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Developments in Teaching Sustainable Product Design for Industrial Design Engineering

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Abstract
Developments in the field of sustainable product design are manifold, which means that education in this field is rapidly evolving as well. In this paper, the continuously evolving portfolio of courses offered at Delft University of Technology's Industrial Design Engineering faculty is systematically discussed, with a focus on content, course formats, assignments and lessons learned from course evaluations in recent years. It is concluded that in particular integration in existing contexts (academic and industrial) is of utmost importance.

Keywords: Sustainable Product Design, Ecodesign, Sustainability Education, Curriculum Development

1 Introduction
The first initiatives in the field of Ecodesign started in late eighties in Europe and the USA. In the beginning of the 90's, a first range of 8 Ecodesign demonstration projects in different industrial sectors (like furniture, automotive and packaging) took place in the Netherlands. Based upon the experiences, a first serious attempt was made to develop Ecodesign methodology and tools.
This was done at Delft University of Technology's Faculty of Industrial Design Engineering (IDE), where the emerging topic of ecodesign was picked up relatively fast, and where a small group of researchers formed the later called Design for Sustainability Program. This research group, in collaboration with other Dutch partners published in 1994 the "PROMISE" Ecodesign manual [1]. Three years later an updated version was launched in assignment of the United Nations Environment Program (UNEP) called "Ecodesign: a promising approach" [2].
This "PROMISE" Ecodesign approach has been the starting point for the development of several other international and local Ecodesign manuals. Since then, the Design for Sustainability Program has evolved into a widely acknowledged centre of expertise for sustainable product design.

Since 1992, Ecodesign has also been part of the Industrial Design Engineering curriculum at Delft University of Technology (DUT). From a basic 'ecodesign' Bachelor level course in the early nineties, it has now evolved into a range of courses on both and Bachelor and Master level. The term 'Ecodesign' as such has been replaced by Sustainable Product Design, or Design for Sustainability, whilst 'ecodesign' is used in cases where one refers to traditional,

predominantly technical product improvement, using tools such as the Life Cycle Design Strategy Wheel and the MET matrix, that were developed in the mid-nineties by Delft University of Technology [2]. The expansion in number courses mainly reflects an expansion in scope of Design for Sustainability. "Environmental" is nowadays replaced by "sustainable", designing products increasingly means designing product life cycles, and transferring knowledge increasingly means addressing a contextual framework as opposed to teaching mere facts and tools; these and other developments have made it necessary to broaden the scope of subjects taught at the Faculty of Industrial Design Engineering. In the IDE curriculum, students will receive elementary knowledge of various sustainability related topics, as well as the opportunity to select various courses specifically focusing on a particular perspective. In addition, efforts have been made to integrate sustainability in part of the regular curriculum. Here, the term sustainability is used in a broad sense; giving exact definitions of sustainability – if possible at all – is considered less meaningful, instead the focus is on making students aware of the different perspectives and definitions on sustainability that stakeholders in the life-cycle of products might have themselves.

2 Paper outline

In the light of contributing to the growing body of knowledge and disseminating teaching experiences among interested fellow educators in sustainable product design, the aim of this paper is to present the current portfolio of sustainable product design education offered by the Design for Sustainability Program. To do so, each course is systematically discussed. This is done using the following framework: For each course it is explained why this course emerged, using a reflective model. Consecutively, content, the used course format, and the assignments that students have to complete are addressed. For each course, in conclusion a number of lessons learned by the DfS staff are addressed and shared.

The reflective model used for explaining the existence of courses and the motivation for incorporating it in the IDE curriculum, is done using three perspectives.

- From 'environmental' to 'sustainable'; whereas environmental product improvement was the focus of most activities in the mid-1990s – in industry as well as academia – in recent years the sustainability concept has broadened considerably, and became to include balancing environmental, economical, and a variety of societal criteria. This development can also be observed for example in the yearly reporting activities of multinationals, where earlier, *'environmental report'* was commonly used terminology, whereas in recent years, terms like *'global sustainability report'* and *'corporate social responsibility report'* are more frequently used. This means that students need to become aware of more than just environmental aspects. In fact, it means that for students, as future professional designers, it becomes increasingly important to develop an awareness of their own engagement towards issues like creating needs versus fulfilling needs, production in low-wage countries, the power of commerce, and so on.
- From 'product design' to 'product life cycle design'; students are to become aware that a product interacts with many different stakeholders in many different ways during its life cycle. This requires not only thinking in terms of product-user interaction; generally a large number of stakeholders can be identified, which may include municipalities, service people, producers, suppliers, retailers, interest groups etc. Interaction can be measured in terms of money, but also in terms of environmental impact, information, and various types of emotion (such as fun and convenience). As product design implies balancing interests and making trade off decisions, students need to become aware that depending on the stakeholder perspective taken, different types of interaction may be more or less relevant. It also means that just adding up costs or environmental impacts may be difficult when

making a true ‘life cycle assessment’, as different types of interaction are measured with different dimensions.

- From factual to contextual; with the knowledge and experience present a decade ago, it sufficed to teach students mostly factual knowledge. Teaching Sustainable Product Design – in those days (and still often) referred to as ecodesign or design for environment – mostly meant teaching design rules and design tools to systematically apply those design rules. Today, the context in which application of rules of execution of tools takes place is more important – as we are more aware (though still not very knowledgeable) of the social and industrial requirements that implementation of sustainable product design practices faces. This insight has brought about a completely new research field within the domain of sustainable product design, often referred to as “Base of the Pyramid”, and instigated by the work of for example Prahalad et al. [3,4]. The approach practised here is to design commercially interesting sustainable products and services for the markets of emerging economies. Especially the extreme differences in user context require a fundamental different approach for identifying needs, product interaction and potential successful business models.

  Additionally, it should be noted that in comparison to other bases of ecodesign education, where focus is more on (production) engineering aspects (e.g. Jeswiet and Luttropp [5]) or LCA (e.g. Jørgensen et al. [6]), the main focus at IDE is in understanding and addressing needs of companies and their stakeholders (with respect to consumers, technology and knowledge transfer, and managerial issues). In most cases this means that sustainability in a product life cycle context is addressed using economical, environmental and social/ethical criteria. Depending on the course, stress is put more or less on one of those criteria.

3. Sustainability in the IDE curriculum

The Industrial Design Engineering curriculum at Delft University of Technology consists of one Bachelor’s and three Master’s curricula. Whereas the Bachelor’s curriculum has a broad orientation, the faculty offers three specialized Masters, which are Strategic Product Design, Design for Interaction and Integrated Product Design. The latter Master caters for approximately 160 students, and features most prominently the topic of sustainability. Additionally, two variants are offered, Medisign en Automotive Design. Figure 1 provides a general overview, pointing out which courses have more or less explicit sustainability content in the Bachelor and IPD Master curriculum.

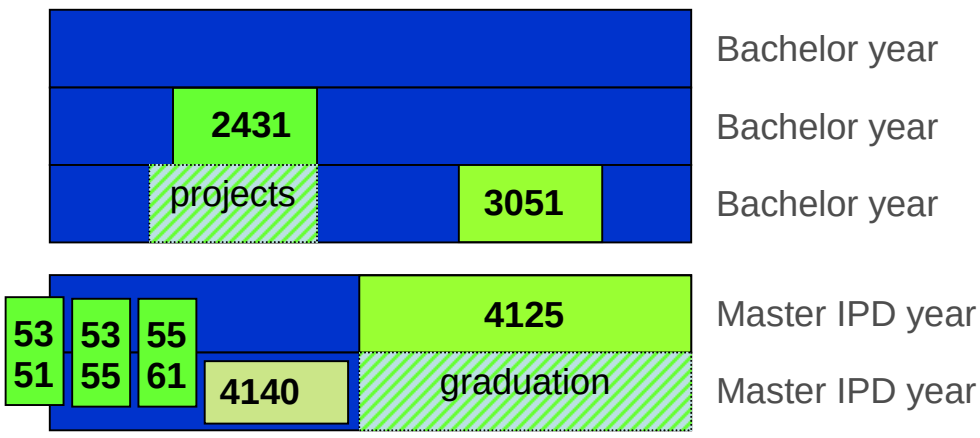

Figure 1. Overview of the IDE curriculum

The course codes correspond with the following courses:

- ID2431: Introduction to Sustainable Product Design
- ID3051: Design 5
- ID4125: Life Cycle Engineering and Design
- ID4140: Internationalisation
- ID5351: Applied Environmental Design (elective)
- ID5355: Environment and Design in Business (elective)
- ID5561: Product Service Systems

In addition, students can choose a topic addressing sustainability in their 3rd year research project and/or their final graduation assignment. The staff of IDE's Design for Sustainability (DfS) Program is responsible for providing students and teaching staff from other departments with domain-specific knowledge and understanding about how to integrate sustainability issues into regular product development processes. In the next paragraphs, each course will be discussed as explained in chapter 2.

3.1 Introduction to Sustainable Product Design (ID2431, Bachelor, compulsory)

In the first two years of the curriculum, students in DUT-IDE's bachelor's curriculum take courses that will educate them to become designers capable of designing products on a global level integrating aesthetics, ergonomics, manufacturability, market considerations and sustainability. In order to become successful future designers, they need to have to their disposal both domain-specific knowledge and general (domain-independent) procedural knowledge of the design process itself. Integration of various domain-specific disciplines and general domain-independent process knowledge is therefore a key element and goal of design courses [7]. With respect to sustainability, both aspects are ensured in the Bachelor curriculum. In the first semester of the second year, students are required to take a basic environmental sciences course. In this course, students obtain domain-specific knowledge about environmental impacts related to products and their environment. In former years, the content of the course was essentially split in environmental product analysis and environmental product improvement. Whereas these aspects are still taught as valuable basic knowledge, it is now tried to provide students an overview of all that is sustainable product design; so from a sustainable instead of an environmental perspective only, and in a contextual form instead of a mere factual form. Social criteria receive an increasing amount of attention, which is also justified by the interest of students themselves: it is not uncommon for students to 'struggle' with their personal engagement as future designers, with respect to ethical issues. Students are interested in discussing for example the complex issue of fulfilling needs (perceived as ethical) versus creating needs (perceived as unethical) by industrial activities. Apart from domain-specific factual knowledge, students are also offered a range of domain-specific tools for integrating such knowledge in product development processes. Since time is limited for this course, this has resulted in a course format where most of the factual knowledge is offered as reading material, with only limited explanation in plenary classes. These plenary classes are used to put subjects into perspective, and sketch the relevance of topics in the context of the industrial design engineer's profession. Through a series of assignments, in which student groups have to analyse and improve a household appliance, the traditional ecodesign skills are tested.

Lessons learned: the field of sustainable product design has gained both scope and depth in recent years. In order to offer an overview of the field in a 3 ECTS course, decisions have to made what to address and what not. Splitting factual information (which can be learnt by self

study) and contextual information may be necessary. However, bachelor students are more likely to want to absorb ready-to-eat chunks of knowledge, and are not experienced yet in digesting contextual insights.

3.2 Design 5 (ID3051, Bachelor, compulsory)

In the second semester of the last year of the DUT-IDE's bachelor curriculum, the content focus is on the integration of abilities, including, as such, the integration of sustainability issues into product design. The main course that addresses the latter is the so-called Design 5 course. In this course, that addresses most of the Product Development Process (PDP) chain (from mission statement to conceptualisation), students are required to explicitly address sustainability issues, while at the same time taking traditional business considerations into account, as well. This course is clustered in a 16 ECTS course cluster with theoretical courses addressing 'Product Development in Industrial Context' and 'Market and Consumer'. The objective is to encourage students to apply the theory obtained from these latter courses into the Design 5 course.

The course format for this course is as follows: Teams of five students each are simulated to operate as 'young product innovation consultancies', and to profile themselves as such through the use of logos, presentation templates, etcetera. Based on a business case description which they receive in the first week, students advance through a number of stages that represent, in an extremely compressed time frame, the complete product development process. After each stage, which usually takes one week, their assignment is to report to an (impersonator of a) company representative referred to as 'the client'. Selected business cases are usually based upon SMEs with little or no prior experience with sustainability issues. The businesses are real-life companies; the business case descriptions are however, partly fictitious.

In Boks and Diehl [8] the considerations for setting up and improving this course are extensively addressed, as well as a number of lessons learned. The most important lessons were the insight that it should be considered a satisfactory result when students have both identified and evaluated options for sustainable product concepts. If this means that the final concept choice does not exhibit an explicit 'sustainability flavour', it does not mean that students failed, it just means that given the short term horizon of the business, alternative solutions for product innovation were simply more attractive. Secondly, Design 5 has taught that putting sustainability in a wider scope, to include for example issues around consumer safety, has, at least, helped to make staff members that are usually not involved in sustainable product design, better accept sustainability as a source for creativity and evaluation. There is however a pitfall. Whereas incremental redesign, i.e. taking into account basic ecodesign principles, is generally easily addressed by students, accepting safety and well-being in general as equally important elements of sustainability clearly takes away attention of environmental issues, especially in terms of product and function innovation. It is currently discussed within the DfS staff to what extent this is an acceptable development.

3.3 Life Cycle Design and Engineering (ID4125, Master, compulsory)

As a result of the nation-wide transformation from a traditional Dutch 5 year curriculum to an internationally more common Bachelor-Master structure, and the subsequent establishment of the Integrated Product Design (IPD) master, a new 21 ECTS course cluster was developed, encompassing the courses Life Cycle Engineering and Design (LCED), Smart Systems and Technologies, Advanced Design Support and Project Advanced Products (PAP). The idea is that in the first three courses, students primarily learn theory which is then to be applied in a PAP assignment, which is practical rather than theoretical and is to be carried out for industry. Sustainability is prominent in the LCED course. The content of LCED is based on the idea

that students need to become (more) aware of what it means to develop product life cycles, instead of just 'products'. This is done on basis of the insight that various life cycles play a role in product development. Any product development project will include different stages between idea generation and market launch. Products that are launched will generally pass through stages of growth, saturation and decline in market share. At the same time, products interact with a range of stakeholders during their existence, both while still under development and while in use by the end customer. From an environmental perspective products are often assessed from the perspective of raw materials extraction, manufacturing, transport and distribution, use, and end-of-life. Depending on the perspectives taken, product developers are faced with many different kinds of challenges, trade-offs, and decisions to be made. Many of these are related to choices for different technologies, such as energy technologies and materials application.

Although LCED is not an environmental course per se, this awareness creation is done using a number of topics that have a clear connection with sustainability thinking. For example, it is believed that every industrial design engineer should now what a fuel cell is and should recognize an opportunity for application! In LCED, a number of such topics are bundled together and offered as intellectual and operational baggage for further professional careers. Although the course format is primarily based on lectures, students are required to hand in questions prior to selected lectures, encouraging them to read relevant material before the lectures, which should improve absorption of the material offered during lectures, and a sense of involvement in discussions.

Two other assignments exist for LCED, namely the Dilemma Assignment and the Stakeholder Assignment. As LCED runs parallel to the Project Advanced Products, a few weeks into their PAP assignment, students need to hand in the first part of their so-called Dilemma Assignment. Here, groups are to hand in 5 design or development 'dilemmas' that they have encountered or expect to encounter in their PAP project, such as using less materials resulting in less cost and lower environmental impact versus using more materials with higher reliability and robustness as a result, or development of a sustainable innovative solution with a big market potential on a medium long time horizon (relatively high uncertainty) versus development of an incremental solution that will provide less profit but is less risky. At the end of the course, students need to reflect on these dilemmas in the second part of their Dilemma Assignment. The Stakeholder Assignment involves a description of a particular product (usually the PAP product) and the system around the product, as well a description and discussion of all relevant stakeholders that play a role at every stage of the life-cycle. Within chose system boundaries, students need to indicate flows of money, materials and information between the most relevant stakeholders, and perform both an environmental and economical assessment for the life-cycle of the product, for a particular stakeholder of their choice.

This assignment clearly reflects the choice to teach based on a 'product life cycle design' perspective rather than a mere 'product design' perspective, as indicated in section 3 of this paper.

Various lessons learned regarding this course were already presented in Boks and Remmerswaal [9]. These included the insight that students have difficulties with developing their own evaluation methods for multi criteria decision making, as is basically required in this course. However, the experience is also that letting students develop their own methods can be considered a very good learning experience and may even lead to benefits that exceed those of using standardized tools. Another issue that has come forward is that students need to be made better aware of the possibility to represent their findings in a relative way (for example by comparing product life cycle evaluation with alternative products) as apparently this does not come natural.

3.4 Applied Environmental Design (ID5351, Master, elective)

Since 2001, an elective course named Applied Environmental Design has been dedicated to practical application of ecodesign principles in the context of the electronics industry. The content addressed various topics related to design, engineering and management of environmental issues in industry. In the period 2001-2004, the course format has been primarily traditional lectures as well as a practical disassembly session based on which students had to write an assignment consisting of a disassembly and improvement analysis, an essay and a take home exam.

Several lessons learned were already pointed out in Boks and Stevels [10], in which this course is described in more detail. All of these were related to the large amount of material that can be offered potentially (and which partly needs to be offered in order to be able to fulfil the course objective of putting ecodesign principles in industrial perspective), and which is too comprehensive to present in depth in the available time – especially as it is the wish of the supervisors to allow for spontaneous discussions on adjacent issues – which are frequently brought up by the students. This brings a dilemma between offering less material with sufficient depth, and offering a wide range of subjects to provide a general overview without going very much into detail on separate issue (see continued discussion in section 5.3).

3.5 Environment and Design in Business (ID5355, elective)

Because of growing knowledge and understanding, and increased interest from students (also in terms of wanting to discuss rather than just learn), in 2005 the content of the Applied Environmental Design course has been split into two new courses. One course – still with the name Applied Environmental Design (AED) – focuses, more than before, on design and engineering principles. Product analysis and improvement in industrial context are the backbone topics of this course. However, ecodesign has in recent years evolved beyond design and engineering principles only, and has gained significant interest from management and social sciences. Consequently, topics with a more managerial content, that were previously only marginally discussed, needed to find a place in the curriculum. To this end, a new course was created, named Environment and Design in Business (EDB). Whereas AED focuses on the ability to apply theoretical knowledge in product design, the content of EDB focuses on understanding the (much less unambiguous) role of environmental issues in managing ecodesign. The main issues discussed in this course are (1)Various angles on environmental performance measurement, (2) The role of environmental value chains in implementation and management of ecodesign, (3) Green purchasing, (4) Green marketing, (5) Organisation of take-back systems, and (6) Organisation of strategies, roadmaps and processes. Because of the relative immaturity of this scientific subdiscipline, and the range of opinions that exist on these topics, the course itself lends itself better for a course format based on interaction and discussion with students. One of the main aims of the course is to make students acknowledge that there are multiple stakeholder perspectives involved, such as the consumer's view, the OEM's view, environmental organizations, consumer organizations, legislation, press, academics etc., but that multiple views also exist within companies, which can 'make or break' implementation. Many students interested in eco-design are mainly aware of the environmental organizations' view of eco-design, and are not yet capable of seeing eco-design in mainstream business practice. Electives like this attract highly motivated students that respond to the challenge to collect additional material in preparing for class. Hence, discussion is highly animated, which often results in crowding out the prepared lecture. The discussions were stimulated by the assignment form, for which students were challenged to bring forward propositions based on comparing actual sustainability reports by electronics multinationals. The final assignment consisted of writing a real letter to an electronics company, discussing their performance based on the contents of their sustainability report.

As Environment and Design in Business is a new course, lessons learned are based on the 2005 course only. However, it became very clear that this course format is extremely rewarding for both students and teachers. Involving students in discussions by daring them to provocative propositions (that often reflect their personalities and ideologies) and by making them write real letters to real companies creates a situation in which they are highly motivated to do the preparatory work required.

3.6 Product Service Systems (ID5561, elective)

Research into Product Service Systems (PSS) has received an increasing amount of attention in recent years. To improve the success rate of the sustainable product services systems, the available knowledge from more traditional new product development and new service development should be integrated with PSS theory. This conclusion and the findings of the reflective practice with the development of product- service systems at the Design for Sustainability (DfS) Program were the driving forces to start an innovative course linking business school students of the Erasmus University Rotterdam (EUR) with Industrial Design Engineering students of the Delft University of Technology (DUT). Linking these kinds of school has the potential to fill the needed knowledge spectrum to improve the success rate of PSS. As for content, during seven weeks students were provided with parallel courses on entrepreneurship, new business and new venture development and the combined product service design. Students from the DUT were specially trained to work with a new PSS-module developed for the forthcoming UNEP manual 'Design for Sustainability' (D4S) [11]. Although students from DUT were familiar with the concept of *sustainable* PSSs, sustainability was not a prerequisite for the group assignment together with the business school students.

The course format for this course was unique: students groups were challenged to participate in the Dutch New Venture 2004 contest (www.newventure.nl). Another challenge was offered by the organization Area 010 (www.area010.nl). This business incubator in the Rotterdam area is willing to facilitate the best business plans with a hundred days of consultancy for transferring the plans into real businesses. The primary goal of the assignment was the development of a new business or a new venture. Groups dealing with new business development had to come up with a concrete plan for a new activity within an existing company. Groups dealing with new venture development had to deliver a business plan for a start-up company.

This course provided a number of lessons learned. Most importantly, not forcing sustainability into the solutions, but providing the students with the knowledge and tools necessary to be able to develop a sustainable solution was one of the important conclusions brought into practice this way. To keep sustainability on the 'agenda' during the development process of seven weeks, the students were asked to use an assessment tool covering the three dimensions of sustainability – people, profit and planet - to test the feasibility of the ideas, concept and plans. This tool is based on the 'LIDS-wheel' [12] (planet) and is extended with similar 'wheel' for the socio-cultural (people) and the economic (profit) dimension.

4. Conclusion and outlook

In recent years, students have become increasingly interested in sustainability issues, and often have a pro-active and positive attitude towards integrating sustainability concerns into what is to become their professional careers as industrial design engineers. However, throughout their university education, this is often based on ideological thinking, lacking a complete perspective, in particular that of industry. Leaving a mere product focus, and offering education based on a product life-cycle focus, addressing stakeholder needs and interpretations from actors both within and external to companies, offers the opportunity to

address sustainable product design from many sides. In the experience of DUT-IDE, that when students are properly triggered, they become curious about the mechanisms through which sustainability plays a role in society, and industry in particular. It has been a learning trajectory for the DfS staff how to incorporate developments in product-related sustainability thinking in the 'regular' IDE curriculum, and obviously this is an ever developing process. This paper however has presented the current Sustainable Product Design course portfolio as it is currently taught. It has presented each of the six most relevant courses in terms of content, course format, assignment, and lessons learned. It has been pointed out that in the experience of DfS, communicating sustainability criteria is most successfully when done in an integrative setting, mimicking real life design problems. There, students learn to face the challenge of addressing multiple criteria. Making them think on how to solve such dilemmas, through discussion, through letting them create their own tools, or even by letting them experience themselves in which cases environmental concerns will often be outweighed by more traditional business criteria, makes students more realistic on one hand, but also more aware of how to channel their positive attitude towards good design solutions that are likely to get implemented.

As said, the presented course portfolio is a snapshot in time. Developments in society make that the development of course material never comes to a halt. Especially in the field of sustainable product design, with its multidisciplinary nature as well as fast societal developments, this is true. It is expected that in the years to come, new topics related to sustainability thinking will find their way into the various Industrial Design Engineering.

The curriculum of Industrial Design Engineering is changing as well; it is expected that in 2007 a new Bachelor curriculum will be implemented. Discussions are on the way about the integration of sustainability into this new curriculum. Likely, the new curriculum will see sustainability integrated in a new course addressing socio-economic and cultural aspects of industrial design engineering. This provides an opportunity to discuss sustainability in the context of other societal developments, and will facilitate interaction with other teaching staff. However, it remains to be seen what the consequences will be of not devoting a dedicated Bachelor's course to sustainable product design. The DfS staff will report on these new experiences in future publications, as it is considered very important to share these developments and underlying considerations with fellow teaching scholars in academia.

References

[1] Brezet, H. et al. (1994). Promise: Handleiding voor milieugerichte productontwikkeling. ’s-Gravenhage: SDU Uitgeverij

[2] Brezet, H., and van Hemel, C. (1997) *Ecodesign: A promising approach to sustainable production and consumption*. United Nations Environment Programme (UNEP), Paris

[3] Prahalad, C. K. and A. Hammon (2002). "Serving the World's Poor, Profitably." Harvard Business Review.

[4] Prahalad, C. K., Hart, S. 2002. The fortune at the bottom of the pyramid. Strategy Business, Issue 26: 54–67

[5] Jeswiet, J., Luttropp, C., EcoDesign Courseware Cooperative, CIRP Journal of Manufacturing Systems, Vol 34 (2005), No 1.

[6] Jørgensen, M.S., Bey, N., Hauschild, M., Education and training in LCA and life-cycle thinking – experience and needs, CIRP seminar on Life Cycle Engineering, May 2003, Copenhagen, Denmark

[7] Christiaans, H.H.C.M., 1992, Creativity in design: the role of domain knowledge in designing. Utrecht: Lemma

[8] Boks, C., Diehl, J.C., 2006, Integration of Sustainability in Regular Courses: Experiences in Industrial Design Engineering. Accepted for publication in the Journal of Cleaner Production.

[9] Boks, C., Remmerswaal, H., 2004, Life Cycle Costing: How students develop their own methods, Proceedings of the International Conference on Engineering Education in Sustainable Development, October 27-29, 2004, Barcelona, Spain

[10] Boks, C., Stevels, A., 2002, Experiences with Teaching Applied Environmental Design. Engineering Education in Sustainable Development. October 24th/25th 2002, Delft, The Netherlands

[11] Tischner, U. and C. Vezzoli, 2006, *Sustainable Product Service Systems*, in *D4S (Design for Sustainability) Manual*. (forthcoming), Delft University Press: Delft.

[12] Brezet, H. and van Hemel, C.,1997, *Ecodesign; a promising approach to sustainable production and consumption*. United Nations Environmental Programme.