitly challenging (and guiding) them to identify, measure, and evaluate behavioural related aspects, does result in an understanding and consequent enthusiasm about the topic studied, unleashing a spur of creativity and an appreciation for research and analysis as a complementary activity in the design process.

REFERENCES

- [1] Boks, C., McAlloone, T. (2009). The Design of Eco Board Games as deep-learning approach to Sustainable Product Design Education. DS 59: Proceedings of E and PDE 2009, the 11th Engineering and Product Design Education Conference - Creating a Better World, pp. 390-395
- [2] Boks, C., McAlloone, T. (2009). Transitions in Sustainable Product Design Research. International Journal of Product Development, Vol. 9, No. 4. pp. 429-449
- [3] Tromp, N., Hekkert, P., Verbeek, P.P. (2011): Design for Socially Responsible Behaviour: A Classification of Influence Based on Intended User Experience. Design Issues, Vol. 27, No. 3
- [4] Lockton, D., Harrison, D., Stanton, N. (2010): Design with Intent. 101 patterns for influencing behaviour through design. Windsor, Berkshire, UK
- [5] Zachrisson, J. and C. Boks (2012) Exploring Behavioural Psychology to Support Design For Sustainable Behaviour Research. Journal of Design Research, Volume 10, No. 1/2
- [6] Zachrisson, J., Storrø, G., Boks, C. Using a guide to select design strategies for behaviour change; Theory vs. Practice, in: Matsumoto, M., Umeda, Y., Masui, K., Fukushige, S. (ed.): Design for Innovative Value: Towards a Sustainable Society. Proceedings of Ecodesign 2011, Springer Verlag, 2011
- [7] Pettersen, I.N. and C. Boks (2008). The ethics in balancing control and freedom when engineering solutions for sustainable behaviour. International Journal of Sustainable Engineering, Volume 1, Issue 4, December 2008, pp. 287-297
- [8] Laitala, K. and C. Boks (2012). Sustainable clothing design: Use matters. Journal of Design Research, Volume 10, No. 1/2