

# INTEGRATING SUSTAINABILITY AND INNOVATION THROUGH A MASTER'S PROGRAM IN PRODUCT-SERVICE SYSTEMS

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## Abstract

The results of unsustainable product innovation are evident worldwide. Products and their usage contribute to global sustainability problems. Companies building competence in innovation for sustainability will therefore gain competitive advantages in the evolving sustainability-driven market at the same time as sustainability is a driving force for innovation.

Blekinge Institute of Technology (BTH) has a research group that brings together competences with the unifying purpose of supporting industrial capacity for *sustainable product-service system innovation*. From this research, it is evident that there is a need for systems innovators who can help create leap frog solutions as well as make sure that incremental improvements fit into a viable strategy towards a sustainable society. Industry needs people who can manage the whole innovation process for sustainability, including need-finding, design, implementation through to remanufacturing. BTH is therefore offering a comprehensive master's program to prepare people to be systems' innovators for sustainability.

This programme is focused where sustainability, innovation and product-service systems (PSS) meet. Supporting areas such as leadership, management and entrepreneurship are also included. The two-year program will allow students to engage in front-edge research results and will be continuously developed in close collaboration with industry to develop a relevant profile for graduates.

Students will be engaged in ongoing research projects and have industrial projects. Upon completion, students will have practical experience in using methods and tools that support sustainable product innovation, as well as have a thorough theoretical understanding as a basis for development of new supplementary methods and tools as necessary.

**Keywords:** *strategic sustainable development, product service-system innovation, ecodesign*

## 1. Introduction

At BTH a research environment called SPIRIT, Sustainable Product Innovation Research Initiative, has been developed during the past 15 years. This covers a range of competences, including development of a basic framework for strategic sustainable development, strategic life cycle modeling and simulation, methods for sustainable product development, and advanced simulation and calculation problems for how to optimize complex products. See e.g. Byggeth et al. 2007a, which presents a case study of a water jet cutting machine using an iterative optimization procedure that combines a technical assessment with a sustainability assessment. Sustainability assessment methods/tools can be first used to identify prominent sustainability problems from present-day flows and practices ("societal indicators") and to generate ideas of long-term solutions and visions.

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In the research group SPIRIT, several support tools and methods have been developed with the purpose to integrate a strategic sustainability perspective in product development, e.g. (Byggeth et al 2007b and Ny et. al. 2008). This research has also identified a need for a list of key improvements for how a company could integrate sustainability in its strategic decision system (Hallstedt et al, 2010). These recommendations are:

- (i) creating an overarching supporting organizational context, including senior management awareness and commitment to a widely adopted definition of sustainability, sustainability integration in business goals and policies, and, to that end, adequate resource allocation,
- (ii) institutionalizing internal company capacity building and communication on sustainability,
- (iii) introducing integrated methods, tools and indicators for both senior management and product development teams that focus on how to close the gap between the present situation and long-term socio-ecological sustainability.

Based on this research, we believe that to be effective in their work after studies, graduates of the MSPI programme should be able to:

- apply a strategic sustainability perspective within different technical competence areas
- contribute to a change through application and knowledge of different support tools and methods for Sustainable Product Development
- run sustainable innovation programmes/projects in companies and public organisations
- create innovative strategies for attractive Product Service System (PSS) offers - well oriented in different businesses and types of PSS

A successful pre-cursor to MSPI is the Master's programme in Strategic Leadership towards Sustainability (MSLS) which was launched in 2004 at Blekinge Institute of Technology. The MSLS programme was founded on knowledge and experience built up over a period of more than ten years, which included several activities such as the integration of sustainability concepts into the engineering education (Broman et al. 2002) and the development of the research area 'Sustainable Product Development and Innovation'. An objective evaluation of sustainability integration in engineering education also supports this: the Engineering Education for Sustainable Development (EESD) Observatory Report (Alliance for Global Sustainability 2009) ranked BTH number one in Sweden and number three in Europe for extent to which sustainability has been integrated in engineering educations.

The objective of this paper is to give ideas through an example of the Master's programme in Sustainable Product-Service System Innovation, of how to integrate sustainability and innovation through PSS. The purpose is also to present some ideas for how to cooperate with industry to create an industry relevant education.

## 2. MSPI Programme purpose and aims

The programme is focused around BTH's new profile areas: sustainability, innovation and systems engineering. Supporting areas such as mechanical engineering, leadership, management, entrepreneurship and economics are also included to some degree.

The program will include the concepts, methods and tools within the areas of strategic sustainable development, strategic life cycle modeling and simulation, creativity, entrepreneurship, business development, product planning, product development, product design, modeling and simulation-driven design and product realization. The first year gives a theoretical base within the area of sustainability, innovation and product-service systems (PSS), as well as practical applications of those tools. The second year will be characterized by industry-related projects and divided into two tracks: one that prepares students for further research after their master's programme, (research track) and the other more oriented toward preparation for a career in the business side, either as an entrepreneur or as a product development manager in a company. This is illustrated in Figure 1.

The two-year program will offer front-edge research results in different themes such as strategic sustainable development; innovation and entrepreneurship; and methods for sustainable product-service system development.

With regard to

- *Strategic sustainable development*: Students will become familiar with a framework for strategic sustainable development by applying it to different topics. Leadership and organizational learning concepts are embedded because a person cannot act for sustainability alone. Facts about the state of the world and major sustainability challenges are also included.
- *Innovation and entrepreneurship*: These are some of the key drivers for the economic growth of countries, industries, existing companies and new firms. Future managers and policy-makers need to be able to deal with the challenges of innovation, entrepreneurship, and business development in the intersection of management, technology and economics.
- *Method for sustainable product-service system development*: Students will learn about product-service system development methods and tools that support a full socio-ecological sustainability perspective and which are integrated with and utilize advanced IT support for product data management, knowledge enabled engineering, multi-criteria prioritization, etc. This draws directly from the leading edge research performed at BTH within this field. Upon completion, students will have practical experience in using such methods and tools as well as a thorough theoretical understanding as a basis for development of new supplementary methods and tools as necessary.

Research has shown that those who work with product innovation benefit greatly from having expertise in strategic sustainable development and have the ability to evaluate a product's positive and negative socio-ecological impact during its life cycle, as well as the related economic conditions and implications (Hallstedt et al. 2010). It is therefore necessary to have an overview of the system "society in the biosphere" -- and this is what the programme intends to deliver.

The aim of this Masters programme, in-line with the main purpose of research in sustainable product and service innovation at the university, are:

1. To support the sustainable development of global economy and society, and
2. To strengthen Swedish industry in the increasingly sustainability-driven global market.

An important objective of the program is that students will gain insight and knowledge of how different companies work. More specifically, the academic goals for the students are to be able to:

- Analyze sustainability challenges for an organization in a scientific manner.
- Introduce a strategic perspective of sustainability to a product innovation process in a company.
- Use new methods and tools, and former engineering specialty, to work with sustainable product and service innovation in industry.
- Support a transition towards a more service-oriented economy.

**Year 1**

Period 1	Period 2	Period 3	Period 4
Introduction to strategic sustainable development (7.5 credits)	Strategic Management for Sustainability (7.5 credits)	Methods for Sustainable Product Development (7.5 credits)	Systems Engineering (7.5 credits)
Innovative firm and entrepreneurship (7.5 credits)	Engineering for a Sustainable Society (7.5 credits)	Management of Innovation and Technology (7.5 credits)	Creativity and the Development Process (7.5 credits)

**Year 2 – Business innovation track**

Period 1	Period 2	Period 3	Period 4
User-centered Innovation (7.5 credits)	Business Plan Design (7.5 credits)	Master Thesis in Sustainable Product-Service System Innovation  (Project-based Business Plan Development with emphasis on Sustainable Product-Service System innovation)  (30 credits)	
Project PSS Extreme Innovation (15 credits)			

**Year 2 – Research track**

Period 1	Period 2	Period 3	Period 4
Product-Service System Design research (7.5 credits)	Scientific Methodology (7.5 credits)	Master Thesis in Sustainable Product-Service System Innovation  (30 credits)	
Project PSS Extreme Innovation (15 credits) Note: Same as the course in the above track)			

Figure 1: Programme structure of the Master Programme in Sustainable Product-Service System Innovation

Even though the programme is only in its first year, it has attracted applications from students in more than 36 countries from all regions of the world. In the first year, we are running it with 16 students, and expect to settle into around an average of 30 students

per class, representing 10-15 countries. A strength of this programme is that it is open to early- to mid-career professionals with a bachelor's degree in mechanical engineering, industrial design and industrial ecology, and therefore it can be a multi-disciplinary group of students every year. The diversity (age, culture, nationality, background, discipline, etc.) itself creates a rich learning environment that is valuable for the students and the industrial partners.

### **3. Collaboration with industry for an attractive student profile for industry**

This Master Programme is developed together with several industry partners to ensure that graduates will fulfill the requirements and needs of industry, including supporting and complementing the competences in industry. The industry partners represent different company types (small, medium and larger corporations), as well as different product, services, and PSS's. The industry partners are: Volvo Trucks Corporation, Volvo Aero Corporation, Volvo Construction Equipment AB, Dynapac Compaction Equipment AB, Coresource AB, Aura Light International AB, AB Tetra Pak, Blekinge Business Incubator AB, Cleantech Inn Sweden, Sapa Heat Transfer AB, and Ocean Harvesting Technologies AB.

These companies represent a broad range of industries and products/services, as well as bringing to this master's program a wide range of knowledge and experience. Many of these companies have been involved with our research and educational teams over the past many years through various research projects, while there are also some new companies that have been brought into this project. We expect this diversity to be a core strength of the MSPI program because it will inject diversity of thought into the approach of the MSPI program: innovation happens differently in big companies (e.g. Volvo Trucks) than it does in very small companies (e.g. Ocean Harvesting Technologies). By exposing students to these different approaches to innovation, they will see that innovation works in different ways in different settings. The diversity of industry and company size will also attract a wider range of students, who in their diversity will learn from and challenge each other.

Several activities that can generate advantages for all partners involved or have or will take place on a regular basis. Examples of such activities involve:

- Industry partners and education staff co-design courses and projects together to create a student profile that will fulfill the industry needs;
- Relevant study visits;
- Collaborative projects between industry and students;
- Development of course modules with industry examples and relevant guest lecturers;
- Development of practical thesis projects
- Create idea generating activities when the company partners together with students have ideas and insights with new perspectives, so called "brain-drain-creativity space".

One advantage for industry partners for being part of the external group is to be able to influence the graduate profile and thereby investing in competence that is needed in the future. Another advantage is that they are part of a network that can generate new contacts and partners in the area.

So far, the industry group has identified working areas where an MSPI graduate is expected to be able to fit. This means that a graduate should be able to:

- be part of a support group for development, production, customer support, marketing/sales;
- be able to understand product development processes and how sustainability can be included in them;
- be familiar with tools like life cycle assessment (LCA) and life cycle costing (LCC);
- demonstrate and use visualization tools for communication;
- extend traditional engineering competence into areas such as the environment, innovation, and customer value.
- contribute to product planning: connecting engineering, business development, customer needs to anticipate future customers' needs
- do sustainability reporting for the company, including planning, target setting
- know how to learn and to adapt to what each company needs
- be an entrepreneur and innovator

#### **4. Discussion**

There are many challenges to reach success in the field of higher education with focus on sustainability. For example it requires a deep understanding of complex theory and interdisciplinary research and processes (Dale and Newman, 2005). It is also of importance to give lecturers that inspire graduates to gain change agent skills so they also can actively engage in addressing and intervening in the sustainability challenges they will meet in their future jobs. (Down, 2006 and Svanström et. al., 2008). In the one year Master Programme in Strategic Leadership towards Sustainability given at Blekinge Institute of Technology the focus has been to merge two key themes - a "Framework for Strategic Sustainable Development" and "Personal and Organisational Leadership and Learning." The basic premise of the programme's design is that both these themes are needed to adequately affect a change towards a more sustainable society. The MSPI Programme will use this internationally attractive one year Master Programme as a good example for how to merge sustainability together with another subject.

Several factors come together to provide unique opportunities for MSPI to be an extremely valuable education programme. Demand for entrepreneurship in graduate education has continued to increase in recent times, and recent studies support the path that MSPI intends to take regarding entrepreneurship: shifting away from commercialization strategies commonly associated with entrepreneurial education, and instead focusing more on developing the essential skills that are key to developing confidence and competence that are essential to entrepreneurial capacity (Hegarty and Jones 2008). Bringing together sustainability and product-service systems present a truly unique opportunity to pursue the "transformative sustainability learning" by "engaging head, hands and heart" presented by Sipos et al. (2007) in support of the UN's Decade of Education for Sustainable Development.

Also used from the MSLS programme is a special pedagogical approach of learning loops (as described by Waldron and Leung 2009), that has been developed to take care of the advantages of having a diverse student group and at the same time let the students go progressively into more depth in their own special areas. The pedagogical approach adjusts the role of the teaching staff from initially lecturing (to provide basic content), then to active coaching (as students take on more responsibility for their own learning) and finally to an advisory role during the thesis.

One of the main strengths with the MSPI Programme is that it is developed in close cooperation with industry, which means that the graduate student will be relevant to industry. The students will also be able to do assignments and larger projects that are based on real-life problems as well as get a good understanding of the challenges and opportunities these companies are facing with regard to innovating towards more sustainable PSS. The weakness of the Programme is that it is a unique Programme with no graduates out in industry yet and students might hesitate to get an education in a new area. A threat to the programme is that it has not attracted many European students so far and the applications from non-European countries will probably decrease as a tuition fee is going to be introduced for the next application year.

The opportunities for the MSPI programme is to build educational programmes that use the same courses for their different educational programmes and thereby a large enough student group will make it economically possible to run the courses. In Sweden we still have a five-year Nordic Master and this can be built on a Bachelor and a two-year Master instead. This would give the students a higher flexibility and possibility to go deeper into a specialized area later on in their education.

## **5. Conclusion**

Research has shown that products and their usage contribute to global sustainability problems. Furthermore a product's socio-ecological impacts - positive and negative throughout its life cycle - are largely determined by decisions during phases of the product innovation process. Companies building competence in innovation for sustainability will therefore gain competitive advantages in the evolving sustainability-driven market at the same time as sustainability is a driving force for innovation.

There is a need for system innovators that can manage the whole innovation process for sustainability – including need-finding, design, implementation through to remanufacturing. BTH is therefore now offering a comprehensive master's program to prepare people to be systems innovators for sustainability. This paper has presented ideas of how to merge sustainability and innovation through product-service systems in a Master's Programme. It has also presented some ideas for how to cooperate with industry to create an industry relevant and attractive educational programme.

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