

# HOW TO INCORPORATE SUSTAINABLE DESIGN IN THE INTERNATIONAL EUROPEAN PROJECT SEMESTER PROGRAMME: INSIGHTS FROM PRACTICE

**Elli VERHULST<sup>1</sup>, Sarah ROHAERT<sup>2</sup> and Karine VAN DOORSSELAER<sup>2</sup>**

<sup>1</sup> Norwegian University of Science and Technology, Norway

<sup>2</sup> University of Antwerp, Belgium

## **ABSTRACT**

Sustainable design is highly relevant for design and engineering education, as designers and engineers are the ones that shape the (future) world. They can support a move towards achieving sustainable transformations. This article focuses on an educational initiative that incorporates knowledge and insights on sustainable design with the skills and attitude needed for interdisciplinary and international collaboration in a context of problem based learning. The article describes the approach taken for integrating sustainable design in the European Project Semester Programme, and how the content of the course has supported the student projects. The article concludes with lessons learned and future opportunities for further integrating sustainable design in an interdisciplinary educational programme.

*Keywords: Sustainable design education, interdisciplinary projects, international collaboration, problem based learning.*

## 1 INTRODUCTION

Design and engineering education plays an important role in equipping its students with the necessary knowledge, insights, skills and attitudes that are needed in order to deal with the challenges the world faces. In order to tackle these challenges, graduates need to be able to work in interdisciplinary teams, often in an international context, and with a focus on current and future problems. Many of these challenges are related to sustainable development, such as climate change, resources, health issues, energy, etc. [1]. Sustainable design is one of the aspects that can support sustainable development and that is highly relevant for design and engineering education, as professional designers and engineers are the ones that do and will shape the (future) world, whereby they can support a move towards achieving sustainable transformations [2].

This article focuses on an educational initiative that incorporates knowledge and insights on sustainable design with the skills and attitude needed for interdisciplinary and international collaboration in a context of problem based learning. This context is the European Project Semester (EPS) Programme, an educational programme that assembles students from different backgrounds – both educational and geographical – interdisciplinary teams. The aim of the article is to offer insights on how sustainable design has been integrated in the EPS programme at the University of Antwerp in the Spring semesters of 2013 and 2014. Next to the approach taken to integrate sustainability in the programme, the paper describes how the content of the course has been applied by the students in their projects. The article goes also deeper into lessons learned from our experiences and suggests improvements and possibilities for further integrating sustainable design in the EPS programme.

## 2 THE EPS PROGRAMME

The EPS programme is an international educational programme that brings together students from different disciplines, backgrounds and nationalities during one semester. It offers the students a framework to practice cross-disciplinary product innovation and research in small teams [3]. Next to interdisciplinary project work, the students are challenged by courses taught by local and international guest lecturers. The projects always start with a specified problem statement and take place in a real-world environment in close cooperation with local industry. Since 2011, the University of Antwerp is

one of the providers within Europe that offers the EPS programme to 25-30 of their own and exchange students, with a focus on the study programmes *product development, engineering, business studies, social work* and *teacher training*. Sustainable design has been added as one of the courses in the programme since 2013, thereby anticipating on the growing need for integrating sustainability in higher education. The early inclusion of the sustainable design course in the EPS programme at the University of Antwerp gave the flexibility to shape and adapt both the course and the programme to each other's needs and to arising opportunities, which strengthened the integration of sustainability within the complete semester.

### 3 SUSTAINABLE DESIGN IN THE EPS PROGRAMME

Higher education has the important task to prepare its graduates for the challenges the world faces. Many of these challenges are related to sustainable development. It is thus important to provide students with the insights and skills that can support societies to become more sustainable [4, 5]. The approach taken to integrate sustainable design in the EPS programme aims at supporting the students' competences for sustainable development, combining the four different aspects of competences: knowledge, insight, skills and attitude [4].

Competences for sustainable development can be divided into generic competences and field-specific professional competences. This first group of competences applies to everyone, regardless the area of study, and its goal is that students, - as future professionals, policy makers and consumers – are capable of reacting to changing situations and complex challenges in society such as globalisation, climate change, etc. [6]. Roorda presents six basic competences: responsibility, emotional intelligence, system-oriented, future-oriented, personal commitment and practical ability [7].

The manner in which the EPS programme is organised encourages and supports the students to develop most – if not all – of these generic competences for sustainable development. The interdisciplinary project work strengthens the development of different social and communicative skills that are needed to successfully collaborate in team, which increases emotional intelligence [3]. Moreover, the EPS programme strongly focuses on other aspects of collaborative and interdisciplinary work such as the division of responsibilities and the follow-up of personal commitment. Furthermore, all the projects the students work on focus on value creation for now and the future, and they require a systemic perspective from the students in order to bring together knowledge and skills from their different backgrounds and educational disciplines.

Supplementary to the generic competences, the course on sustainable design aims at supporting the development of specific professional competences by offering theoretical knowledge on environmental and social aspects of sustainable design, as well as it offers the opportunity to reflect on and apply this new knowledge in the semester projects. The sustainable design course is a course with a weight of 2 ECTS credits, led by two experienced sustainable design (guest) lecturers. The student group counts around 30-35 students (6-7 semester projects) each year. Teaching methods used in the course are interactive lectures, project work and a presentation of the results by the students. Most of the courses, work sessions and the presentations take place in a one week timeslot, which make it an intensive course for both lecturers and students. It preferably takes place in the concept stage of the EPS semester (between weeks 4-10 of the project), as this is the period in which the students have had enough time to get acquainted with the team, the project goals and its background, and they still have sufficient space and time to integrate sustainability within their projects.

Each of the elements of the sustainable design course within the EPS programme is explained in more detail within the following sections, thereby also indicating how it supports the different aspects of competences (knowledge, insight, skills and attitude).

#### **3.1 Knowledge on environmental and socially sustainable design strategies**

Theoretical knowledge on environmental and social aspects of sustainable design is offered in two parts of the course, each given by a different lecturer with her own specific expertise. The first part of the course introduces sustainable design, including the basics of life cycle thinking and the triple bottom line of sustainable development and design. It focuses on the environmental aspects of sustainable design and offers insights in ecodesign tools and strategies. The second part of the course targets social aspects of sustainable design. This includes an introduction on different sustainable design strategies such as design for sustainable behaviour, product service systems and system thinking, and sustainability in Do-It-Yourself (DIY). In total, the students have 6 hours of lectures in

which this knowledge is presented to them in an interactive manner. However, in order to create sustainable value, it is equally important to be able to reflect on and apply the new knowledge in society, which is what the students do in the following part of the course.

### **3.2 Integration of sustainability in the EPS projects**

In the practical part of the course, the student teams are asked to select and apply sustainable design strategies within their semester project. This means that the students need to reflect on the presented material and on the importance and relevance of the different strategies for sustainable design in the case of their specific project. The first aspect of the assignment for the students is to make a selection of strategies that are most relevant for their project, as well as to discuss and develop the argumentation behind their choice. No selection criteria are thereby given. The reasoning behind this reflective exercise is to let the students make the switch from gathering *knowledge* – based on the lectures - into getting *insight* on the different strategies for sustainable design, their relevance, possible impact, feasibility and their possible application in the context of their project.

Subsequently, the students are given the assignment to apply the selected strategy (or strategies) into their semester project. This step supports the development of the students' sustainable design *skills*. In practice, this means that the students work on different aspects and elements of one or some of the selected strategies, whereby each sustainable design strategy has its own specificity. The following overview indicates the main elements of each of the strategies the students need to consider.

#### **Ecodesign strategy using the Life Cycle Design Strategies (LiDS) wheel and life cycle thinking.**

The students study the life cycle of their product and/or service within their project with the help of the LiDS wheel [8]. This tool indicates the different stages in the life cycle of a product/service with design strategies that fit each stage in a spin chart, visualising both the current and improved design solution. It supports the students in understanding the life cycle and in selecting relevant environmental strategies for their project, such as focusing on diminishing material use, selecting environmentally friendly materials, focus on the use stage of the product, extending the lifespan, etc.

**Design for sustainable behaviour.** The selection of this strategy implicates that the students make an analysis of the current behaviour of their target group. Main principles from social practice theory can support them by gaining these insights, such as the use of the elements material, skills and image that together can form a practice [9]. Based on the understanding of the current behaviour, the students need to define the wanted behaviour of their users in the context of their project. After doing this, the students can look for opportunities to influence the behaviour, using models on behavioural change and tools that present and support the selection of different principles for design for sustainable behaviour [10, 11]. During this work, the students also reflect on and apply main principles of design for sustainable behaviour, such as the distribution of control [10].

**Product Service Systems (PSS).** The selection of this strategy gives the students the opportunity to frame their project in a systemic context that brings together the physical product(s) and the service(s) they are developing. The students need to define the type of PSS (product, use or result oriented) that best represents their project [12], reflect on the stakeholders that are relevant for the PSS, define the PSS function and its energy, material and information flows, work out a PSS user scenario and develop a draft of the system with its different elements and flows [13]. Examples and a PSS template support the students in this process.

**Do-It-Yourself (DIY).** This strategy makes the students reflect on the accessibility of their project: how 'open' is it for others that are not part of the project team, but that can add sustainable value to the result? And how can the students facilitate this external knowledge and create the project in cooperation with users and other people that are involved and interested in their project? The selection of this strategy invites the students – in cooperation with the external project partner - to discuss the questions above and to discover if and how their project can become a platform for sustainable design that makes people share interest and knowledge and create a more sustainable world together [14, 15]. Applying the knowledge and learning the new skills of the presented sustainable design strategies also has an impact on the students' *attitude* towards sustainable design, however, this is not discussed further in this article. The following section presents the results of the student work in the EPS programme at the University of Antwerp in the spring semesters of 2013 and 2014.

## 4 SUSTAINABLE DESIGN IN THE PROJECT RESULTS

As a last part of the sustainable design course, the student teams present their work to the complete group. In this presentation, the students explain the selected sustainable design strategies in function of their semester project, the rationale behind that strategy choice, as well as how the group can and will integrate these strategies in their project. The presentation of the project results has a dual goal: to share the results with the complete group of EPS students so they can learn from each other and see how sustainable design strategies can be applied in different contexts, as well as to score the students on the work they delivered.

In the spring semester of 2013, six EPS projects were completed with the following topics: *home-made wind turbines, an interactive game to teach children about the history of music, an interactive cultural tour in a challenging intercultural area in the city of Antwerp, an interactive exposition about nuclear waste, a mobile snuggle space for children, and an e-board game that uses NFC technology.*

In the 2014 spring semester, five project covered the topics: *a follow-up of the interactive cultural tour in Antwerp, an interactive game for youngsters for the zoo of Antwerp, a hospital cocoon for new-born babies, a security awareness campaign in cooperation with a large international consultancy agency, and the development of a headset that can measure brain waves and brain activity* (more information on the projects on <http://eps.ap.be/>). As one can notice, there is a large variety on the project topics. This makes it interesting to see the selection of sustainable design strategies, but on the other hand, it also makes it difficult to generalise the results of the work done. However, reviewing the results from the courses in 2013 and 2014 gives interesting preliminary insights on how this course influences and supports the students, their projects and the broader EPS programme.

### 4.1 Selection of strategies

The selection process of relevant strategies for sustainable design for their project is an important aspect of the course, as it is there and then that the students need to understand what the different strategies entail, but also what the consequences of their choice are to their project. In order to make this reflection, a lot of freedom is given to the students, i.e. which selection criteria to use. Within the different groups and projects, and both in 2013 and 2014, it is clear that most project teams selected more than one strategy, and some teams selected all strategies to be relevant and to be applied in their project. This indicates that the sustainable design strategies presented to the students are considered relevant to their projects. Next to that, the argumentation behind the selected strategies is however rather limited, and sometimes even missing, although it is one of the questions asked in the student assignment for this course. The difficulty of selecting the most relevant strategy, together with the latter observation on a lack of argumentation of the students' choice, might indicate that the students reflect insufficiently on their choice and the consequences of that choice for their project and that this need for *insight* asks for more attention and emphasis in the course.

In 2013, the use of the LiDS wheel and design for sustainable behaviour were selected as the strategies to apply in the majority of the projects, whereas PSS and DIY were selected and applied in only two projects that year. A change in the time plan of the course in 2014, together with the limited applicability in the projects made us decide to remove DIY as a strategy in that edition of the course. PSS was kept as both the course lecturers and the EPS coordinator saw a high potential for applying this strategy in the projects for that year's EPS programme.

### 4.2 Application of strategies

An interesting observation on the application of the selected strategies in the semester projects is that the different groups selected some elements within each strategy that they consider interesting and applied these to their project. The two groups that selected PSS as a strategy in 2013 for example only defined the type of PSS that fits their project and a first, rough idea of how products and services can be combined in their project. Whereas design for sustainable behaviour as a strategy was selected in five projects in 2013, but four of the teams only used the 'design with intent' toolkit as a way of applying this strategy to their project. This user-friendly tool offers 101 inspiring patterns for influencing behaviour through design and can be used for brainstorming or as guidance for exploring the field of design for behavioural change [11]. One team made an analysis to understand, define and influence the current behaviour of their users. The restricted time of this course could explain the limited depth in which the students can elaborate their work and integrate the selected strategies in their project. However, a shift can be noticed in the results of 2014, in which several groups looked at

the elements of the PSS and benefits for different stakeholders, as well as they made a draft of the PSS system and a functional analysis of the system. A similar path can be seen in the application of design for sustainable behaviour as a strategy, in which three of the groups that applied this strategy looked at understanding, defining and influencing behaviour. Two main changes in the course might offer an explanation for this improvement in the results: a) the limitation of strategies from four to three, which makes it easier for the students to focus and b) the introduction of a consultation and feedback moment per group, after the theoretical classes were given and before the students presented their work to the complete group.

The application of strategies for sustainable design has given new insights to students and the sustainability perspective has offered new opportunities and possibilities for the projects that the students did not consider previously. This is reflected in some of the reports of the groups, in which the students emphasize the added value of the sustainability perspective for their project, e.g. *'This course helped us improve our project by creating a surplus value (planet, people, profit). By doing this, our product becomes more interesting for both the company and the consumers'* (Scabbls – snuggle space team report).

## 5 LESSONS LEARNED AND FUTURE DIRECTIONS

A reflection on the sustainable design course and its results within the EPS programme of 2013 and 2014 offer some lessons learned and possible future directions. The aim of the sustainable design course is to offer the students theoretical knowledge on environmental and social aspects of sustainable design, as well as to offer the opportunity to apply this knowledge in the students' semester projects.

A first lesson learned comes from the results of the course that are shortly discussed in this article. They indicate that the strategies that are presented in class, such as environmental strategies assembled in the LiDS wheel, PSS and others, are highly relevant for the EPS students and the semester projects they work on. Indications are however also given on the limited depth of applying the sustainable design strategies in the project. This might result from strong time constraints of the course in general, but it might also be linked to the students' selection of several strategies, which implicates a higher work load within different areas of expertise. Moreover, the argumentation behind the strategy selection pinpoints a limited reflection of the students on their choice as well as on the consequences of that choice. More attention needs to be given to the students' insights in order to be able to make a good selection of sustainable design strategies. This could be done by guiding the selection process more by making the selection criteria more explicit. Selection can e.g. be based on the relevance of the strategy for the project, feasibility of applying it, possible impact of the strategy, available knowledge and skills in the team, etc.

A second lesson learned also applies to the limited depth of integrating the selected strategies as described above. A lot of new knowledge is presented to the students, after which they are expected to apply this new knowledge in a short time span. The results of the course indicate that bits and pieces of each selected strategy have been integrated in the different EPS projects and this new perspective is indicated by the students to strengthen the projects. However, it does not lead to a profound understanding of one or more of the strategies. What these insights offered us is to reflect on the necessity for the students of fully grasping one or more of the sustainable design strategies, or if it is more important to offer them an introduction to different opportunities on how sustainability can find access to their projects. A future direction could be to spread the course over time within the semester, in which the students first get the theoretical classes, and subsequently get some time to digest the new knowledge and to start applying it in their projects. A session some weeks later can provide the students with feedback on how they are integrating sustainability in their project, which can support the further integration of the selected sustainable design strategy into the project's progress.

A third lesson learned concerns the aim to support competences for sustainable design, including knowledge, insight, skills and attitude. Knowledge and skills are covered well within the course, and a stronger focus on insight and reflection from the students has been discussed previously. However, the attitude towards sustainable design from the students has been underexposed in this article. This can be explained due to a lack of available measurements on attitude. Assessment of the EPS semester programme combines grading on the project result, process assessment, peer reviews and reflections from the students, and grading on the supporting courses. Measuring the (change in) attitude towards

sustainability from the students could be integrated in this assessment process, e.g. with a survey or as part of the reflective writing process.

A fourth and last lesson learned is related to the content of the projects. As described earlier, the projects cover a high variety of subjects. Some of these projects do have an environmental or sustainable focus, e.g. the home-made wind turbines, whereas other projects have other priorities, e.g. a security awareness campaign. The course aims at offering some interesting insights to all kinds of projects by including different sustainable design strategies, however there can still be variations in the potential and applicability of these strategies within the different projects. How to deal with this, especially in the scoring process, is an issue that needs further attention.

Although there are still improvements possible, we do believe that the sustainable design course within the EPS programme supports the development of sustainability competences of our students.

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