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Organisations

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Publications:

Ecodesign Implementation and LCA
Ecodesign is a proactive product development approach that integrates environmental considerations into the early stages of the product development process so to improve the environmental performance of products. In this chapter, the ecodesign concept will be discussed, in terms of its implementation into manufacturing companies. Existing methods and tools for ecodesign implementation will be described, focusing on a multifaceted approach to environmental improvement through product development. Additionally, the use of LCA in an ecodesign implementation context will be further described in terms of the challenges and opportunities, together with the discussion of a selection of simplified LCA tools. Finally, a seven-step approach for ecodesign implementation which has been applied by several companies will be described.

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Authors: McAloone, T. C. (Intern), Pigosso, D. C. A. (Intern)
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Linking ecodesign capabilities to corporate performance: proposal of a simulation-based approach
The absence of mechanisms to evaluate the potential benefits of ecodesign prior to implementation is a major barrier to wider adoption. There is a need to understand how the development of ecodesign capabilities affect corporate performance considering its dynamic complexity. Drawing upon the Ecodesign Maturity Model, this paper systematically
reviews the literature on relevant applications of dynamic modeling and develops the foundations of a simulation framework, aimed at deriving business cases for ecodesign implementation. Preliminary results and streams of future research are discussed.

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A DSM-based framework for integrated function modelling: concept, application and evaluation

Function modelling is proposed in the literature from different disciplines, in interdisciplinary approaches, and used in practice with the intention of facilitating system conceptualisation. However, function models across disciplines are largely diverse addressing different function modelling perspectives and using different structures and forms for representing the contained information. This hampers the exchange of information between the models and poses particular challenges to joint modelling and shared comprehension between designers from different disciplines. This article proposes an integrated function modelling framework, which specifically aims at relating between the different function modelling perspectives prominently addressed in different disciplines. It uses interlinked matrices based on the concept of DSM and MDM in order to facilitate cross-disciplinary modelling and analysis of the functionality of a system. The article further presents the application of the framework based on a product example. Finally, an empirical study in industry is presented. Therein, feedback on the potential of the proposed framework to support interdisciplinary design practice as well as on areas of further improvement has been obtained from participants working in industry.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Delft University of Technology, University of Luxembourg, Singapore University of Technology and Design
Authors: Eisenbart, B. (Ekstern), Gericke, K. (Ekstern), Blessing, L. T. M. (Ekstern), McAloone, T. C. (Intern)
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A guide for evaluating the environmental performance of Product/Service-Systems

Environmental issues, such as climate change, resource depletion and pollution are societal concerns, which are also increasingly affecting the way we do business. Concepts such as circular economy, sharing economy, and service economy, often highlight that more sustainable businesses can be created when focusing on product performance (e.g. by offering lighting as a service) rather than the physical products (e.g. by selling light bulbs).

Such strategies of integrating products and services to deliver required user functionality are often termed Product/Service-Systems (PSS). This guide is intended to support studies that aim to explore if or when a PSS is leading to environmental improvements. The guide consists of six steps, which will assist the user to evaluate the environmental...
performance of PSS using Life Cycle Assessment (LCA) methodology. Special attention is given to the scoping phase of the study. This section of the guide introduces PSS as a concept, explains the aim of the guide, and provides an overview of stakeholders with potential interest in the guide plus the set of competences needed to perform the study.

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**A Guide for Evaluating the Environmental Performance of Product/Service-Systems**

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**Applying Multi-Class Support Vector Machines for performance assessment of shipping operations: The case of tanker vessels**

Energy efficient operations are a key competitive advantage for modern shipping companies. During the operation of the vessel, improvements in energy use can be achieved by not only by technical upgrades, but also through behavioural changes in the way the crew on board is operating the vessels. Identifying the potential of behavioural savings can be challenging, due to the inherent difficulty in analysing the data and operationalizing energy efficiency within the dynamic operating environment of the vessels. This article proposes a supervised learning model for identifying the presence of energy efficient operations. Positive and negative patterns of energy efficient operations were identified and verified through discussions with senior officers and technical superintendents. Based on this data, the high dimensional parameter space that describes vessel operations was first reduced by means of feature selection algorithms. Afterwards, a model based on Multi-Class Support Vector Machines (SVM) was constructed and the efficacy of the approach is shown through the application of a test set. The results demonstrate the importance and benefits of machine learning algorithms in driving energy efficiency on board, as well as the impact of power management on energy costs throughout the life cycle of the ships.

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ISI indexed (2013): ISI indexed yes
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Scopus rating (2009): SJR 1.063 SNIP 1.975
Web of Science (2009): Indexed yes
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Scopus rating (2008): SJR 0.935 SNIP 1.673
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Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.887 SNIP 1.773
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Scopus rating (2004): SJR 0.715 SNIP 1.338
Web of Science (2004): Indexed yes
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Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.886 SNIP 1.149
Scopus rating (2001): SJR 0.599 SNIP 0.983
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Assessing transformational change from institutionalising digital capabilities on implementation and development of Product-Service Systems: Learnings from the maritime industry

Digitization is rapidly reshaping industries and economic sectors. It enables novel Product-Service Systems (PSS) that transform customer/supplier relationships and introduces new value propositions. However, while opportunities for novel types of PSS arise, it is not clear how digitization and the institutionalisation of digital capabilities, particularly within the customer organisations, may affect implementation of PSS, potentially leading to transformational changes in the customer organisation. This paper examines one such potential transformational change from three complementary viewpoints – the resource based, the dynamic, and the relational viewpoint. It does so through action research study in the context of the maritime industry, which is particularly attractive for PSS offerings. The research methodology comprised a two-step action research process, focusing on both digitization and PSS development and implementation. The main findings are that rather than facilitating procurement to co-development of PSS, institutionalisation of digital capabilities facilitated development of PSS by stakeholders internal to the company, and strategic co-development with external stakeholders. The new digital capabilities circumvented cost barriers associated with the procurement of services from external stakeholders, supported process standardization - to the expense of process innovation-, and transformed the network that delivered PSS by closing opportunity gaps for externally procured services. Furthermore, the uptake of digital capabilities highlighted the importance of cost estimation in making the customer more responsive to threats and opportunities.

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Scopus rating (2015): SJR 1.609 SNIP 2.383 CiteScore 5.57
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BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.661 SNIP 2.477 CiteScore 4.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.644 SNIP 2.581 CiteScore 4.47
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.706 SNIP 2.328 CiteScore 4.07
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 2
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ISI indexed (2011): ISI indexed yes
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Building a Business Case for Eco-design Implementation: A System Dynamics Approach

Several potential business benefits obtained from eco-design are consistently reported by academic studies and companies. These benefits comprise increased innovation potential, development of new markets and business models, reduction in risks and costs, improvement of organizational brand, among others. However, there are still significant challenges for adopting eco-design, specially concerning the capture and measurement of the expected business benefits. To address such gap, this paper proposes an exploratory concept of a simulation-based business case for eco-design implementation, grounded on a System Dynamics approach. The study builds upon the Ecodesign Maturity Model (EcoM2) and the related capabilities of eco-design managements practices, offering an integrative outlook into how eco-design capability building can potentially affect corporate performance outcomes over time. Preliminary results point towards the potential for managers and key organizational decision-makers to use the business case simulator to assessing eco-design benefits and testing multiple implementation scenarios (e.g. what-if questions).

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Ecodesign, Sustainability, Business case, System dynamics, Simulation
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Economic and Environmental Impact Trade-Offs Related to In-Water Hull Cleanings of Merchant Vessels

Merchant vessels are equipped with antifouling systems to prevent accumulation of marine organisms on the hull—a phenomenon known as fouling. In many cases, however, fouling accumulates and in-water hull cleaning is required. Hull cleanings are part of a hull management scheme, and although they are an established practice, their associated
environmental and economic trade-offs and conflicts have remained largely unexplored. The purpose of this article is to quantitatively assess both economic and environmental impacts of hull management schemes on the operation of tanker vessels. After identifying induced and avoided costs and environmental impacts from the hull management system, we used both temporally and spatially distributed models to capture the degradation of the antifouling system as well as the global sailing profile of the vessels. Last, we analyzed how each of the modeled impacts varied with the frequency of hull cleanings within the hull management scheme. Our analysis revealed a convex relationship between the frequency of hull cleanings and fuel savings. The higher the frequency of hull cleanings, the less fuel savings can be achieved per cleaning. In terms of costs, from some point on the costs of the service are likely to offset the savings—especially if fuel prices are low. In regards to climate change, avoided emissions due to fuel savings are likely to outweigh the limited impacts from the service itself. Last, while ecosystem impacts from marine, terrestrial, and freshwater eco-toxicity are likely to increase from hull cleanings, they are subject to high uncertainties.

**General information**

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Pagoropoulos, A. (Intern), Kjær, L. L. (Intern), Dong, Y. (Intern), Birkved, M. (Intern), McAloone, T. C. (Intern)
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- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 1.44 SNIP 1.689 CiteScore 3.82
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.628 SNIP 1.706 CiteScore 3.07
- Web of Science (2014): Indexed yes
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- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 1.03 SNIP 1.529 CiteScore 2.24
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- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 1.031 SNIP 1.228 CiteScore 2.13
- ISI indexed (2011): ISI indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 0.891 SNIP 1.329
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 1.192 SNIP 1.411
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 1.226 SNIP 1.624
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.165 SNIP 1.686
In an ever-changing world, the roles of product development, business innovation, advanced manufacturing, service delivery and end-of-life management become increasingly important to enhance the competitiveness of industrial companies. The boundaries between disciplines soften and it is increasingly apparent that the scope for innovation and market disruption is to be found in the careful integration of numerous life cycle activities as the object of design. Industrial Product/Service-Systems (IPSS) are one answer to this development, offering solutions towards the conceptualisation, design, planning and deployment of new solutions and value propositions in fundamentally different ways than before. Implicit in the philosophy behind IPSS is to create customer-oriented solutions that function for longer and thus increase resource productivity, minimise resource consumption and enhance the ultimate value-add to the end user. In this context, PSS solutions have a great potential to enable the transition to a Circular Economy, where the goal is to think in circular product- and system life cycles, rather than our current linear "take-make-waste" paradigm. This Procedia CIRP Special Issue collects manuscripts from the 9th CIRP IPSS Conference, IPSS2017, which focused its theme on "Circular Perspectives on Product/Service-Systems". With this theme, the conference, and therefore these manuscripts, have explored how the transition to a Circular Economy can be supported by PSS, in terms of life cycle, sustainability, optimisation, design and user satisfaction. The Special Issue is organised in five complementary and synergic tracks, offering a holistic and systemic view on the circular perspectives of PSS.

**General information**

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Tokyo Metropolitan University
Authors: McAloone, T. C. (Intern), Pigosso, D. C. A. (Intern), Mortensen, N. H. (Intern), Shimomura, Y. (Ekstern)
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Embracing Circular Economy: a journey seen through the perspective of Sustainability Maturity

Circular Economy has been progressively acknowledged as a promising and consistent approach to maximizing value by increasing resource productivity, while minimizing resource consumption and related waste. Manufacturing companies operating on a linear fashion are faced with a wealth of potential business benefits derived from a circular economy. However, this transition requires a systemic change mindset, encompassing a wide array of organizational processes and functions: from strategy and business models to take-back and end-of-life management. With a view to supporting the transition of manufacturing companies towards Circular Economy, this article presents a maturity-based approach that supports manufacturing companies to develop and implement strategic roadmaps and action plans for the transition. An analysis of twelve key management practices to manage the transition towards Circular Economy is presented and briefly discussed. Industrial applications of the proposed maturity approach indicate that the maturity approach can effectively strengthen companies’ abilities to embrace the beneficial prospects of the Circular Economy.

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How can design science contribute to a circular economy?
Circular Economy is increasingly seen as a key approach to operationalising goals and supporting the transition to a sustainable society by enhancing competitiveness and economic growth. Creating a Circular Economy requires fundamental changes throughout the value chain, from innovation, product design and production processes all the way to end of life, new business models and consumption patterns. This paper explores how design science can support the transition from the traditional linear 'take-make-consume-dispose' approach, to a Circular Economy. By means of a systematic literature review, this paper discusses the role of a set of design topics in this transition.

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Making the Transition to Circular Economy through readiness assessment

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Measuring the implementation of ecodesign management practices: a review and consolidation of process-oriented performance indicators
Ecodesign plays an important role in manufacturing companies' quest for improved sustainability performance. However, many ecodesign efforts are geared towards tackling single-issue discrete improvements, in contrast to operationalizing, measuring and acting upon the consistent improvement of ecodesign implementation and management. To enable a systematic and streamlined integration of ecodesign practices into the product development processes, adequate mechanisms are needed to capture and measure performance improvements, and thereby achieve consistent improvements in a company's efforts towards enhanced sustainability performance. In face of this challenge, this paper aims at providing organizations with a set of process-oriented indicators to supporting and enhancing ecodesign implementation and management. This research was grounded on a 2-phase approach to (i) cross-analyze performance indicators from literature against ecodesign practices at the process level and (ii) propose, evaluate and consolidate new indicators. After being subjected to the evaluation of 8 experts in ecodesign, a repository is presented with 27 indicators from literature and a set of 114 newly proposed indicators for companies to customize, adapt, mix and derive according to their needs, strategic drivers and overall context.

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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.661 SNIP 2.477 CiteScore 4.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
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Moulded Pulp Manufacturing: Overview and Prospects for the Process Technology

Eco-friendly packaging such as moulded pulp products have gained commercial importance in the recent years. However, it remains a greatly under-researched area, and there is an arising need to consolidate the best practices from research and industry in order to increase its implementation. The goal of this paper is to give an overview of the main aspects involved in the manufacture of moulded pulp products. This includes a classification of moulded pulp products, historical and current applications, production processes, materials, mechanical properties and environmental sustainability. Moreover, based on the latest research in the field, an innovative drying technique that utilizes concepts derived from impulse drying is presented, and the implementation of this process technology is discussed.

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Main Research Area: Technical/natural sciences
Product/Service-System Origins and Trajectories: A Systematic Literature Review of PSS Definitions and their Characteristics

Literature provides multiple definitions on Product/Service-Systems (PSS), and as the field develops, certain trajectories emerge. The purpose of this article is to provide an overview of the stabilization of PSS definitions within PSS research, by presenting the most prominent PSS definitions and their interrelationships. As the result of a strict protocol, the paper identifies 52 prominent definitions related to PSS, where the citation relationships between the prominent definitions are studied and graphically illustrated. The definitions are furthermore analyzed to identify common PSS definition characteristics and eleven different characteristics identified. Descriptive analysis is carried out on the identified PSS definition characteristics, to determine commonalities and differences in the field. Even though the literature provides many different variations of PSS definitions, there is certain convergence regarding key characteristics of PSS, including Product and Services as well as Customer Needs.

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Scientific support for business with implementing circular economy for enhanced competitiveness and sustainability

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Simulation-Based Business Case for PSS: A System Dynamics Framework

Many potential business benefits have been widely associated with the implementation of PSS. Still, several significant challenges for transitioning to PSS persist, especially in regards to materializing the business benefits. To tackle such difficulty, this paper suggests a theory-driven concept of a business case for PSS implementation and management, based on a System Dynamics simulation framework. With a maturity-oriented theoretical perspective and the associated capability concepts, the study provides insights into how the development of PSS capabilities can potentially affect corporate performance over time. The paper’s preliminary results identify the potential for managers and other decision-makers to use the business case simulator to assessing PSS-related business benefits and responding to multiple implementation scenarios and strategies.

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The emergent role of digital technologies in the Circular Economy: A review

Digital technologies have enabled the formulation of multiple Product Service-Systems (PSS) with considerable economic, environmental and societal benefits. One of the most promising paradigms, which is inspired by business models and value propositions that have already been described in the PSS literature, is the concept of Circular Economy. Circular Economy is characterized as an economy that is restorative and regenerative by design and is attracting significant attention from researchers and policy makers alike. In light of the recent proliferation of digital technologies such as Big Data and the Internet of Things, this article attempts to identify how can digital technologies support the transition to Circular Economy. This article conducted a systematic review of the literature based on a review protocol, in an effort to evaluate the application of key digital technologies in Circular Economy. The study concludes by identifying research gaps, reflecting on the application of digital technologies in the field of PSS and proposing suggestions for future research.

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Publication information
The influence of costs and benefits' analysis on service strategy formulation: Learnings from the shipping industry

Although servitization as a transformation process is being recognized by an increasing number of firms as a source of competitive advantage, the role of economic evaluations in service strategy formulation has so far attracted limited attention—and predominantly from the manufacturer perspective. This paper assesses how the analysis of costs and benefits of Product-Service Systems (PSS) as servitized offerings influences the formulation of service strategies in the shipping industry. The study examines both the manufacturer and customer perspectives using two case studies from the shipping sector. Life Cycle Costing (LCC) was used as a tool to assess the associated costs and benefits of two proposed PSS. Based on the results of the LCC, the drivers and barriers of the actual transformation processes were explored through workshops and interviews served to map the perspectives of both manufacturers and customers. For both case studies the LCC revealed that, while the PSS resulted in a decrease in life cycle costs and a possible revenue opportunity, there was also a lack of fundamental demand for PSS that could complicate the formulation of service strategies. Towards formulating service strategies, the analysis of costs and benefits highlighted the importance of the abilities of both the customer and the manufacturer to deliver and implement a PSS. Moreover, the customer perspective highlighted the importance of internal functions and capabilities that allowed the customer to implement and benefit from service strategies.

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A framework for conceptualisation of PSS solutions: On network-based development models

Manufacturing companies are changing. More and more companies are taking greater responsibility for their products, expanding their customer relationships and providing new sets of service offerings. Increasing amounts of manufacturing companies are even switching from offering products (e.g. trucks) to offering performance (e.g. transport solutions). This transition is challenging, as it puts great demands on the company’s capabilities, both within the company and externally, in the company’s inter-organisational relationships. Taking greater responsibility of the product performance includes greater risk for the manufacturer, for which reason network capabilities become vital. Relationships to suppliers – and to suppliers’ suppliers – become essential factors in securing high-quality products, availability assurance, and suitable cost. Likewise, the customer relationship changes from a transactional to a relational interaction, in order to proactively meet the customer’s changing needs and establish to a continuous information flow, allowing preventive maintenance. Dissolving the sequential value chain into a collaborative ecosystem of stakeholders is a necessity, when offering Product/Service-System (PSS) solutions. Altered relationships and roles embracing the success of all involved stakeholders is one way (arguably, the only way) to a successful PSS. Danish maritime suppliers are involuntarily facing this challenge; a lifeline of large order books from the Danish OSS shipyard at Linde, near Odense, was cut with its closure in the early part of the second decade of the 2000’s. This forced suppliers to switch their focus from the shipyard to the shipowner. Thus, in one year the business changed from a product focus to an after-sales focus. This research project, which has been part of the Danish Innovation Consortium PROTEUS (PRoduct-service/system-Tools to Ensure User centred Services), was carried out at the Technical University of Denmark at the Section of Engineering Design and Product Development. The project’s aim was to investigate how to support the Danish maritime industry in this upheaval and change towards a new mode of business- and product development. The research presented in this thesis is based on action-research, involving all ten companies participating in the PROTEUS consortium, plus a comparative case study of MAN PrimeServ Frederikshavn and Alfa Laval Aalborg. The main contributions of the thesis are the following:

A comprehensive longitudinal empirical study across a whole industry sector, which was in transition from product- to product/service-system oriented business.

A theoretical foundation for PSS development, with a particular focus on network collaboration. In addition, a contribution to the theoretical knowledge about how the network paradigm “network oriented product development” and PSS theory can be assessed and developed.

An objectively derived normative framework of combined network-oriented PSS development, based on theoretical and empirical findings and verified in case companies. Three new PSS tools to support PSS conceptualisation.

Contributions to the PROTEUS Workbook series – communicating the results of the PROTEUS research consortium to both academics and industry practitioners.

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Applying Robust Design in an Industrial Context
The ability to develop and manufacture products of high quality is a decisive competitive parameter for any production company. The costs of non-quality, i.e. not fulfilling the functional requirements for a given product, are considerable, often manifesting as scrapped products, product recalls, lost sales, customer complaints and delayed product launches. Over time, the responsibility for obtaining consistent product performance has moved upstream in the development process, motivated by the saved costs of discovering and removing design errors prior to large investments in manufacturing tools and production facilities. An extensive set of frameworks, tools and methods are available for ensuring and improving product quality. The research presented in this thesis focuses on the Robust Design Methodology – which is a collection of methods and tools intended to support the design engineer in creating products with consistent performance, despite influences from manufacturing variability and use conditions. Although Robust Design is claimed to be applicable during the early phases of product development, surveys have shown (Thornton et al 2000; Gremyr et al 2003; Araujo et al 1996) that it is only used by a small minority of production companies and it has been criticised for being too complex to use and only being applicable during late-stage design optimisations. This project addresses these issues and contributes to the industrial understanding and application of Robust Design methods and principles, by attempting to remove the existing barriers for widespread industrial use of the Robust Design Methodology. The research finds, through the definition of an impact model linking non-robustness to profit loss in an organisation. The link is made through a series of causal factors such as overly tight tolerances, high scrap rates, missed launch dates, and product recalls. All of these causal factors are considered as symptoms of non-robustness and are used in an applicability assessment to gauge the potential benefit of implementing Robust Design in an organisation. One particular symptom has been investigated in greater detail to partially verify the impact model, namely the ‘Misapplication of R&D resources’. In one case-company it is shown that R&D resources used to make late design changes after ‘Design Verification’, where the design is ideally frozen and prepared for production, was up to 400% more than used during the design and development phase! On deeper investigation of the change notes, it is shown that over 60% of these are related to kinematic and mechanical interface issues. With such apparent robustness issues embedded into the geometry of designs seen throughout industry, Robust Optimisation, which is the main focus in academia, is quite futile. There is a need to lay out the foundation for the Robust Design Methodology (RDM) using the approaches of kinematic design and design clarity, two fundamental methods to be added to RDM providing the guidance for designing robust mechanical architectures. Furthermore a set of 15 robust design principles for reducing the variation in functional performance is compiled in a format directly supporting the work of the design engineer. With these foundational methods in place, the existing tools, methods and KPIs of Robust Design are reviewed and positioned within a framework, which also identifies the need for quantitative, leading indicators of robustness, which are now further developed in the so-called Six Theta® framework. However, the lack of adoption of robust design is not simply due to the lack of simplicity, education and coherence around the available tools and methods, but also the organizational change management that is key to any successful implementation. After identifying four companies seen as front runners in terms of robust design implementation, all from different industries but based on mechanical design, a series of interviews were conducted to identify best practice procedures. The analysis and results showed that there is no single solution and each company had a different approach, which worked for their company culture and the nature of the products they were developing. As a result different implementation archetypes are created so that R&D managers are able to choose and take inspiration for the archetype that they think best fits their company. The methods Kinematic Design and Design Clarity are applied in a consumer electronics company to give an indication of the observable results, and also to verify the impact model, namely the ‘Misapplication of R&D resources’. In one case-company it is shown that R&D change notes, it is shown that over 60% of these are related to kinematic and mechanical interface issues. With such apparent robustness issues embedded into the geometry of designs seen throughout industry, Robust Optimisation, which is the main focus in academia, is quite futile. There is a need to lay out the foundation for the Robust Design Methodology (RDM) using the approaches of kinematic design and design clarity, two fundamental methods to be added to RDM providing the guidance for designing robust mechanical architectures. Furthermore a set of 15 robust design principles for reducing the variation in functional performance is compiled in a format directly supporting the work of the design engineer. With these foundational methods in place, the existing tools, methods and KPIs of Robust Design are reviewed and positioned within a framework, which also identifies the need for quantitative, leading indicators of robustness, which are now further developed in the so-called Six Theta® framework. However, the lack of adoption of robust design is not simply due to the lack of simplicity, education and coherence around the available tools and methods, but also the organizational change management that is key to any successful implementation. After identifying four companies seen as front runners in terms of robust design implementation, all from different industries but based on mechanical design, a series of interviews were conducted to identify best practice procedures. The analysis and results showed that there is no single solution and each company had a different approach, which worked for their company culture and the nature of the products they were developing. As a result different implementation archetypes are created so that R&D managers are able to choose and take inspiration for the archetype that they think best fits their company. The methods Kinematic Design and Design Clarity are applied in a consumer electronics company to give an indication of the observable results, and also to verify the impact model, namely the ‘Misapplication of R&D resources’. In one case-company it is shown that R&D
Challenges when evaluating Product/Service-Systems through Life Cycle Assessment

Life Cycle Assessment (LCA) is a state-of-the-art method for conducting environmental assessments of systems, whether these consist of goods or services, or a combination of the two. However, current LCA guidelines focus on assessing tangible products and lack specific attention to more complex systems, such as Product/Service-Systems (PSS), which also consist of intangible elements. PSS imply a shift in business paradigm from selling specific products to delivering a function, through a mix of products and services, thereby incentivising resource efficiency as well as user satisfaction. Despite their potential to reduce environmental impacts, PSS are not by default more environmentally benign compared to conventional systems, and quantifications of their environmental performance are called for. This paper contributes by showing that specific challenges need to be addressed when using LCA to evaluate the environmental performance of PSS. We identify a set of PSS characteristics that can challenge an LCA study. Three relevant scopes are distinguished, where LCA may be applied: (1) evaluating options within the PSS itself; (2) comparing a PSS with an alternative; and (3) modelling the actual contextual changes caused by the PSS. We derive three pronounced challenges when conducting LCA within the three scopes: (i) identifying and defining the reference system; (ii) defining the functional unit; and (iii) setting system boundaries. We elaborate on how these challenges are discussed in current literature. Recommended future work includes developing adapted guidelines and further empirical case studies that quantify the environmental changes and impacts caused by introducing PSS.

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Exploring the dynamic and complex integration of sustainability performance measurement into product development

In order to deal with the complex and dynamic nature of sustainability integration into the product development process, this research explore the use of a qualitative System Dynamics approach by using the causal loop diagram (CLD) tool. A literature analysis was followed by a case study, aiming to depict the structure of the used sustainability indicators and their relationships. The results showed the main information feedback loops and were discussed in terms of the CLD’s advantages and limitations, and how this exploratory study could lead to a more comprehensive modelling approach.

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Authors: Rodrigues, V. P. (Intern), Morioka, S. (Ekstern), Pigosso, D. C. A. (Intern), Carvalho, M. (Ekstern), McAloone, T. C. (Intern)
Framework for measuring the sustainability performance of ecodesign implementation

Companies and academic studies are consistently reporting several potential business benefits gained from ecodesign implementation, such as increased innovation potential, development of new markets and business models, reduction in environmental liability, risks and costs, improvement of organizational brand and legal compliance, among others. However, there is a number of challenges that still hamper corporate adoption of ecodesign, mainly regarding the capture and measurement of the estimated business benefits. Furthermore, ecodesign efforts have been primarily evaluated in terms of environmental performance and product-related (technical) measures, such as shape, material and energy consumption. Because the ecodesign business benefits go beyond the pure environmental performance and its implementation should follow a consistent process-oriented integration, an approach based on the triple bottom line and focused on the managerial perspective is required to deriving a consistent business case for ecodesign.

This research aims at proposing a simulation-based framework geared towards laying out the fundamental rationale of the business case for ecodesign implementation. The study particularly builds upon the EcodesignMaturity Model (EcoM2), a management framework that offers a systematic, step by-step approach for the integration of ecodesign into product development processes. With more than 600 ecodesign practices systematized and organized according to maturity levels, the EcoM2 offers an application method with 4 steps, organized in two phases (Figure 1). The simulation framework draws upon the current and desired capabilities of ecodesign practices, and offers an integrative outlook into how capability building will potentially affect corporate indicators over time, such as revenue, market share, expenses, risk, employee productivity, among others. It is expected that decision makers use the business case simulator to assess the potential benefits of ecodesign and test multiple scenarios (what-if questions) with a view to deriving more robust implementation policies, in alignment with corporate sustainability strategy and main drivers.

How to evaluate the environmental performance of Product/Service-Systems (PSS)?

Popular concepts such as “circular economy”, “sharing economy”, and “service economy”, often promote that more sustainable businesses can be created when offering product performance (e.g. lighting as a service) rather than selling products (e.g. light bulbs). These types of offerings are often termed Product/Service-Systems (PSS). However, offering or buying a PSS does not necessarily lead to environmental improvements, as highlighted by several examples (such as car sharing). Due to a set of challenges with the current methodologies, the actual environmental performance of PSS is traditionally rarely quantified. The guidelines developed in this research (Figure 1) are intended to support studies that aim to explore if or when a PSS is leading to environmental improvements.

The guidelines are built on Life Cycle Assessment (LCA) and can be applied at different stages and by different users, e.g. designers and decisionmakers. They aim at guiding the user to perform a study, where the environmental performance of a PSS is objectively evaluated and quantified; taking a holistic perspective when comparing different options for needs fulfilment. Focus is on analysing the environmental impact changes when a PSS is compared to a reference system.
**How to mature the abilities of companies to a successful transition to Circular Economy?**

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**Abstract**

To successfully transition to a Circular Economy, companies need to enhance their abilities to manage and utilize resources efficiently. This involves understanding and adapting to the principles of recycling, reuse, and remanufacturing. The ability to do so requires a transformation of current business models and operational strategies. Companies must develop strategies that optimize resource use, reduce waste, and promote sustainability. This involves integrating various aspects of the business, from product design to supply chain management. The transition to a Circular Economy represents a significant challenge for companies, requiring a combination of technological, managerial, and cultural changes. Effective strategies must be developed to facilitate this transition, ensuring that companies are equipped to operate in an environment where resources are managed sustainably.

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**Integrating Product and Technology Development: A Proposed Reference Model for Dual Innovation**

Although dual innovation projects, defined in this article as the concurrent development of products and technologies, often occur in industry, these are only scarcely supported methodologically. Limited research has been done about dual innovation projects and their inherent challenges (e.g. managing dependencies) and opportunities (e.g. streamlining development). This paper presents five existing reference models for technology development (TD), which were identified via a systematic literature review, where their possible integration with product development (PD) reference models was investigated. Based on the specific characteristics desired for dual innovation projects, such as integrated product development and coverage of multiple development stages, a set of selection criteria was employed to select suitable PD and TD reference models. The integration and adaptation of the selected models has led to a proposed integrated reference model for dual innovation that is currently being instantiated in the context of an ongoing action research project.

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- **Main Research Area:** Technical/natural sciences

**Abstract**

Integrating Product and Technology Development: A Proposed Reference Model for Dual Innovation

Although dual innovation projects, defined in this article as the concurrent development of products and technologies, often occur in industry, these are only scarcely supported methodologically. Limited research has been done about dual innovation projects and their inherent challenges (e.g. managing dependencies) and opportunities (e.g. streamlining development). This paper presents five existing reference models for technology development (TD), which were identified via a systematic literature review, where their possible integration with product development (PD) reference models was investigated. Based on the specific characteristics desired for dual innovation projects, such as integrated product development and coverage of multiple development stages, a set of selection criteria was employed to select suitable PD and TD reference models. The integration and adaptation of the selected models has led to a proposed integrated reference model for dual innovation that is currently being instantiated in the context of an ongoing action research project.

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Maturity-based approach for the development of environmentally sustainable product/service-systems

Despite their substantial potential for enabling increased environmental performance, product/service-systems (PSS) are not intrinsically environmentally sustainable. In order to ensure increased environmental performance, PSS best practices should be integrated with ecodesign best practices, from the early stages of the development process. This paper aims to identify the best practices for PSS development, based on a systematic literature review, and to propose their integration into an existing maturity model for ecodesign, the EcoM2, into which 30 best practices for PSS development are identified and integrated. The proposed approach has the potential to enable the development of environmentally sustainable PSS offerings.
Process-oriented performance indicators for measuring ecodesign management practices

In order to support ecodesign performance measurement from a business perspective, this paper performs an exploration of available process-oriented indicators to be applied to ecodesign management practices. With the Ecodesign Maturity Model as a background framework, a systematic literature review coupled with a cross-content analysis was carried out to assign proper indicators to the practices. Results show that the currently available indicators do not fully reflect the characteristics of ecodesign and there is significant room for improving the development of tailor-made indicators.

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Process-related key performance indicators for measuring sustainability performance of ecodesign implementation into product development

Developing products with improved environmental performance is regarded as a crucial component of companies' commitment towards sustainable development. The potential benefits derived from ecodesign are constantly highlighted in the literature, and go beyond the pure environmental dimension. However, the primary focus has been positioned on evaluating those benefits in terms of product-related environmental performance, which leaves an open potential for capturing performance from a broader managerial perspective. Consequently, the major challenges tackled by this paper relate to the limited focus on process-oriented perspectives that cover all dimensions of the triple bottom line and offer a systematized view on ecodesign performance measurement. Therefore, this paper presents a comprehensive set of process-related key performance indicators for product development, based on a three-step systematic literature review, followed by systematization of indicators and a critical analysis. A total of 787 indicators were identified and classified according to the sustainability dimensions, product development phases and units of measurement. The results point to a relevant asymmetry in the number of indicators proposed for each sustainability dimension, with large dominance of economic indicators. A critical analysis is presented and discussed in terms of the main organizational functions addressed, emphasizing a potential growth trend towards multi-dimensional indicators in recent years. The paper indicates that product development performance is still being mainly discussed in terms of product physical characteristics, along with a broad assortment of topics - from very specific document-related measures to high-level strategic dimensions - without focusing on environmental aspects, which is mainly due to the intangible and uncertain nature of product development processes.

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BFI (2017): BFI-level 2
This paper seeks to improve the understanding of how service-based companies can benefit from developing and delivering service offerings from a standardised core of service modules, which are organised through a service architecture. Research within the field is relatively sparse, and there is scope for an explicit definition of elements related
to the development of modular service platforms and architectures. A study of the existing literature, combined with a comprehensive case study in a global engineering consultancy, has created the basis for development and evaluation of the conceptual model for modular service design synthesis presented in this paper. The case study is based on internal documentation and a high level of interview data. Inductive research methods have been used for the analysis. The presented conceptual model defines three suggested dimensions (Market Segmentation, Service Roadmap and Service Architecture Layout) to be included in development of modular service platforms and architectures. Testing indicates a significant standardisation potential for service configuration across service families. Our understanding is that the approach can increase strategic flexibility and adaptability to changes in a quick evolving service market. The empirical part of this paper is exploratory in nature and is limited to one provider of high-end engineering consultancy services. Thus, further research will be needed to verify the aspects of the presented methodology to allow a further generalisation of our findings. Nevertheless, this paper contributes to the emerging literature on service modularity by presenting a specific operational approach for description and utilisation of modular service platforms and architectures.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Løkkegaard, M. (Intern), Mortensen, N. H. (Intern), McAloone, T. C. (Intern)
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BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.271 SNIP 2.588 CiteScore 2.48
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
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Scopus rating (2012): SJR 1.825 SNIP 3.307 CiteScore 2.13
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.086 SNIP 2.739 CiteScore 2.37
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.222 SNIP 1.589
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Scopus rating (2008): SJR 0.901 SNIP 1.09
When servitization is not transforming the way we do business - analysis of two unsuccessful service offerings from the shipping industry

Purpose: Although servitization as a transformation process is recognized as a source of competitive advantage for both manufacturers and their customers, it has also suffered from limited success, dissatisfactory returns and slow adoption rates. The majority of the studies in literature are primarily focused on conceptualizing servitization and recognizing drivers and barriers towards successful implementation from the manufacturer point of view. Far less attention has been given to the customer organisation and to negative results, where manufacturer’s servitization attempts have failed to transform the perception of the customer.

Design/Methodology/Approach: Based on the hypothesis that unsuccessful attempts to servitize would share common characteristics and flaws, a longitudinal observational study was conducted from the customer’s point of view. The main research subject was a shipping company in the role of the customer that in the course of two years turned down two different servitized offerings from two manufacturers: one pooling and servicing agreement and one performance agreement.

Findings: The customer disregarded the servitized offerings because they were not perceived as important sources of value. Based on the two cases, two motifs emerged. The first was the lack of synergy between customer and supplier capabilities and focus, since the manufacturers’ service offerings were either indirectly competing or not complementing the customer’s internal resources. Together with the higher initial cost of the offerings, the customer company essentially challenged the necessity and efficiency of the transformation. The second was the manufacturer’s inability to deliver to the customer’s expectations. Even in cases where the customer was able to communicate its own needs and requirements, the manufacturer’s service organization was unable to match them with the proposed offerings.

Originality/Value: The results suggest that manufacturers should aim for better integration of their offerings within the customers’ business environment, in order to help transform customers into proactive buyers of service offerings.

General information
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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Pagoropoulos, A. (Intern), Kjær, L. L. (Intern), McAloone, T. C. (Intern)
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Publication date: 2016
Application of Environmental Input-Output Analysis for Corporate and Product Environmental Footprints—Learnings from Three Cases

An increasing number of companies are expanding their environmental impact reduction targets and strategies to include their supply chains or whole product life cycles. In this paper, we demonstrate and evaluate an approach, where we used a hybrid Environmental Input-Output (EIO) database as a basis for corporate and product environmental footprint accounts, including the entire supply chain. We present three cases, where this approach was applied. Case study 1 describes the creation of total corporate carbon footprint accounts for three Danish regional healthcare organisations. In case study 2, the approach was used as basis for an Environmental Profit and Loss account for the healthcare company, Novo Nordisk A/S. Case study 3 used the approach for life cycle assessment of a tanker ship. We conclude that EIO-based analyses offer a holistic view of environmental performance, provide a foundation for decision-making within reasonable time and cost, and for companies with a large upstream environmental footprint, the analysis supports advancing their sustainability agenda to include supply chain impacts. However, there are implications when going from screening to implementing the results, including how to measure and monitor the effect of the different actions. Thus, future research should include more detailed models to support decision-making.

General information
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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, NIRAS A/S, 2.-O LCA Consultants APS
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Best practices for the integration of social sustainability into product development and related processes

Much sustainability communication has been in the realm of corporate reports of performance. While rigorous documenting efforts of corporate sustainability activity are helpful, there is limited reach of these materials beyond the scope of the boardroom. Few efforts have been made in corporate sustainability reporting other than to issue text documents. Some researchers even posit that the corporate community is “unwilling” to engage the wider stakeholder community on sustainability issues. But what if this limited reach of business communications is because the conversation is so intractable that it is considered off-mission? The interaction required for two-way communication and “real dialog” may strain existing human resources. This might even demand a trained “sustainability communicator” that would interface with the planners and producers of the sustainability activity and disseminate this activity to stakeholders. Short of hiring an additional professional, perhaps the issue is not so much “willingness” as knowing how to address sustainability communication in an ICT Setting. This paper will articulate how to augment corporate sustainability reports by addressing key points in developing a short format video. These videos can offer a touch point to engage stakeholders and draw them deeper into existing sustainability efforts and documentation. It’s argued that this is a cost effective addition to the tool box of sustainability officers. Research indicates a trend that these videos can influence positive affect and content retention. Sustainability communication opens up a range of perspectives on the definition and theory associated with concepts of sustainability and communication. A brief overview of the literature and its measure is presented with a dialogic perspective in mind.

Practical matters of the video length, production methods and design are described. Potential projects can be evaluated with the sustainability testing rubric advanced by Polk, Reilly, Servaes, Shi and Yakupitijage. The presentation exhibits a three minute video that was produced and evaluated based on this literature review. A step by step guide to sustainability communication facilitated by short form video will also be described. An easy to digest “layman’s handbook” is included.

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Characterization of the State-of-the-art and Identification of Main Trends for Ecodesign Tools and Methods: Classifying Three Decades of Research and Implementation

Ecodesign is a proactive management approach that integrates environmental considerations in product development and related processes (such as purchasing, marketing and research & development). Ecodesign aims to improve environmental performance of products throughout their life cycle, from raw material extraction and manufacturing to use and end-of-life. Over the last three decades, an intense development of new ecodesign methods and tools could be observed, but uptake by the industry remains a challenge. The purpose of this research is to perform a review of existing ecodesign tools and methods through a systematic literature review linked to bibliometric analyses, in order to explore the state of the art of ecodesign methods and tools and identify trends and opportunities in the field for the next decade.

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Does the Ecomark Label Promote Environmentally Improved Products in India and What Experiences Can Be Drawn from the Nordic Ecolabel?

Ecolabels are used to give consumers information about the environmental impact of products and thereby give an informed choice and an incentive to the consumer to choose the ecolabelled product. The environmental effectiveness of ecolabels ultimately relies on consumers' willingness to pay extra for a product with a lower environmental impact than alternative products. Various ecolabels exist throughout the world, but the difference between the successful and the non-effective ecolabels is large. This paper compares a best practice example of an ecolabel with a less successful ecolabel – each belonging to a different region of the world. Firstly we analyse, the ability of the Indian "Ecomark" label to promote environmentally improved products in India. The Ecomark scheme was launched in 1991, however the Ecomark label currently remains a nonstarter, with little awareness and no real consumer demand. India's Ecomark scheme has been analysed in several studies, all of which indicate that the scheme has had some flaws from the outset regarding its basic structure and execution. With a point of departure in these existing studies and further empirical insights from ecolabelling experts in Europe, this paper seeks to identify the differences between the Ecomark label and the second ecolabel under analysis – the much more successful "Nordic Ecolabel" from Scandinavia. The structural differences, selection process for criteria and the demand and awareness of the two ecolabels are analysed, in order to create suggestions of how to learn from the schemes and ensure knowledge transfer, regarding best practice.

Ecodesign Maturity Model as a framework to support the transition towards ISO 14.001: 2015 certification

Currently, the certification standard for Environmental Management Systems (EMS) ISO 14.001:2011 is under a major revision process, regarding its structure and requirements. The current draft entails major changes related to the integration of the product life cycle perspective into business processes, such as product development and value chain. The standard is expected to be launched in late 2015 with a 3-year transition period. This paper explores the application of the Ecodesign Maturity Model (EcoM2) as a framework to support the planning and implementation of ISO 14.001:2015, based on a case study carried out in a large manufacturing company. The EcoM2 supports the identification of the gaps to be fulfilled based on the diagnosis of the current maturity profile, the definition of the activities to be carried out in a strategic roadmap deployment, and the systematic measurement of the achievements obtained over time, towards the fulfillment of requirements and improved maturity profiles.
From LCC to LCA Using a Hybrid Input Output Model – A Maritime Case Study
As companies try to embrace life cycle thinking, Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) have proven to be powerful tools. In this paper, an Environmental Input-Output model is used for analysis as it enables an LCA using the same economic input data as LCC. This approach helps align LCA and LCC while avoiding cut-offs in the LCA. The efficacy of the method is illustrated by a real case study of a tanker ship.

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KPIs for measuring the sustainability performance of ecodesign implementation into product development and related processes: a systematic literature review

The development of products with improved environmental performance is increasingly part of companies’ engagement towards sustainable development. Ecodesign is an approach for integrating environmental aspects into the product development and related processes (PDRP), such as manufacturing, marketing, procurement etc. in order to develop products with increased environmental performance. The application of ecodesign potentially presents a set of sustainability benefits, such as innovation potential, development of new products and business models, the ability to meet or exceed customer expectation regarding the product/service, reduction in environmental liability and improvement of organizational brand, promotion of health and safety aspects along the life cycle, among others. However, despite the potential benefits and the existence of systematized frameworks for ecodesign implementation, many difficulties still surround the implementation and management of ecodesign. The main challenges in embedding ecodesign into PDRP are: (i) the lack of support to select key performance indicators (KPI) to measure how well a company is being successful in ecodesign integration from a product development process perspective; and (ii) to quantify the sustainability benefits of ecodesign implementation. Various frameworks for performance measurement systems (PMS) have been proposed, such as the Balanced Scorecard (BSC) and Neely’s “Performance Prism”. The PMS bundles the set of individual indicators with the company’s internal and external environment. However, these framework-based approaches do not incorporate the sustainability dimensions. Furthermore, their use in product development activities have been criticised in the literature due to the fact that the traditional accounting measure are not suitable for strategic-level decision. Besides, the traditional metrics are also pointed out to be historical and hard to correlate, providing little information on the root cause of problems. The literature also highlighted the fact that research and development performance is not focused on the performance result’s impact on the overall corporate behaviour. This research aims at presenting a comprehensive set of sustainability KPI to measure the ecodesign implementation into the PDRP by systematically reviewing the relevant literature regarding sustainability KPIs (social, economic and environmental dimensions). The underlying research question is “which are the KPIs for measuring sustainability of ecodesign integration into the product development and related processes?” This research excludes the indicators dealing directly and exclusively with product’s attributes and properties, such as energy and material consumption, once the main focus is positioned at the development process itself. The main results of this research include: (i) a comprehensive database of sustainability KPIs for PDRP; and (ii) a common ground for communicating and reporting improvements in ecodesign implementations. These results are expected to lead the pathway for building a sustainability-focused performance measurement system and ground an accurate assessment of sustainability integration into the PDRP. Furthermore, with a more appropriate sustainability-based performance measurement system in place, companies will be able to perform benchmarking, including intra-sector and cross-sector settings. Initial discussions on how to incorporate these KPI in an effective decision-making approach for implementing ecodesign into manufacturing companies is carried out in this paper. These perspectives lead to some suggestions of future work, which are based deriving relationships between PDRP sustainability indicators and ecodesign management practices as a stepping-stone for building relevant assessment tools in the field of sustainability performance of ecodesign implementation.

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Authors: Rodrigues, V. P. (Intern), Pigosso, D. C. A. (Intern), McAloone, T. C. (Intern)
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Ecodesign is a proactive environmental management and improvement approach employed in the product development process, which aims to minimize the environmental impacts caused during a product’s life cycle and thus improve its environmental performance. The establishment of measurable environmental performance indicators for the product development process is often cited as a successful factor for effective ecodesign implementation, since it enables setting targets and monitoring achievements towards the accomplishment of environmental ambitions. However, companies still face difficulties in the selection and application of environmental performance indicators - a more structured approach is still lacking. This paper presents the efforts made to identify and systematize existing leading product-related environmental performance indicators, based on a systematic literature review, and to develop a guide to support the selection of these indicators by manufacturing companies. From the review, 261 environmental performance indicators were identified and systematized in a digital database. The database supports the application of the environmental performance indicators guide, which proposes a five-step approach to support the selection of indicators. Based on
improvement opportunities identified from a case study for theory-testing in Denmark, an improved version of the guide was developed and subsequently applied in a case study in Brazil. The results from both evaluations indicate that the guide supported the studied companies in the selection of environmental performance indicators in the context of ecodesign implementation. This paper presents the results of the literature review, the systematization of environmental performance indicators and the support guide. © 2015 Elsevier Ltd. All rights reserved.
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Scopus rating (2003): SJR 0.501 SNIP 1.152
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Scopus rating (2002): SJR 0.481 SNIP 1.103
Web of Science (2002): Indexed yes
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Scopus rating (2000): SJR 0.694 SNIP 0.888
Web of Science (2000): Indexed yes
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Maturing the sustainability performance of manufacturing companies

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PSS Support for Maritime Technology Ventures: From Exploration to Methodology and Theory
In the last decade, the situation for Danish maritime suppliers has gone from growth and prosperity to crisis and foreclosures. The reason for this downturn can be found in macroscopic factors like the economic crisis of 2008, the closing of Danish shipyards and the emergence of cost-efficient, competitive Eastern suppliers. The Danish suppliers - by some considered the world leaders in terms of technological knowledge - are faced with a difficult choice: Either try to survive by cutting costs and competing on price or attempt to leverage their unique knowledge of technology to the market and build new business ventures, which are not dependent on cost as a competitive factor. The recommendation of this thesis is to pursue the latter option and adopt entrepreneurial strategies as a means to future prosperity. To achieve this goal, the area of Product/Service-Systems (PSS) is introduced as a candidate for a supporting framework. PSS holds the potential to enable the maritime suppliers to build innovative businesses based on a superior understanding of the customers’ operational activities and a portfolio of PSS offerings tailored to address the needs related to these activities.

Before the appropriateness of PSS support can be established, the phenomenon of technology entrepreneurship processes has to be understood. To build this understanding, the research areas dealing with the phenomenon are explored and an empirical study is conducted. The exploration of the entrepreneurship and engineering design fields reveals that the phenomenon of technology entrepreneurship processes is under-researched and that few empirical insights exist. A lack of appropriate research methods for researching the phenomenon is identified as a root cause for the poor empirical understanding. To build an empirical understanding, the thesis proceeds to develop a new process research tool and a related Entrepreneurship Process Research (EPR) methodology. The software-based, automated research tool is then used to gather empirical data from a large number of technology venture processes and to build an extensive and detailed process dataset.

On analysing the empirical data, three studies lead to a number of findings: The first study reveals that technological dimensions affect the process characteristics, mandating special attention be given to technology-dependent ventures. In the second study, an attempt is made to validate an existing theory for entrepreneurship process against the data. This study fails to find proof for or against the assertions of the theory. In the last study, a grounded theory approach is used for building a conceptual framework for entrepreneurship processes. As such, the framework is entirely abduced from
empirical evidence. Its explanatory power is tested by applying it to a number of maritime cases. Based on the empirical understanding of the phenomenon, the thesis proceeds to discuss the conceptual likenesses between the entrepreneurial process and a traditional engineering design process, plus the similarities between the entrepreneur and the designer. In extension of this, the relevance of a number of PSS tools as support for the processes observed is discussed. Great potential is found for the use of PSS and its tools in supporting technology entrepreneurship processes. Furthermore, the new context is found to pose a challenge to the tools, which need to be adapted and given new roles in order to support technology venturing.

In closing the thesis, the potential for research and practice synergies at the overlap between PSS, technology and entrepreneurship processes is discussed and a number of promising venues for future efforts are proposed.
Teaching sustainable solutions in engineering

The increasing societal and industrial emphasis on sustainability requests that the next generation engineers needs to be trained in the context of sustainability. One of the means to address students at DTU is the establishment of a course aimed at bachelor students from all of the university's study lines. The objectives of the course 'Sustainability in engineering solutions', is for the participants to understand the basic concept of sustainability and its three dimensions (people, profit, planet), as well as to analyse problems and synthesise solutions that are sustainable throughout their life cycle. The course runs over a full time 3-week period and employs project-based learning with several sub-projects/problems. This paper takes an in-depth discussion of the considerations concerning how to teach such a complicated subject to students of widely differing backgrounds, and reflects both the teachers' and the students' experiences with the course.

General information

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BFI (2012): BFI-level 1
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ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
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Building an Ontology of Product/Service-Systems: using a maritime case study to elicit classifications and characteristics

In recent years, the innovation strategy and development process entitled Product/Service-Systems (PSS), has attracted considerable attention from the research and industrial communities. The many contributions have come from various academic and professional viewpoints, which despite providing a rich view of PSS as a strategy, also leaves some confusion as to what actually constitutes a PSS. The definition of a PSS ontology could provide the basis for a more systematic knowledge gathering within the field and facilitate the application of integrated solutions within the industry. Ontologies provide an effective tool for a knowledge management process, due to their semantic capabilities, interoperability and extendibility. A PSS ontology for domain conceptualisation is proposed that captures the underlying end-user value and relates to existing PSS offerings. The PSS ontology is subsequently integrated into an ontology for the maritime sector, in order to allow for the identification of the PSS implementation opportunities within the industry. A maritime ontology can help the industry to document and reuse tacit knowledge while facilitating the implementation and value assessment of PSS solutions.
Comparing LCC with LCA to assess PSS sustainability: the case of the eco-box
Product/Service-Systems strategies are increasingly proving to be a source of competitive advantage and environmental improvement for engineering companies, the main hypothesis being that PSS should allow to decouple functionality, user satisfaction and financial income on the one hand, from the total environmental impact of the function-delivering technology on the other. This paper describes an integration of Life Cycle Assessment (LCA) and Life Cycle Costing (LCC), in an attempt to see if the two life cycle elements are related.

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Department of Management Engineering, Quantitative Sustainability Assessment, Production and Service Management, Engineering Systems Group
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Life cycle costing (LCC), Life cycle assessment (LCA), Product/service-systems, Sustainable building, Life cycle design, Holistic sustainability assessment
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Deployment and implementation of the Grundfos’ sustainability strategy by means of the ecodesign maturity model
Companies are increasingly realizing the needs and opportunities for implementing sustainability into their business processes and corporate culture. This paper describes the approach followed by Grundfos to deploy its Sustainability Strategy for the development of Sustainable Product Solutions, by means of the Ecodesign Maturity Model (EcoM2), which included the diagnosis of their current maturity profile, the definition of a strategic roadmap for ecodesign implementation and the implementation of the defined projects.

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Universidade de Sao Paulo
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Development of a data capture tool for researching tech entrepreneurship
Startups play a crucial role in exploiting the commercial advantages created by new, advanced technologies. Surprisingly, the processes by which the entrepreneur commercialises these technologies are largely undescribed - partly due to the absence of appropriate process data capture tools. This paper elucidates the requirements for such tools by drawing on knowledge of the entrepreneurial phenomenon and by building on the existing research tools used in design research. On this basis, the development of a capture method for tech startup processes is described and its potential discussed.

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Andersen, J. A. B. (Intern), Howard, T. J. (Intern), McAloone, T. C. (Intern)
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Title of host publication: 13th International Design Conference - Design 2014
Publisher: Design Society
Development of a Toolbox for the Implementation of Sustainability in the Product Development Processes at Grundfos Holding A/S

Grundfos, one of the world’s leading pump manufacturers, has been actively engaged in sustainability integration into its business over the last decades. This paper presents the approach followed by the company to develop a toolbox that aims to systematically integrate sustainability into the processes for strategic planning, frontloading and product development, following a life cycle approach. The methodology for development, validation and implementation of the toolbox was based on an action research framework, leading to the development of a tailored approach according to Grundfos’ culture and internal processes. The main elements and tools of the SPS toolbox and key learnings within its development are presented in this paper, which can inspire companies in the approach to be followed when developing, customizing and developing new tools for integrating sustainability in their business processes.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, GRUNDFOS Holding A/S
Authors: Pigosso, D. C. A. (Intern), McAloone, T. C. (Intern), Pattis, A. (Ekstern)
Pages: 8
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Main Research Area: Technical/natural sciences
Electronic versions:
Going_Green_CARE_Innovation_Grundfos_v06.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Driving behavioural change towards ecodesign integration: Nudging experiment in industry

This paper describes a research study conducted at Natura, a large Brazilian cosmetic company, in order to stimulate more systematic sustainable innovation practices by means of behavioural change. Within the “soft side” of ecodesign implementation, “nudging” is a novel approach brought from social sciences and policy making. An empirical experiment identified and tested employee motivations in combination with behavioural influences, in order to positively affect employees’ intention to practice ecodesign. This original experience of green nudging in a private company context supported the diffusion of the current ecodesign programme, which may contribute to turn change strategies more effectively in complex business and human organisational situations, where management styles evolve and rely on more autonomous individuals and teams. Further research and application on sustainable changes should systematically consider individuals’ engagement, including behavioural aspects, interaction with project teams and higher level business organisations.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Universidade de Sao Paulo, Technical University of Denmark
Authors: Brones, F. (Ekstern), Gyldendal Melberg, M. (Ekstern), Monteiro de Carvalho, M. (Ekstern), Pigosso, D. C. A. (Intern), McAloone, T. C. (Intern)
Pages: 15-23
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Sustainable Innovation 2014
Main Research Area: Technical/natural sciences
Conference: Sustainable Innovation, Copenhagen, Denmark, 03/11/2014 - 03/11/2014
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SIC_14_Brones_et_al_Ecodesign Behaviour_change_FINAL.pdf
Source: PublicationPreSubmission
Source-ID: 110952668
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Eco-Innovation Manual: Working version for Pilot Application

Aim of this manual is to introduce a methodology for the implementation of eco-innovation within small and medium sized companies in developing and emerging economies. The intended audience of this manual is organizations that provide professional services to guide and support manufacturing companies to improve their sustainability performance.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: O'Hare, J. A. (Intern), McAloone, T. C. (Intern), Pigosso, D. C. A. (Intern), Howard, T. J. (Intern)
Number of pages: 119
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Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
Source-ID: 103567378
Publication: Research - peer-review › Book – Annual report year: 2014

Eco-Innovation Manual: Tools instructions

This tool is designed to support you in identifying companies that are more likely to be willing and able to benefit from eco-innovation services. The tool provides questions to guide your research analysis, starting at the industry sector level, before progressing through the market level, down to specific companies.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: O'Hare, J. A. (Intern), McAloone, T. C. (Intern), Pigosso, D. C. A. (Intern), Howard, T. J. (Intern)
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Eco_Innovation Manual_Tools_Instructions.pdf
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Eco-innovation: The opportunities for engineering design research

Eco-innovation is an approach that has the potential to deliver step change improvements in the environmental performance of products, but the uptake by industry to date has been disappointing. The paper presents a selective review of the academic literature, choosing examples of research that give a flavour of the key trends and interesting topics that are emerging from the eco-innovation body of knowledge. We conclude by suggesting 10 areas where we see potential for the engineering design research community to contribute to the advancement of eco-innovation.

General information
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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: O'Hare, J. A. (Intern), McAloone, T. C. (Intern)
Pages: 1631-1640
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Publisher: Design Society
Main Research Area: Technical/natural sciences
Conference: 13th International Design Conference, Dubrovnik, Croatia, 19/05/2014 - 19/05/2014
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014
Supporting eco-design implementation within small and large companies

There is a need for a strategic and systematic approach towards eco-design implementation. By bringing together two case studies (one in a SME, the other in a multi-national company) this paper examines the impact of the organisational context and chosen eco-design implementation methodologies. As well as providing empirical evidence of the opportunities and challenges faced in these two industrial contexts, the paper also highlights important generalities and differences. The learning outcomes are relevant to researchers and industry managers engaged in eco-design implementation.

Survey on Industry Requirements and Drivers for the Development of a Process-Related Certification Scheme for Ecodesign Implementation and Management

Despite the existence of a large amount of eco-labels and eco-standards for product declaration, there is still limited research for the development of process-related certification schemes dealing with ecodesign implementation and management. In order to identify companies’ drivers, barriers and expected benefits in regards to the development and application of process-related ecodesign certification schemes, a survey was carried out in this research. This paper presents and discusses the main results obtained in the survey, which comprised the participation of more than 100 professionals from more than 25 countries. The results will be employed for the development of an ecodesign process-related certification scheme based on the Ecodesign Maturity Model (EcoM2).
Systematization of best practices for ecodesign implementation

Despite the recognition of ecodesign potential benefits, its application has not reached companies over the last decades mainly due to difficulties in ecodesign implementation and management and lack of a systematization of existing practices. In order to support companies in dealing with those challenges and provide a structured classification of ecodesign practices, a systematic literature review was performed for the identification and classification of the existing practices, supporting the selection of the most suitable ones according to companies' specific needs and characteristics.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Universidade de Sao Paulo
Authors: Pigosso, D. C. A. (Intern), McAloone, T. C. (Intern), Rozenfeld, H. (Ekstern)
Pages: 1651-1662
Publication date: 2014

Teaching sustainability in engineering solutions with Campus Service as case

Engineers potentially influence the sustainability of technological solutions significantly. At DTU Management Engineering we aim to address sustainability to all engineering students at DTU. One of the means to address students throughout DTU is the establishment of a course aimed at bachelor students on all study lines. The objectives of the course is for the participants to acquire an understanding of the basic concept of sustainability and its three dimensions as well as getting an overview of a number of tools for analysis and synthesis of solutions that are sustainable throughout their life cycle and acquire the skills to use the most central of the tools. Furthermore, they should understand the engineer's role and responsibility in the development of sustainable solutions. Examples of learning outcomes are:

- Explain that each sustainability dimension is multifactorial and that trade-offs exist within and between them
- Illustrate how companies can work towards the development of sustainable solutions
- Know and use various simplified tools for use in sustainability assessment
- Be able to relate critically to the results of various tools
- Master the analysis of solutions using life cycle check
- Master the synthesis of solutions using ideal concepts in product development

The course runs over the June three week period. It employs project based problem oriented learning and is organized around a theme within which there are several subprojects/problems that the students workon in groups of 4-5 persons. Different themes have been used but especially “The Sustainable Campus” incooperation with CAS has been successful. CAS frequently has to choose between different solutions for DTU Campus - but how to choose the most sustainable? The students get engaged since DTU Campus is part of their everyday life and they get a real opportunity to influence how CAS operate. The general outline of the course is that theory lectures and exercises are given in the morning whereas the afternoons are fully devoted to project work applying the theory learned in the morning. However, app. half of the days are fully devoted to project work with supervision. Several milestones for the project are defined at which the student presented their work. The students were evaluated on their presentations, their final report and a multiple choice questionnaire.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Mechanical Engineering, Engineering Design and Product Development, Production and Service Management, Centre for Facilities Management
Authors: Olsen, S. I. (Intern), McAloone, T. C. (Intern), Nielsen, S. B. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences
An inquiry on managers use of decision-making tools in the core front end of the innovation process

This paper focuses on the Core Front End (CFE) activities of the innovation process to say, Opportunity Identification and Opportunity Analysis. In the CFE of innovation, several tools are used to facilitate and optimise decisions. To select them, managers of the product development team have to use several premises to decide which tool is more appropriate to which activity. This paper provides an overview of these mechanisms by looking inside five companies from two different countries. Those mechanisms underline the dimensions influencing the decision process before a specific tool is chosen and how those tools impact specific performance metrics. From the analyses and hypotheses testing performed, it clearly emerges that there is no link between being aware of basic requirements (inputs/outputs) to appropriately use a certain tool and dimensions such as tools’ effectiveness, difficulty in usage, frequency of usage and estimate investment for using them. Also, interesting cross-case patterns emerge.

General information
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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Scuola Superiore Sant'Anna, Ecole Polytechnique de Montreal
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Main Research Area: Technical/natural sciences

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BFI (2016): BFI-level 1
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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.267 SNIP 0.613 CiteScore 0.62
BFI (2014): BFI-level 1
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BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.282 SNIP 0.478 CiteScore 0.61
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.218 SNIP 0.413 CiteScore 0.36
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.249 SNIP 0.673 CiteScore 0.52
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.205 SNIP 0.351
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.289 SNIP 0.647
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.21 SNIP 0.651
Scopus rating (2007): SJR 0.176 SNIP 0.385
Scopus rating (2006): SJR 0.214 SNIP 0.447
Scopus rating (2005): SJR 0.101 SNIP 0.141
Original language: English
Fuzzy front end, New product development, Tools, Decision making, Input, Output, Awareness
DOIs:
10.1504/IJPD.2013.058546
Deciding on PSS: A Framework for PSS Strategies
Product/Service-Systems (PSS) are a strategic approach wherein the value proposition covers the performance of a system throughout the whole life cycle. Many industrial companies are challenged on many levels in the transition process towards a PSS oriented approach. Much of the literature has until now focused on PSS from a design object perspective, and less focus has been on how the business model of the company must be designed simultaneously with the offering, covering topics as organisational restructuring, value chain collaboration plus a change management focus. This paper presents a PSS strategy topic matrix, as a boundary object for the company, aimed at creating a shared understanding of important factors in the organisation while evaluating, developing, implementing and operating a PSS strategy. This is done through an empirical foundation of twelve companies representing a whole branch industry, together with three cases of industrial best-practice.

General information
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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
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Series: Lecture Notes in Production Engineering
ISSN: 2194-0525
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Conference: 5th CIRP International Conference on Industrial Product-Service Systems, Bochum, Germany, 14/03/2013 - 14/03/2013
Product/Service-System, Business model strategies, Organisational change, value-chain collaboration, PSS, Product life, Innovation
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Drivers and barriers for implementation of environmental strategies in manufacturing companies
In order for environmental strategies to come into effect in industry practice, they need to be implemented and applied in daily business routines. Based on a dedicated comprehensive international survey in product developing and manufacturing companies, this paper identifies major current drivers for implementing product life cycle oriented environmental strategies but also barriers and obstacles that need to be addressed. On this basis it provides a number of recommendations for manufacturing companies as well as policy makers to consider for a successful implementation of strategic environmental goals in manufacturing industry.

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Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Bey, N. (Intern), Hauschild, M. Z. (Intern), McAloone, T. C. (Intern)
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 1.672 SNIP 3.072
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.639 SNIP 3.185 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.73 SNIP 3.99 CiteScore 4.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.455 SNIP 3.875 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.175 SNIP 4.2 CiteScore 3.04
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.153 SNIP 3.507 CiteScore 2.81
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.172 SNIP 3.45
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.625 SNIP 2.205
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.069 SNIP 1.615
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.145 SNIP 1.482
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.867 SNIP 1.962
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.936 SNIP 1.843
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.575 SNIP 2.264
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.155 SNIP 1.703
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.82 SNIP 2.063
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.576 SNIP 2.107
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.088 SNIP 1.907
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Lifecycle, Decision making, Strategy implementation, Product life, Innovation, Ecodesign
DOIs:
Ecodesign maturity model: a management framework to support ecodesign implementation into manufacturing companies

Over the last few decades, ecodesign has emerged as a promising approach to integrate environmental concerns into the product development and related processes. Ecodesign aims to minimize environmental impacts throughout the product's life cycle, without compromising other essential criteria such as performance and cost. Despite the potential benefits of ecodesign and the existence of several tools and techniques for product design, the actual application of ecodesign has not reached companies worldwide, mainly due to difficulties in ecodesign implementation and management. This paper introduces the ecodesign maturity model, a framework aimed at supporting the ecodesign implementation process. Based on a diagnosis of the current maturity profile of a company's product development and related processes regarding ecodesign implementation, the model proposes the most suitable ecodesign practices and improvement projects to be applied, by adopting a continuous improvement approach for process improvement. The model is thus intended to support ecodesign managers in their deployment of strategic and tactical roadmaps for ecodesign implementation. The paper discusses the main concept of the model and the results of its application into a large manufacturing company. In addition to the academic benefits related to the systematization of the ecodesign knowledge, the application of the model is shown to provide companies with: a benchmarking of ecodesign practices; an assessment of strengths and weaknesses; and a common language and a shared vision for ecodesign implementation. © 2013 Elsevier Ltd. All rights reserved.

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Universidade de Sao Paulo
Authors: Pigosso, D. C. A. (Intern), Rozenfeld, H. (Ekstern), McAloone, T. C. (Intern)
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.83 SJR 1.615 SNIP 2.382
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.609 SNIP 2.383 CiteScore 5.57
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.661 SNIP 2.477 CiteScore 4.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.644 SNIP 2.581 CiteScore 4.47
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.706 SNIP 2.328 CiteScore 4.07
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.461 SNIP 1.825 CiteScore 3.19
ISI indexed (2011): ISI indexed yes
Despite the recognition of the potential benefits of ecodesign, a promising approach to integrate environmental concerns into the product development process, its application has failed to reach large numbers of companies and sectors worldwide due to managerial difficulties. In response to that a comprehensive framework has been developed, with the aim of ensuring systematic management, implementation and continuous improvement of the ecodesign process. The framework, called Ecodesign Maturity Model (EcoM2), enables the diagnosis of the company’s ecodesign maturity profile; the identification of strengths and limitations; and the establishment of strategic roadmaps for improved ecodesign implementation. This paper describes the development of the EcoM2 web portal, which will allow for the framework to be tested on greater numbers of companies and at the same time to provide a quick diagnosis of their current ecodesign maturity profile. Analyses of the collected data will allow the establishment of patterns on ecodesign implementation in regards to criteria such as sector and size of companies and the improvement of empirical knowledge on ecodesign implementation and best practices.
Environmental improvement through product development - in Japanese: A guide

Companies in Denmark and abroad are working increasingly to reduce human impacts on the environment and nature. At the same time there must still be a large focus on the creation of value for customers and consumers. This development gives rise to a huge potential for Danish companies, to create new business opportunities, where sustainable development and value creation are integrated early in the design of new products and services. There is a great opportunity for businesses to create a new and positive agenda, where the focus is on all the good that companies can do for the environment, society and economic growth. Such an agenda must, of course, be based on a high involvement of the competencies of the companies’ own employees, as well as those of partners in the value chain. The Danish Environmental Protection Agency and the Confederation of Danish Industry are cooperating to promote and aid the establishment of such a new agenda. We place our focus on how products and services can be designed so not to harm humans, the environment and nature. With this Guide to environmental improvement through product development, we take the first step in this collaboration. The Guide gives inspiration and a stepwise approach to integrating positive environmental effects into companies’ design and product development processes. The Guide is intended primarily for product developers who have the task of building environmental thinking into the product development process. However, environmental staff, industrial designers, manufacturing staff and others can also benefit from reading the Guide. The Guide is based on a review of the environmentally-oriented methods used and product development activities carried out in Danish and international companies, as well as experience gained through a series of workshops with Danish companies. The Guide has been created by the Technical University of Denmark (DTU) and IPU Product Development, in cooperation with the Confederation of Danish Industry and the Danish Environmental Protection Agency. Development of the Guide was financed through the Danish Environmental Protection Agency’s company funding scheme. We hope you will be inspired!

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Main Research Area: Technical/natural sciences
Ecodesign, Product life, PD methods
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Publication: Research - peer-review > Book – Annual report year: 2013

Fuzzy Decision Support for Tools Selection in the Core Front End Activities of New Product Development
The innovation process may be divided into three main parts: the front end (FE), the new product development (NPD) process, and the commercialization. Every NPD process has a FE in which products and projects are defined. However, companies tend to begin the stages of FE without a clear definition or analysis of the process to go from Opportunity Identification to Concept Generation; as a result, the FE process is often aborted or forced to be restarted. Koen’s Model for the FE is composed of five phases. In each of the phases, several tools can be used by designers/managers in order to improve, structure, and organize their work. However, these tools tend to be selected and used in a heuristic manner. Additionally, some tools are more effective during certain phases of the FE than others. Using tools in the FE has a cost to the company, in terms of time, space needed, people involved, etc. Hence, an economic evaluation of the cost of tool usage is critical, and there is furthermore a need to characterize them in terms of their influence on the FE. This paper focuses on decision support for managers/designers in their process of assessing the cost of choosing/using tools in the core front end (CFE) activities identified by Koen, namely Opportunity Identification and Opportunity Analysis. This is achieved by first analyzing the influencing factors (firm context, industry context, macroenvironment) along with data collection from managers followed by the automatic construction of fuzzy decision support models (FDSM) of the discovered relationships. The decision support focuses upon the estimated investment needed for the use of tools during the CFE. The generation of FDSMs is carried out automatically using a specialized genetic algorithm, applied to learning data obtained from five experienced managers, working for five different companies. The automatically constructed FDSMs accurately reproduced the managers’ estimations using the learning data sets and were very robust when validated with hidden data sets. The developed models can
be easily used for quick financial assessments of tools by the person responsible for the early stage of product development within a design team. The type of assessment proposed in this paper would better suit product development teams in companies that are cost-focused and where the trade-offs between what (material), who (staff), and how long (time) to involve in CFE activities can vary a lot and hence largely influence their financial performances later on in the NPD process.

**General information**

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Ecole Polytechnique de Montreal, Scuola Superiore Sant'Anna
Authors: Achiche, S. (Ekstern), Appio, F. (Ekstern), McAloone, T. C. (Intern), Minin, A. D. (Ekstern)
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.78 SJR 1.224 SNIP 1.76
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.956 SNIP 1.827 CiteScore 1.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.259 SNIP 2.435 CiteScore 2.38
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.271 SNIP 2.588 CiteScore 2.48
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.825 SNIP 3.307 CiteScore 2.13
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.086 SNIP 2.739 CiteScore 2.37
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.222 SNIP 1.589
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.752 SNIP 1.269
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.901 SNIP 1.09
Scopus rating (2007): SJR 0.671 SNIP 1.387
Scopus rating (2006): SJR 0.764 SNIP 1.579
Scopus rating (2005): SJR 0.579 SNIP 1.718
Scopus rating (2004): SJR 3.038 SNIP 4.009
Scopus rating (2003): SJR 1.513 SNIP 1.422
Web of Science (2003): Indexed yes
Industry specific PSS: A study of opportunities and barriers for maritime suppliers

Product-Service System (PSS) business models are finding applications with suppliers and manufacturers across industries, but the models have yet to establish a strong foothold in the maritime sector. A number of metrics for evaluating the attractiveness of PSS business models have been proposed in chiefly design research and operations management literature. This paper applies a number of these metrics to the maritime sector using data from a number of maritime suppliers. It is found that the industry is, at least in some aspects, attractive from this PSS metrics standpoint. To explain the inherent lack of PSS maturity in the industry despite this metrics-based conclusion, the discussion moves beyond the quantitative factors and considers a number of organisational, structural and cultural issues that stand in the way of PSS. This paper is based on the initial responses provided by maritime suppliers in a maritime research consortium in (name of country removed).

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Main Research Area: Technical/natural sciences
Product-service systems, Requirements, Recovery strategy, Entrepreneurship
Electronic versions:
Industry_specific_PSS.pdf

Maritime Branch Analysis: A workbook in the PROTEUS series

The vast majority of countries in the developed world are now dependent on their service sectors for between 70-80% of their gross domestic product. Even companies with decades of expertise in producing manufactured products are experiencing an increased need to understand before-, during- and after-sales service and have therefore embarked on business development activities that tightly combine product and service offerings in their portfolios. Closer customer contact, commoditisation of goods, total cost of ownership, and product liability are just some of the reasons for this transition. As yet there are only few systematic guidelines and instruments available to aid the development of servitised products. Therefore this series of workbooks. In this first workbook we present an industry sector of great importance and source of wealth to the Danish society, which is also experiencing and influencing a move towards intensified service integration into business- and product development activities. The workbook has been created by condensing the transcripts and the insights we have gained from a wealth of studies across the maritime branch, and it serves to provide a unique insight into a whole industry sector’s readiness and first steps towards servitisation. Although this book is written primarily for our partners on the PROTEUS project, we are sure it can be a source of inspiration to a broad range of practitioners, policy makers, academics and students.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Copenhagen Business School, Institute for Product Development
Authors: Mougaard, K. (Intern), Neugebauer, L. M. (Intern), Garcia i Mateu, A. (Intern), Andersen, J. A. B. (Intern), McAloone, T. C. (Intern), Hsuan, J. (Ekstern), Ahm, T. (Ekstern)
Melhoria ambiental por meio do desenvolvimento de produtos: um guia
Companies in Denmark and abroad are working increasingly to reduce human impacts on the environment and nature. At the same time there must still be a large focus on the creation of value for customers and consumers. This development gives rise to a huge potential for Danish companies, to create new business opportunities, where sustainable development and value creation are integrated early in the design of new products and services. There is a great opportunity for businesses to create a new and positive agenda, where the focus is on all the good that companies can do for the environment, society and economic growth. Such an agenda must, of course, be based on a high involvement of the competencies of the companies’ own employees, as well as those of partners in the value chain. The Danish Environmental Protection Agency and the Confederation of Danish Industry are cooperating to promote and aid the establishment of such a new agenda. We place our focus on how products and services can be designed so not to harm humans, the environment and nature. With this Guide to environmental improvement through product development, we take the first step in this collaboration. The Guide gives inspiration and a stepwise approach to integrating positive environmental effects into companies’ design and product development processes. The Guide is intended primarily for product developers who have the task of building environmental thinking into the product development process. However environmental staff, industrial designers, manufacturing staff and others can also benefit from reading the Guide. The Guide is based on a review of the environmentally-oriented methods used and product development activities carried out in Danish and international companies, as well as experience gained through a series of workshops with Danish companies. The Guide has been created by the Technical University of Denmark (DTU) and IPU Product Development, in cooperation with the Confederation of Danish Industry and the Danish Environmental Protection Agency. Development of the Guide was financed through the Danish Environmental Protection Agency’s company funding scheme. We hope you will be inspired!

Product-related Environmental Performance Indicators: a systematic literature review
Ecodesign is a proactive environmental management approach employed in the product development process (PDP) which aims to minimize the environmental impacts caused during products’ life-cycle, improving its environmental performance. The establishment of measurable environmental performance indicators (EPIs) during PDP is often cited as a successful factor for effective ecodesign implementation, since it enables the monitoring towards the accomplishment of
environmental performance improvement goals. However, companies still face difficulties in the selection and application of EPIs - a more structured approach to support EPIs selection is still lacking. This paper presents the efforts made in order to identify, classify and systematize the existing EPIs based on the systematic literature review. From the review, 261 EPIs were identified, classified, and then systematized in a digital database. The results and the state of art regarding environmental performance indicators are presented in this paper.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Universidade de Sao Paulo
Authors: Issa, I. I. (Ekstern), Pigosso, D. C. A. (Intern), McAloone, T. C. (Intern), Rozenfeld, H. (Ekstern)
Number of pages: 6
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Publisher: Korea National Cleaner Production Center
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**PSS Business Models: A workbook in the PROTEUS series**

**General information**
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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Andersen, J. A. B. (Intern), McAloone, T. C. (Intern), Garcia i Mateu, A. (Intern), Mougaard, K. (Intern), Neugebauer, L. M. (Intern), Hsuan, J. (Ekstern), Ahm, T. (Intern)
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**PSS Organisation: A workbook in the PROTEUS series**

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Apitz, N. (Ekstern), McAloone, T. C. (Intern), Garcia i Mateu, A. (Intern), Andersen, J. A. B. (Intern), Mougaard, K. (Intern), Neugebauer, L. M. (Intern), Hsuan, J. (Ekstern)
Number of pages: 60
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PSS Partnerships: A workbook in the PROTEUS series

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Andersen, J. A. B. (Intern), Mougaard, K. (Intern), McAloone, T. C. (Intern), Garcia i Mateu, A. (Intern), Neugebauer, L. M. (Intern), Hsuan, J. (Ekstern), Ahm, T. (Intern)
Number of pages: 54
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Main Research Area: Technical/natural sciences
Electronic versions:
PSS_Partnerships.pdf
Publication: Research - peer-review › Book – Annual report year: 2013

PSS Readiness Manual: A workbook in the PROTEUS series

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Avlonitis, V. (Ekstern), Hsuan, J. (Ekstern), McAloone, T. C. (Intern), Garcia i Mateu, A. (Intern), Andersen, J. A. B. (Intern), Mougaard, K. (Intern), Neugebauer, L. M. (Intern), Ahm, T. (Intern)
Number of pages: 48
Publication date: 2013

Publication information
Publisher: Technical University of Denmark (DTU)
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Number: PRO-03
Main Research Area: Technical/natural sciences
Electronic versions:
PSS_Readiness.pdf
Publication: Research - peer-review › Book – Annual report year: 2013

PSS Tool Book: A workbook in the PROTEUS series

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Finken, K. H. (Intern), McAloone, T. C. (Intern), Avlonitis, V. (Ekstern), Garcia i Mateu, A. (Intern), Andersen, J. A. B. (Intern), Mougaard, K. (Intern), Neugebauer, L. M. (Intern), Hsuan, J. (Ekstern)
Number of pages: 78
Publication date: 2013

Publication information
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Original language: English
Teaching sustainability in engineering solutions as a generic bachelor course

Engineers have the potential to significantly influence the sustainability of technological solutions. At DTU we aim to address sustainability to all engineering students at DTU. One of the means to address students throughout DTU is the establishment of a course aimed at bachelor students from all of the university's study lines. The objectives of the course, which is named "Sustainability in engineering solutions", is for the participants to acquire an understanding of the basic concept of sustainability and its three dimensions (people, profit, planet), as well as to get an overview of a number of tools for the analysis of problems and the synthesis of solutions that are sustainable throughout their life cycle. The course ensures that the participants acquire the skills to use the most central of the tools introduced. Furthermore, the participants should understand the engineer's role and responsibility in the development of sustainable solutions. Examples of learning outcomes are:

• Describe the three dimensions of sustainability
• Explain that each dimension is multifactorial and discuss the trade-offs that exist within and between them
• Illustrate how companies can work towards the development of sustainable solutions
• Know and use various simplified tools for use in sustainability assessment
• Be able to relate critically to the results of various tools.

The course runs over a three week period, where the students work full time on the course. It employs project-based learning and is organised around a theme, within which there are several subprojects/problems that the students work on in groups of 4-5 persons. The theme in 2011 was “everyday appliances”, in 2012 “the sustainable primary school”, and in 2013 “the sustainable campus”. In 2012 the students worked together with a primary school interested in improving their environmental performance and in which they could do some empirical work. Several sub-projects were suggested and 5 were chosen: heating, water use/supply, use of electronics, cleaning, and ventilation. Similarly in 2013 they worked with DTU Campus service who defined a number of projects. The general outline of the course (especially in the beginning) is that theory lectures and exercises are given in the morning and in which they could do some empirical work. Several sub-projects were suggested and 5 were chosen: heating, water use/supply, use of electronics, cleaning, and ventilation. Similarly in 2013 they worked with DTU Campus service who defined a number of projects. The general outline of the course (especially in the beginning) is that theory lectures and exercises are given in the morning and the afternoons are fully devoted to project work, applying the theory learned in the morning. As the course progresses and after the front-loading of large amounts of the course material, a number of the days are fully devoted to project work with supervision. Several milestones for the project are defined, where the students should present their work. The students are evaluated on their project presentations and final report, plus a multiple-choice examination, to test their theoretical understanding.

This paper takes an in-depth discussion of the considerations concerning how to teach such a complicated subject to students of widely differing backgrounds, and reflects both the teachers’ and the students’ experiences with the course.

General information

State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Production and Service Management, Centre for Facilities Management, Department of Mechanical Engineering, Engineering Design and Product Development, Technical University of Denmark
Authors: Olsen, S. I. (Intern), Nielsen, S. B. (Intern), Ejlertsen, M. (Ekstern), McAloone, T. C. (Intern)
Number of pages: 8
Pages: Paper 72
Publication date: 2013

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Title of host publication: Proceedings of Engineering Education for Sustainable Development EESD13
Publisher: University of Cambridge
Main Research Area: Technical/natural sciences
Electronic versions:
Paper_72.pdf
Source: dtu
Source-ID: u::9085
Publication: Research - peer-review › Book chapter – Annual report year: 2013

Timing and Targeting of PSS Methods and Tools: An Empirical Study amongst Academic Contributors
The emergence of product/service-systems has meant that development methods for such systems have emerged from academia. This paper investigates existing methods that are aimed at developing product/service-systems. Two aspects are determined for each examined method. The first aspect that has been surveyed is when a given method is meant to
be used in the development of a product/service-system. This aspect has been determined through a qualitative assessment of each method. The second aspect surveyed is which persons in an organisation who are seen as the main drivers in the use of the methods. To gain this insight a questionnaire for each method has been conducted with the authors of the methods as participants. The main finding indicates that current PSS methods cannot thoroughly support the development of product/service-systems as their specificity is too low and that the methods need strong intra-organisational collaboration or even roles that do not yet exist.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Department of Management Engineering, Technical University of Denmark
Authors: Nøhr Hinz, H. (Ekstern), Bey, N. (Intern), McAloone, T. C. (Intern)
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Conference: 5th CIRP International Conference on Industrial Product-Service Systems, Bochum, Germany, 14/03/2013 - 14/03/2013
Product/Service-Systems, Methods, Design, Organisation, PSS, Product life, PD methods
DOIs: 10.1007/978-3-642-30820-8_12
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Visually Augmented Analysis of Socio-Technical Networks in Engineering Systems Design Research
In characterizing systems behaviour, complex-systems scientists use tools from a variety of disciplines, including nonlinear dynamics, information theory, computation theory, evolutionary biology and social network analysis, among others. All of these topics have been studied for some time, but only fairly recently has the study of networks in general become a major topic of research in complex engineering systems. The research reported in this paper is discussing how the visually augmented analysis of complex socio-networks (networks of people and technology engaged in a product/service-system (PSS) life cycle) may be applied in engineering design research. Network thinking of the kind described in this paper could be fundamental for developing new and effective techniques for solving the problems in the engineering design research related to the interpretation of the huge amount of data captured during experiments and observations that are more and more used as a main research method. Case studies that are presented illustrate also the significance of the network based research approach in providing insight into ways of improving the design process for complex engineering systems.

General information
State: Published
Organisations: Department of Management Engineering, Technology and Innovation Management, Department of Mechanical Engineering, Engineering Design and Product Development, University of Zagreb, Swiss Federal Institute of Technology
Authors: Storga, M. (Ekstern), Stankovic, T. (Ekstern), Cash, P. (Intern), McAloone, T. C. (Intern)
Number of pages: 10
Publication date: 2013

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Main Research Area: Technical/natural sciences
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Socio-technical networks, Visualisation, OrganicViz, Traceability, Engineering design research, PSS, Innovation, PD methods

Bibliographical note
Authors: Štorga M., Stanković T., Cash P., McAloone T. C.
Conference: The Future of Transdisciplinary Design (TFTD13)
June 24-25, 2013, Luxembourg city, Luxembourg
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Source-ID: u::7789
Collaborative Product/Service-Systems – On conceptualisation of PSS offerings and business nets

Collaborative PSS development and operation, where multiple stakeholders are involved, is an emerging research area. This article looks at the intra and inter-organisational company considerations in the industry case of company collaboration in the maritime branch. Initial steps are taken towards a framework that aligns service strategies and their unique value proposition with a set of business nets that seeks lights on the value-logic and management mechanisms to design and control each network.

Establishing Collaborative Networks for the Conceptualisation of PSS

Collaborative PSS development and operation, where multiple stakeholders are involved, is an emerging research area. This article looks at the intra and inter-organisational company considerations in the industry case of company collaboration in the maritime branch. Initial steps are taken towards a framework that aligns service strategies and their unique value proposition with a set of business nets that seeks lights on the value-logic and management mechanisms to design and control each network.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Mougaard, K. (Intern), Neugebauer, L. M. (Intern), McAloone, T. C. (Intern), Bey, N. (Intern), Andersen, J. A. B. (Intern)
Number of pages: 6
Publication date: 2012
Investigating features influence in fuzzy modelling of mass perception of non–functional 3D CAD forms

Users react to products without knowing the intended Kansei integrated into them by the designer. Human beings are equipped with variable preference mechanism. It is argued that human attributes result from three different levels of brain mechanism: the visceral, the behavioural, and the reflective levels. This paper focuses upon the visceral level through the building of a link between geometric properties of non–functional 3D forms and the human perception of these by users. This link is created using a genetic algorithm combined with a fuzzy logic decision support system. Human evaluations of the non–functional 3D shapes against two contrary perception adjectives (massive and light) are used as the learning data set for the genetic algorithm. Eight fuzzy models were developed using different sets of quantitative geometric properties as inputs resulting into different sets of fuzzy design rules. Correlations as high as 99%, between fuzzy and human perception, were obtained.

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Department of Management Engineering, Technology and Innovation Management, Ecole Polytechnique de Montreal
Authors: Achiche, S. (Ekstern), Ahmed-Kristensen, S. (Intern), Howard, T. J. (Intern), McAloone, T. C. (Intern), Baron, L. (Ekstern)
Pages: 112-139
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Main Research Area: Technical/natural sciences

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  BFI (2016): BFI-level 1
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  Scopus rating (2014): SJR 0.292 SNIP 0.597 CiteScore 0.7
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  ISI indexed (2013): ISI indexed no
  BFI (2012): BFI-level 1
  Scopus rating (2012): SJR 0.218 SNIP 0.413 CiteScore 0.36
  ISI indexed (2012): ISI indexed no
  BFI (2011): BFI-level 1
  Scopus rating (2011): SJR 0.249 SNIP 0.673 CiteScore 0.52
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  BFI (2010): BFI-level 1
  Scopus rating (2010): SJR 0.205 SNIP 0.351
  BFI (2009): BFI-level 1
  Scopus rating (2009): SJR 0.289 SNIP 0.647
  BFI (2008): BFI-level 1
  Scopus rating (2008): SJR 0.21 SNIP 0.651
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PD methods, Design, DFX, Ecodesign, Eco-design, Environment, Product development, Environmental impact
Open Design and Crowdsourcing: Maturity, Methodology and Business Models

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Department of Management Engineering
Authors: Howard, T. J. (Intern), Achiche, S. (Intern), Özkil, A. G. (Intern), McAloone, T. C. (Intern)
Number of pages: 10
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Open design, Open hardware, Crowdsourcing, Business models, Open source, Open innovation, Open service, PSS, Innovation, PD methods, Ecodesign, Lifecycle, Sustainability, Tools
Electronic versions:
Open Design - DESIGN12 soac_thow.pdf
Links:
http://www.designsociety.org/publication/30980/ds_70_proceedings_of_design_2012_the_12th_international_design_conference_dubrovnik_croatia

Relations
Activities:
12th International design conference
Source: dtu
Source-ID: u::4166
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Open Innovation Practices in a Cluster Context: A Medicon Valley Case Study

General information
State: Published
Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, DTU Executive School of Business, Technical University of Denmark
Authors: Achiche, S. (Intern), Howard, T. J. (Intern), Ástvaldsdóttir, A. (Intern), Andresen, O. (Ekstern), McAloone, T. C. (Intern)
Number of pages: 10
Publication date: 2012
Main Research Area: Technical/natural sciences

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Activities:
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Source: dtu
Source-ID: u::5086
Publication: Research - peer-review › Paper – Annual report year: 2012

Open Source Development of Tangible Products - from a business perspective

This article's objective is to set up some foundational theory and practices for Open Source Development (OSD) of tangible products, a novel and emerging approach derived from the well-known open source software movement. As a contribution to the first steps of research in this discipline a clear definition for OSD is proposed and used to describe the key elements of a suggested OSD Process model. Several case studies are analysed to create an Archetypal Business Model characterising OSD of tangible products and the possibilities and delimitations within. Furthermore, strategic tools
are suggested for companies that wish to explore the potentials OSD brings which form a so called OSD Method. The result of the method is the OSD Strategy and implementation thereof. This is done with the objective of determining the potential profitability that lies within OSD of tangible products and how companies can utilise this new approach to improve their business models and capture value in innovative ways.

General information
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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Fjeldsted, A. S. (Ekstern), Adalsteinsdottir, G. (Ekstern), Howard, T. J. (Intern), McAloone, T. C. (Intern)
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Publication date: 2012
Main Research Area: Technical/natural sciences
Open source development, Open, Open source hardware, Platforms, Business models, Communities, Innovation, PD methods, Design, Engineering design, Product development, Teaching, Research based learning, Learning based teaching

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NordDesign 2012
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Publication: Research › Paper – Annual report year: 2012

PSS Case Book: A workbook in the PROTEUS series
The transformation process towards a PSS-oriented company is describes, through the presentation of the best pracice cases. Each case describes motivations, challenges, business models and PSS offerings.

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Department of Management Engineering, Quantitative Sustainability Assessment, Copenhagen Business School, Institute for Product Development
Authors: Neugebauer, L. M. (Intern), Mougaard, K. (Intern), Andersen, J. A. B. (Intern), McAloone, T. C. (Intern), Bey, N. (Intern), Hsuan, J. (Ekstern), Ahm, T. (Ekstern)
Number of pages: 40
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Product/Service System development, PSS, Product life, Environment, Environmental Impact, Product development, PSS development, Sustainability, Sustainable Consumption and Production
Electronic versions:
PROTEUS_wbs2.pdf
Links:
http://www.proteus.dtu.dk/Results/Workbooks
Publication: Research - peer-review › Book – Annual report year: 2012

Step-by-step towards PSS – Evaluating, Deciding and Executing
Successful implementation of product-service system (PSS) as business strategy has proven lucrative through many industry examples. However, companies should tread carefully before committing to a costly restructuring towards PSS business creation. This paper claims that before a company moves from being a product to a product-service provider they should carefully consider internal and external aspects with regard to their organization, their market and their network. The paper proposes a three step process labelled the Evaluate-Decide-Execute approach; an approach that should enable the company to first evaluate the foundation for PSS, and then decide whether to commit to this course, and finally execute the transformation.

General information
Towards assessing Product/Service-Systems (PSS) within the Danish maritime industry: A PSS positioning map
In response to requirements resulting from a changing business landscape from solely physical-product-based value creation towards performance-based value creation, this paper presents a questionnaire-based matrix, the PSS Categorization Matrix, that is developed in order to help organizations find their position in terms of the balance between product-related and service-related activities. Judging from a workshop carried out with companies from the maritime industry and researchers in the area, the approach seems promising, but requires improvements on questionnaire and Matrix. These need to incorporate further improvements regarding the factor of time and the applicability related to product/service portfolios, as opposed to single product/services.
The authors already plan further research on the identified issues.
Arduino & RepRap - Creating Wealth by Giving it Away: ICED11 Mechatronics Keynote

Because it is sometimes possible to convert one into the other, money and wealth are often confused. But they are distinct: money is pieces of paper or numbers in a computer; wealth is corn to make bread, or a motor car. Both money and wealth grow as time advances: growth in money is inflation, growth in wealth is longevity and prosperity. Is it possible to grow wealth independently of money? This talk will be from Adrian Bowyer - creator of RepRap, the open-source replicating 3D printer - and from David Cuartielles - creator of Arduino, the open-source microcontroller. Both projects have founded significant and growing industries - and hence significant and growing wealth - by giving away all the data required to build RepRaps and Arduinos completely free. They have also short-circuited most conventional industrial infrastructure by placing the ability to create wealth directly in the hands of private individuals. The presenters contend that this is the way of the future: companies, and - more importantly - those private individuals will be giving away their primary products and making a living on the sideline activities that such donations attract. Software has been heading in that direction for decades. Now hardware is following.

Boundary Conditions for a New Type of Design Task: Understanding Product/Service-Systems

Manufacturing companies have traditionally focused their efforts on developing and producing physical products for the market. Currently, however, many companies are rethinking their business strategies, from selling products to providing services. In place of the product alone, the activity and knowledge associated with the use of the product is increasingly perceived to be the new design object. But how to organise the design of combined products and services, over expanded time domains and new stakeholder boundaries? The design research community is paying increasing attention to this new design object and research paradigm, studying service-oriented approaches to product development and seeking to
understand how to spell the systematic development of these so-called Product/Service-Systems (PSS). When considering the shift towards PSS in the domain of engineering, it is interesting to understand the shifting focus and identification of boundary conditions that manufacturing organisations must undergo, in order to develop just as systematic an approach to the service-related aspects of their business development, as they have in place for their product development. This chapter will attempt to map out some of the boundary conditions for PSS design research, in order to ensure that the phenomenon is successfully transformed into a well balanced design research field, including the necessary domains of expertise and research content to fully understand, develop and also communicate the field to industrial manufacturing companies.

General information
State: Published
Organisations: Engineering Design and Product Development, Department of Management Engineering
Authors: McAloone, T. C. (Intern)
Number of pages: 320
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Publication date: 2011

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Publisher: Springer
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Product/service-systems, PSS, Product life, PD methods, Environment, Environmental impact, Lifecycle, Product development, Sustainability, Sustainable Development
Links:
Source: orbit
Source-ID: 283776
Publication: Research - peer-review › Book chapter – Annual report year: 2011

Designing a Spaceship for Everyone: A new technology and market that is out of this world! ICED11 Aerospace Keynote
Virgin Galactic has been established as a commercial spaceline to provide safe and affordable access to space for people, science and payload. In the first instance, it will transport space tourists on a sub-orbital spaceflight experience, during which they will be able to experience weightlessness for several minutes. Achieving this has already involved overcoming several significant design challenges; a two-stage spaceflight system has been designed, with a spacecraft being released from its mothership at altitude and the spacecraft subsequently deploying a novel means of achieving safe re-entry to the Earth’s atmosphere. In addition, the prototype design for the spacecraft, which was flown by a lone pilot into sub-orbital space in 2004, has been scaled up to include a passenger cabin large enough for Virgin’s commercial flights to carry six passengers. The spacecraft design has also been thoroughly overhauled to provide the spaceflight experience that Virgin’s early research identified as essential to delivering the required customer experience and thereby establishing a sustainable business. This presentation will summarise the main cross-discipline challenges that Virgin is working to overcome and the progress made so far on its plans to turn commercial space travel into a reality.

General information
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Organisations: Engineering Design and Product Development, Department of Management Engineering, Virgin Galactic
Authors: Firth, J. (Ekstern), Howard, T. J. (Intern), McAloone, T. C. (Intern)
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Designing Complex Systems for the 21st Century: ICED11 Design Complexity Keynote
The design of complex “engineered” systems in the 21st century poses a set of common challenges, to name a few, the complexity and computational cost of system analysis, the heterogeneity of information at different levels of abstraction, the various sources of uncertainties, the multidisciplinary organization with conflicting goals, and the difficulty in understanding the socio-technical interfaces. Classical systems engineering approaches which focus on processes for cascading engineering requirements from higher to lower system levels is no longer suited to dealing with the global and socio-technical aspects of the 21st century complex systems. This presentation will first explore the research challenges and opportunities in designing complex “engineered” systems, and then focus on two specific topics in this area, i.e., (1) design of multiscale systems and (2) integrating heterogeneous consumer preference into enterprise-driven product design. Research in multiscale design presents the significant benefits of using computational design techniques for designing novel materials, new products, and new processes with exceptional system performance across diverse application domains such as material, energy, and medicine. Integrating consumer choice models into product design demonstrates the potential of combining analytical choice modeling with social networks for studying the social influence on new product adoption. It is concluded in this presentation that as systems continue to grow with increased complexity and more stringent requirements, many unanswered questions can be tackled using rigorous design methodologies.

Design Research: Embracing the Diversity: ICED11 Design Society Keynote
Design is a topic that has been studied from many disciplinary perspectives, each bringing particular methodological traditions to bear and yielding many different insights into the subject, but the diversity has meant that it has been difficult to achieve a coherent view on research in the domain. This presentation will explore the nature of this diversity and will propose ways in which the research community may work together to develop a consolidated understanding of the design research space. After first exploring the different communities that contribute to design research, and reflecting on a range of topics that have been studied, a number of ways will be presented in which research in the domain might be characterised, building especially on experiences with ICED conferences in recent years. In particular, design research will be differentiated according to the time scales being studied, the number of participants, the complexity and degree of originality of the design context, the research approach and the degree of abstraction employed. Suggestions will then be made for how the research community may collaborate in the future to identify where there are commonalities and differences in results and approaches.
Fossil Dot Com: ICED11 Sustainability Keynote

Since the start of the industrial revolution in 1800, with breakthrough innovations in iron production, textile industry and the steam engine, society has sustained incredible growth and transformation. During the 200 years, worldwide individual productivity has grown more than 32 times, and the transformation has moved 50% of us to live in cities, whereas a mere 3% dwelled in cities in 1800. However, this 200 year long fossil fuelled bubble is coming to an end, which affects societies around the world and the way we design products and services for these societies beyond imagination. With rich technological examples from his background as director of the innovation centre at DONG Energy, Charles Nielsen will discuss the impact of upcoming changes to the backbone of industry: the energy supply. DONG Energy has an ambitious strategy of changing the energy supply from 15% to 85% renewable energy before 2040. Embodiment of the corporate strategy into designs including urban design, bio refineries, offshore wind, sun and electric vehicles will serve as a platform for describing design challenges of the future - A future where society at large becomes the most important stakeholder demanding sustenance. Management gurus have taught us for the last 20 years that in the end we all are delivering products and services to end users. This may still hold true; however, we now need to learn that we all are nothing but subsidiary companies of the nature.

Influence Of Tools Input/Output Requirements On Managers Core Front End Activities In New Product Development

The object of analysis of this explorative research is the Fuzzy Front End of Innovation in Product Development, described by those activities going from the opportunity identification to the concept definition. Business scholars have shown that confusion in terms of goals and different ideas about opportunities; make this early phase of the innovation process uncertain and extremely risky. Literature suggests that the understanding, selection and use of appropriate tools/techniques to support decision making are instrumental for a less fuzzy front end of innovation. This paper considers the adoption and use of such tools and the ways that new product development processes can change accordingly.

The starting hypothesis that we test here, using 5 case studies in Italy and Denmark, is that managers have to fully understand the needed input requirements and be aware of potential of such tools, in order to experience the expected outcomes downstream. By means of in depth semi-structured interviews, questionnaires and an online survey, we will here investigate the dynamics of tools selection, exploring its effect on the level of difficulty of usage and the potential impact on the efficacy of the new product development process is carried-out.

First results show that managers have a low/very low awareness of tools’ inputs/outputs requirements. This gives life to the problem according to which managers cannot select appropriate tools if they do not know their basic characteristics, challenging the opportunity to improve the efficacy of the NPD process. The problem is exacerbated by the contrasting assessments got on the dimension of the tools’ difficulty of usage: the low tools’ inputs/outputs requirements
awareness inevitably affect the level of perceived difficulty of usage which, in turn, pushes managers in the wrong direction when they have to cope with the tools selection problem.

**General information**

State: Published
Organisations: Department of Management Engineering, Sant' Anna School of Advanced Studies
Authors: Appio, F. P. (Ekstern), Achiche, S. (Intern), Minin, A. D. (Ekstern), McAloone, T. C. (Intern)
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Electronic versions: 075-1106-IPDM-EISAM.pdf
Source: dtu
Source-ID: u::3719
Publication: Research › Book chapter – Annual report year: 2012

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**Innovation and Entrepreneurship in the Automotive Business: ICED11 Automotive Keynote**

The global automotive business is one of the most competitive environments you can imagine. As an independent inventor or as a small development company, it is very challenging to be successful in implementing new ideas and components. In this mature and somewhat conservative technical environment, you really need to have a strong and revolutionary proposal. The big global manufacturers of vehicles have tried almost everything when it comes to new technology. When approaching them, you need to have your idea well protected by patents and also reliable data to prove and convince that your invention has appropriate benefits. The timing of the dialog with a potential user or business partner is important when it comes to which issues that have highest priorities or are most frequently discussed in the organization of said user or business partner. If there exist a special issue that your idea is about, there will be a much better access to decision-making processes and get enough interest for a potential business deal. After 20 years as a supplier of engineering services to the automotive industry and 10 years as head of Global R&D at Scania CV AB, I have experienced pros and cons both from a supplier perspective as well as from a vehicle manufacturer perspective.

**General information**

State: Published
Organisations: Engineering Design and Product Development, Department of Management Engineering, Vinnova (Swedish Agency for Innovation Systems)
Authors: Johansson, H. (Ekstern), Mortensen, N. H. (Intern), Howard, T. J. (Intern), McAloone, T. C. (Intern)
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**Bibliographical note**

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**Meeting the Energy Challenge: New Standards for Industrial Motor Efficiency: ICED11 Ecodesign Keynote**

With an annual production of approximately 16 million pumps, production in 12 countries and a commercial representation in 52 countries, Grundfos takes its environmental responsibilities seriously. Grundfos takes a life cycle approach to product development, which corresponds to the company’s “Total Cost of Ownership” (TCO) philosophy. This is important for Grundfos, as important pump improvements address the energy performance and service cost in the product’s operation period. These improvements include energy savings and increased overall pump efficiency. TCO can, therefore, be used to reveal the pump’s environmental profile. Grundfos has lobbied actively to tighten the requirements for electric motors in the European Energy Using Product Directive, leading to energy savings equal to 5% of all electricity in EU.
Mads Sckerl will present Grundfos’ motivation for this approach, and the results from the intensive work in this area.

General information
State: Published
Organisations: Engineering Design and Product Development, Department of Management Engineering, Grundfos Management A/S
Authors: Sckerl, M. (Ekstern), McAloone, T. C. (Intern), Howard, T. J. (Intern)
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Orthogonal Views on Product/Service-System Design in an entire Industry Branch
Product/Service-Systems (PSS) is an emerging research area, with terms such as ‘functional sales’, ‘servicizing’ and ‘service engineering’ all contributing to the foundation and our current understanding of PSS as a phenomenon. The field is still in its formative stages and definitions, understandings and approaches to PSS are still fluid. Much of the literature in the field of PSS has, until now, focused largely on the actual transition from product to PSS and has typically resided in the field of engineering design. Symptomatic of the current literature is the concept of service as the adding-on of non-physical activities and relationships between supplier and customer. There is evidence in the literature, that multi-stakeholder approaches, customer activity understanding, actor-network charting and value chain collaboration are important factors to include in PSS strategies. However, actual case examples of these factors are sparse and limited to conceptual examples. This paper describes five orthogonal views on PSS design, fostering integrated product/service thinking across organisational boundaries, via a systematic approach to user-oriented product and service development.

General information
State: Published
Organisations: Engineering Design and Product Development, Department of Management Engineering
Authors: McAloone, T. C. (Intern), Mougaard, K. (Intern), Neugebauer, L. M. (Intern), Nielsen, T. A. (Intern), Bey, N. (Intern)
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Proceedings of the 18th International Conference on Engineering Design: Vol. 1 Design Processes
The 18th International Conference on Engineering Design, ICED11, was held August 15-18th 2011 at The Technical University of Denmark (DTU), Copenhagen. The Conference is the flagship event of the Design Society, a society dedicated to contributing to a broad and established understanding of development and design. The ICED series of
conferences has a long tradition, which started in 1981 with the first ICED in Rome. A total of 419 papers were presented at ICED11, each double-blind reviewed by multiple reviewers. The papers included research papers and case studies on a variety of topics concerned with design thinking, theory, and practice, with a premium placed on evidence-based research. The papers are published in a total of ten volumes of Proceedings, in addition to electronic publication. This volume is the first of two concerned with Design Methods and Tools, and contains 45 papers on topics relating to tools and methods for design application including modelling, representation, selection, analysis, evaluation, optimisation and other related topics.

General information
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Organisations: Engineering Design and Product Development, Department of Management Engineering
Authors: Culley, S. (ed.) (Ekstern), Hicks, B. (ed.) (Ekstern), McAloone, T. C. (ed.) (Intern), Howard, T. J. (ed.) (Intern), Clarkson, J. (ed.) (Ekstern)
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Innovation, Case study, Design, Design for sustainability, Environment, Sustainability

Proceedings of the 18th International Conference on Engineering Design: Vol. 2 Design Theory and Research Methodology
The 18th International Conference on Engineering Design, ICED11, was held August 15-18th 2011 at The Technical University of Denmark (DTU), Copenhagen. The Conference is the flagship event of the Design Society, a society dedicated to contributing to a broad and established understanding of development and design. The ICED series of conferences has a long tradition, which started in 1981 with the first ICED in Rome. A total of 419 papers were presented at ICED11, each double-blind reviewed by multiple reviewers. The papers included research papers and case studies on a variety of topics concerned with design thinking, theory, and practice, with a premium placed on evidence-based research. The papers are published in a total of ten volumes of Proceedings, in addition to electronic publication. This volume is the first of two concerned with Design Methods and Tools, and contains 45 papers on topics relating to tools and methods for design application including modelling, representation, selection, analysis, evaluation, optimisation and other related topics.

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Authors: Culley, S. (ed.) (Ekstern), Hicks, B. (ed.) (Ekstern), McAloone, T. C. (ed.) (Intern), Howard, T. J. (ed.) (Intern), Reich, Y. (ed.) (Ekstern)
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Proceedings of the 18th International Conference on Engineering Design: Vol. 3 Organisation and Management

The 18th International Conference on Engineering Design, ICED11, was held August 15-18th 2011 at The Technical University of Denmark (DTU), Copenhagen. The Conference is the flagship event of the Design Society, a society dedicated to contributing to a broad and established understanding of development and design. The ICED series of conferences has a long tradition, which started in 1981 with the first ICED in Rome. A total of 419 papers were presented at ICED11, each double-blind reviewed by multiple reviewers. The papers included research papers and case studies on a variety of topics concerned with design thinking, theory, and practice, with a premium placed on evidence-based research. The papers are published in a total of ten volumes of Proceedings, in addition to electronic publication. This volume is the first of two concerned with Design Methods and Tools, and contains 45 papers on topics relating to tools and methods for design application including modelling, representation, selection, analysis, evaluation, optimisation and other related topics.

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Authors: Culley, S. (ed.) (Ekstern), Hicks, B. (ed.) (Ekstern), McAloone, T. C. (ed.) (Intern), Howard, T. J. (ed.) (Intern), Cantamessa, M. (ed.) (Ekstern)
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Proceedings of the 18th International Conference on Engineering Design: Vol. 10 Design Methods and Tools Part 2

The 18th International Conference on Engineering Design, ICED11, was held August 15-18th 2011 at The Technical University of Denmark (DTU), Copenhagen. The Conference is the flagship event of the Design Society, a society dedicated to contributing to a broad and established understanding of development and design. The ICED series of conferences has a long tradition, which started in 1981 with the first ICED in Rome. A total of 419 papers were presented at ICED11, each double-blind reviewed by multiple reviewers. The papers included research papers and case studies on a variety of topics concerned with design thinking, theory, and practice, with a premium placed on evidence-based research. The papers are published in a total of ten volumes of Proceedings, in addition to electronic publication. This volume is the first of two concerned with Design Methods and Tools, and contains 45 papers on topics relating to tools and methods for design application including modelling, representation, selection, analysis, evaluation, optimisation and other related topics.

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Organisations: Engineering Design and Product Development, Department of Management Engineering
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at ICED11, each double-blind reviewed by multiple reviewers. The papers included research papers and case studies on a variety of topics concerned with design thinking, theory, and practice, with a premium placed on evidence-based research. The papers are published in a total of ten volumes of Proceedings, in addition to electronic publication. This volume is the first of two concerned with Design Methods and Tools, and contains 45 papers on topics relating to tools and methods for design application including modelling, representation, selection, analysis, evaluation, optimisation and other related topics.

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Proceedings of the 18th International Conference on Engineering Design: Vol. 6 Design Information and Knowledge
The 18th International Conference on Engineering Design, ICED11, was held August 15-18th 2011 at The Technical University of Denmark (DTU), Copenhagen. The Conference is the flagship event of the Design Society, a society dedicated to contributing to a broad and established understanding of development and design. The ICED series of conferences has a long tradition, which started in 1981 with the first ICED in Rome. A total of 419 papers were presented at ICED11, each double-blind reviewed by multiple reviewers. The papers included research papers and case studies on a variety of topics concerned with design thinking, theory, and practice, with a premium placed on evidence-based research. The papers are published in a total of ten volumes of Proceedings, in addition to electronic publication. This volume is the first of two concerned with Design Methods and Tools, and contains 45 papers on topics relating to tools and methods for design application including modelling, representation, selection, analysis, evaluation, optimisation and other related topics.

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Organisations: Engineering Design and Product Development, Department of Management Engineering
Authors: Culley, S. (ed.) (Ekstern), Hicks, B. (ed.) (Ekstern), McAloone, T. C. (ed.) (Intern), Howard, T. J. (ed.) (Intern), Chen, W. (ed.) (Ekstern)
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Proceedings of the 18th International Conference on Engineering Design: Vol. 7 Human Behaviour in Design

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Organisations: Engineering Design and Product Development, Department of Management Engineering
Authors: Culley, S. (ed.) (Ekstern), Hicks, B. (ed.) (Ekstern), McAloone, T. C. (ed.) (Intern), Howard, T. J. (ed.) (Intern), Badke-Schaub, P. (ed.) (Ekstern)
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Proceedings of the 18th International Conference on Engineering Design: Vol. 8 Design Education

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General information
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The ICED series of conferences is the Design Society's "flagship" event. ICED11 took place on August 15-18, 2011, at the campus of the Danish Technical University in Lyngby/Copenhagen, Denmark. The Proceedings of the conference are published in 10 individual volumes, arranged according to topics. All volumes of the Proceedings may be purchased individually through Amazon and other on-line booksellers. For members of the Design Society, all papers are available on this website. The Programme and Abstract Book is publically available for download.
Product with service, technology with business model: Expanding engineering design

Looking back over the last decade, the importance of an expanded understanding of engineering design has been shared within the engineering design community. Presented concepts and methods to support such expansion include Functional Product Development, Service Engineering, and Product/Service-Systems (PSS) design. This paper first explains PSS design as a type of an expansion of the engineering design of a physical product. Secondly, it gives a review of PSS research and a projection of future research issues, also ranging out into untraditional fields of research. Finally, it presents a new promising concept beyond PSS design; via an integrated development of technology and business model. This can be of particular interest for further research, especially due to its high freedom for designers.

Reflections on Design Methodology Research: ICED11 Design Research Keynote

We shall reflect on the results of Design Methodology research and their impact on design practice. In the past 50 years the number of researchers in the field has expanded enormously – as has the number of publications. During the same period design practice and its products have changed dramatically. Nowadays designers can seldom focus on individual
‘products’ but must address, for example, large complex product/service-systems (PSSs) that require the integration of many different advanced technologies over the whole life cycle of such systems. The processes by which these PSSs are designed and produced are also now far more complex and distributed, putting designers under ever increasing pressure. We shall address the question: Are the results of Design Methodology research appropriate and are they delivering the expected results in design practice? In our attempt to answer this question we shall draw on our extensive experience of design research and design teaching, and on the recent book The Future of Design Methodology, edited by Professor Herbert Birkhofer. We shall also refer to a model that links the Results, Practices, Methods, and Sciences of designing. Some initial conclusions: Design Methodology research often fails to support the tasks currently confronted by practising designers; many valuable research insights are not transferred into practice; the design research field is fragmented and there is a need for consolidation; however, the current design research community is beginning to demonstrate a greater awareness of the needs of designers and to apply greater rigour in its research. Overall we feel optimistic about the future of Design Methodology research and its potential for improving the design process in practice.

General information
State: Published
Organisations: Engineering Design and Product Development, Department of Management Engineering, University of Cambridge
Authors: Andreasen, M. M. (Intern), Wallace, K. (Ekstern), Howard, T. J. (Intern), McAloone, T. C. (Intern)
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RETHINKING VALUE: A VALUE-CENTRIC MODEL OF PRODUCT, SERVICE AND BUSINESS DEVELOPMENT
Globalization and information technologies have made the economical landscape more transparent and customers smarter, more demanding and networked. Companies can see these changes as a threat to their business or as an opportunity to differentiate in the market and be a Prime Mover, by re-thinking customer value within the value system. This article shows how the term “value” is understood in different contexts and fields of economy, to see if these definitions can be merged, in order to understand the concept of value in broader way. The authors argue through literature review and example cases that seeing value from multi-disciplinary viewpoint opens up some unused opportunities for the companies to overcome barriers within a value system, design integrated products and services, work more effectively, co-create value with customers, make use of word-of-mouth promotion and achieve long-term relationships with customers. A new concept for re-thinking the value system is proposed and its main potentials to improve firms’ performance are described.

General information
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Organisations: Engineering Design and Product Development, Department of Management Engineering, Tallinn University of Technology
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Product and service development, Customer activity cycle, Value system, Value-centric model, Business model re-configuration, PSS, Product life, Innovation, PD methods, Design, Design methodology, Design research, Design types
The Future of Innovation - Beware of the Dark Side: ICED11 Innovation & Design Creativity Keynote

Innovation is on the agenda. It does not matter whether your organisation is small or large, whether you work in industry academia or government, or whether you work in the third sector: innovation is today's mantra. It seems to have become the holy grail everyone pursues (with varying degrees of success). We all get excited by the potential and possibilities innovation seems to offer. The presentation will ask whether there might be a dark side of innovation. We certainly need to think about innovation, a lot. But perhaps not quite as we know it, and the way we are used to. The presentation will challenge whether we join the quest for innovation too lemming-like, whether innovation has indeed become an end in itself rather than being a means to an end. It will close with proposing some armoury and companions that might help keep the quest for the innovation grail on the right tracks.

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The Propagation and Evolution of Design Constraints: An Industrial Case Study

The research in this paper reports a case study of a design project which had two scopes for a variant and an adaptive design type. This is quite common practice where designers commonly propose short and long term solutions to design problems. In this particular case, preference was not voiced for an adaptive solution until the 3rd stage-gate of the project. The researcher acted as project manager of the design project using a participatory action research methodology. During the design work the researcher recorded and classified the various design constraints introduced and propagated throughout the design project. Where it was hypothesised that the variant design type will contain all constraints of the adaptive design with additional ones, the study should this not to be the case. The study also revealed that contrary to popular belief, changes at higher systems levels may exhibit less creativity despite having a greater impact.

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Authors: Nair, V. V. (Ekstern), Howard, T. J. (Intern), Culley, S. J. (Ekstern), Dekoninck, E. A. (Ekstern), McAloone, T. C. (Intern)
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Understanding Managers Decision Making Process for Tools Selection in the Core Front End of Innovation

New product development (NPD) describes the process of bringing a new product or service to the market. The Fuzzy Front End (FFE) of Innovation is the term describing the activities happening before the product development phase of NPD. In the FFE of innovation, several tools are used to facilitate and optimise the activities. To select these tools, managers of the product development team have to use several premises to decide upon which tool is more appropriate to which activity. This paper proposes an approach to model the decision making process of the managers. The results underline the dimensions influencing the decision process before a certain tool is chosen, and how those tools impact the performance of costs, time and efficiency. In order to achieve this, five companies participated for the data collection. Interesting trends and differences emerge from the analysis of the data in hand, and several hypotheses are tested. A preliminary version of a theoretical model depicting the decision process of managers during tools selection in the FFE is proposed. The theoretical model is built from the constructed hypotheses.

When Machines Design Machines!: ICED11 Futurology Keynote

Until recently we were the sole designers, alone in the driving seat making all the decisions. But, we have created a world of complexity way beyond human ability to understand, control, and govern. Machines now do more trades than humans on stock markets, they control our power, water, gas and food supplies, manage our elevators, microclimates, automobiles and transport systems, and manufacture almost everything. It should come as no surprise that machines are now designing machines. The chips that power our computers and mobile phones, the robots and commercial processing plants on which we depend, are now largely designed by machines. So what of us - will be totally usurped, or are we looking at a new symbiosis with human and artificial intelligences combined to realise the best outcomes possible. In most respects we have no choice! Human abilities alone cannot solve any of the major problems that confront our species, and machine intelligence is now an imperative. To get the very best results we have to use computer modelling, visualisation and decision support. This also turns out to be a route to new materials, processing, production and thinking that promises to revitalise our industries and realise sustainable solutions. It may even turn out to be a new industrial revolution. Far from being taken out of the design loop, we will find ourselves with a new and more vital role…
Product Platform Modeling: Contributions to the discipline of visual product platform modelling

This PhD thesis has the title Product Platform Modelling. The thesis is about product platforms and visual product platform modelling. Product platforms have gained an increasing attention in industry and academia in the past decade. The reasons are many, yet the increasing globalisation and the change in the global economy seem to be major factors. Manufacturing companies have experienced an intensifying competition and many companies face increasing demands for reductions in costs and lead times in development and production. At the same time many customers have raised their demands for customisation of products. In many companies these changes in the business environment have created a controversy between the need for a wide variety of products offered to the marketplace and a desire to reduce variation within the company in order to increase efficiency. Many companies use the concept of product platforms to overcome this challenge of balancing the external and internal performance demands. Product platforms are found in many different instantiations in various industries and companies, and the concepts and challenges are likewise diverse. This PhD thesis documents a research project with two main purposes; First, various phenomena related to product platforms are investigated and secondly it is investigated how some of these phenomena can be visually modelled in order to support decision making in industrial platform projects. The investigation of platform phenomena is based on the notion that reuse and encapsulation of platform elements are fundamental characteristics of a product platform. Reuse covers the desire to reuse and share certain assets across a family of products and/or across generations of products. Product design solutions and principles are often regarded as important assets in a product platform, yet activities, working patterns, processes and knowledge can also be reused in a platform approach. Encapsulation is seen as a process in which the different elements of a platform are grouped into well defined and self-contained units which are decoupled from each other. These groups can be varied and combined to form different product variants without increasing the internal variety in the company. Based on the Theory of Domains, the concept of encapsulation in the organ domain is introduced, and organs are formulated as platform elements. Included in this introduction is a discussion of the dispositional effects of organ and work element encapsulation. Unlike most present perceptions of platforms and modularity, the concept of organ encapsulation makes it possible to describe the system characteristics of a product platform in which reuse and encapsulation effects are obtained without necessarily introducing standardised physical interfaces between the varying elements. By means of three industrial cases, in the companies Danfoss, Grundfos and Aker Solutions, it is discussed and exemplified how some of the phenomena and effects related to reuse and encapsulation can be visually modelled during product platform projects. A fundamental hypothesis in this project is that decision makers and important stakeholders have to be able to see the platform in order to manage it. Consequently, the thesis also investigates how visual models of important phenomena can support decision makers during a product platform project. The reaction from stakeholders in the case companies indicates that the decision base is improved by means of visual models. Another finding is that the sometimes rather theoretical and intangible phenomena can be instantiated in models and thereby made tangible and visual for decision makers and designers in the organisation.

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Service-oriented product development strategies: Product/Service-Systems (PSS) development

Manufacturing companies have traditionally focused their efforts on designing, developing, and producing physical products for the market. Today, global competition, outsourcing, and legislation commend that companies take greater responsibility for their products. This is driving some manufacturers to shift their business strategies from selling products (e.g., photocopying machines) to the provision of services (e.g., document services). Instead of the product itself, the activity and knowledge associated with the use of the product is perceived to be of more value to customers. In the research community, service-oriented approaches that embrace this change of business focus from individual products to total integrated customer solutions are termed Product/Service-Systems (PSS). The research in this thesis addresses the systematic design and development of PSS solutions in manufacturing firms. Here, PSS are understood on three levels in relation to design: 1. PSS solution – a system of integrated products and services that companies develop and deliver to customers. 2. PSS development – the integrated design processes and development activities that result in PSS solutions. 3. PSS approaches – service-oriented business strategies that coordinate PSS development. Based on an extensive review of the relevant literature and five empirical case studies, the following insights were made: - PSS solutions may be conceptualised by considering the product life phase systems, customer activities, and the actor network. These perspectives are fundamental to the understanding of PSS and provide an answer to how they can be more resource-efficient and competitive than traditional product-based business models. - Development activities related to PSS take place on multiple levels of the organisation in a manufacturing firm, from the formulation of business strategy to individual development projects of products and services, right down to the continuous support of customer activities on an operational level. This identification of PSS related development activities helps companies and researchers in understanding and structuring the development task related to PSS approaches. - PSS approaches require companies to coordinate their business strategy with their development competencies, product strategy, and service offerings in close collaboration with customers and other external partners. These findings resulted in theoretical models, prescriptive methods, and practical tools that are useful for industry, academia, and students interested in adopting PSS approaches.

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Eco-Innovation in the Value Chain

It is well known that companies face challenges integrating environmental considerations into their product development processes and there is an established body of research focusing on ways and means to aid this. The approach for integrating environmental considerations into product development processes is often reactive, resulting in a retrospective and insufficient approach. This paper describes the mechanisms, opportunities, and barriers for the actual realisation of value chain based eco-innovation, together with a first indication of a methodical approach to realising eco-innovation.

General information

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Strategies for Designing and Developing Services for Manufacturing Firms

Product/service-systems (PSS) are in effect an approach to designing integrated products and services with a focus on both customer- and product life cycle activities. Literature offers a range of service-oriented design strategies from product-oriented DfX approaches to more customer-oriented approaches such as integrated solutions and service design. These design strategies are mapped out in relation to how applicable they are to different types of services. Case studies from two industrial companies are used to confront the existing literature in order to improve understanding of how manufacturing companies may align their product and service development activities with their business strategies.

General information
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A systematic approach to service oriented product development

Throughout the last years, manufacturing industry has experienced a trend towards a higher level of operational integration with their customers, i.e. manufacturers differentiate their offer from competitors by combining physical and software products with service plans and service support operations. This integration of manufacturing and service business holds a number of potential advantages, such as optimised operational performance and improved insights into use phase processes. To realise these potential advantages, products and service operations must fit to and support each other, which calls for an integrated approach to their development. The integrated development of solution concepts spanning products, service delivery systems and matching delivery business models is the theme of this thesis. A design based approach - service oriented product development - is proposed for the creation of these Product/Service-Systems (PSS). The contribution builds on the foundations of engineering design and product development research performed at the Section of Engineering Design and Product Development at The Technical University of Denmark, also dubbed the Copenhagen school. Service oriented product development is based on the analysis of existing product life-, business- and use processes. This helps to identify the opportunities of creating improved solutions, through the combined delivery of products and services, potentially supported by altered customer relationship models. The research contribution is based on three industrial case studies, each emphasising several aspects of the case companies’ experiences and challenges in the transition from manufacturing- to service orientation. Two of the case companies are suppliers of equipment to the shipbuilding industry, the other is a global supplier of refrigeration technology. The main contributions documented in this thesis are the following: 1. A systematic approach allowing the visualisation of product life and related use activities is defined. 2. Service oriented product development must consider a broad range of actors not directly associated with use processes, but rather linked to the product life through associated processes and crossing life cycles. 3. Synthesis of PSS concepts relies on the iterative detailing and concretisation of elements utilising three view domains, being artefact-, activity- and actor based. 4. The development of PSS concepts is a collaborative high level effort, spanning across all or many functional areas of the company. 5. The manufacturing company needs to create an organisation or team in every affected functional area in order to contribute to, receive and implement concepts from the collaborative service oriented product development activity.
Environmental improvement through product development: A guide

Companies in Denmark and abroad are working increasingly to reduce human impacts on the environment and nature. At the same time, there must still be a large focus on the creation of value for customers and consumers. This development gives rise to a huge potential for Danish companies to create new business opportunities, where sustainable development and value creation are integrated early in the design of new products and services. There is a great opportunity for businesses to create a new and positive agenda, where the focus is on all the good that companies can do for the environment, society, and economic growth. Such an agenda must, of course, be based on a high involvement of the competencies of the companies' own employees, as well as those of partners in the value chain. The Danish Environmental Protection Agency and the Confederation of Danish Industry are cooperating to promote and aid the establishment of such a new agenda. We place our focus on how products and services can be designed so not to harm humans, the environment, and nature. With this Guide to environmental improvement through product development, we take the first step in this collaboration. The Guide gives inspiration and a stepwise approach to integrating positive environmental effects into companies' design and product development processes. The Guide is intended primarily for product developers who have the task of building environmental thinking into the product development process. However, environmental staff, industrial designers, manufacturing staff, and others can also benefit from reading the Guide. The Guide is based on a review of the environmentally-oriented methods used and product development activities carried out in Danish and international companies, as well as experience gained through a series of workshops with Danish companies. The Guide has been created by the Technical University of Denmark (DTU) and IPU Product Development, in cooperation with the Confederation of Danish Industry and the Danish Environmental Protection Agency. Development of the Guide was financed through the Danish Environmental Protection Agency's company funding scheme. We hope you will be inspired!

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Making Ecodesign Simpler than Ever Before: Experiences from empirical intervention

For the past three decades, environmental awareness has developed at an increasing pace in the research community, on governmental levels, and in industrial organisations. Three waves of environmental awareness have driven efforts in industry and society; each time raising the level of knowledge, activity and actual results achieved. In the meantime, a steady effort from the research community has maintained focus on tools, methods, and mindsets for environmental assessment and improvement, and governments internationally (not least in EU) have systematically increased environmental expectations and requirements in a series of areas. Judging by this brief (and admittedly incomplete) history of environmental awareness over recent decades, it seems that all ingredients are in place to make major breakthroughs in the products and processes developed by companies. And it is true to say that there are many stories of companies, which are working increasingly to reduce their human impacts on the environment and nature. However, on engaging in dialogue with a range of industrial companies, few report to be ready to embrace the task of environmental improvement (ecodesign) into their product development processes, through internal communication and development channels, or through the choice of methods and processes. Various research projects from the late 1990’s focused on the mechanisms necessary to encourage the integration of environmental considerations into the product development
process in organisations; some focusing on the tools necessary to achieve this, others focusing on issues of organisational change. All of these projects pointed towards a few multi-national corporations (e.g. Philips, HP, Motorola) who could clearly be seen to be first-movers in ecodesign implementation, at one end of the scale; and at the other end of the scale a large handful of small enterprises, fighting to make a good environmental idea into reality (e.g. lampshades and fruit bowls from old vinyl records; sandals from old car tyres). In between these extreme cases was a huge collection of enterprises, which had never considered, or never succeeded in implementing ecodesign into their organisations. This paper describes a project, carried out a decade after the above-named projects from the late 1990’s, where the initial conclusion regarding ecodesign implementation was the same as ten years previously. The project, which was supported by the Danish EPA and the Confederation of Danish Industry, carried out a survey of ecodesign methods and tools; an extensive survey of the literature in the field of ecodesign; and a limited survey of a representative group of Danish product developing organisations (15 companies in total), regarding their readiness, experiences and needs in the area of support for ecodesign implementation. Following these surveys, five companies were chosen as active case companies, in which a guide towards ecodesign implementation was developed and tested. The aim of the project was to create awareness and encourage activity, by providing a simple and inspiring guide to ecodesign, consisting of a few easy to implement steps for companies. The guide should be applicable by all types of companies – from large to small organisations; energy using industrial products to domestic objects of design. Furthermore the guide should inspire the product development project team to create space for environmental thinking in their development processes. To satisfy both the ambition of reaching the smallest of Danish companies and that of serving international operating organisations, the guide was completed in both Danish and English, and made available free of charge. Since the guide was completed it has been implemented further by the case companies involved and furthermore tested in a series of other companies. During the initial surveys carried out in the project, a number of interesting results were achieved. Over 50 ecodesign methods and tools were identified and presented to the initial 15 companies. The vast majority of these methods and tools have their origins in academic research projects and dissertations, which have been developed into more or less commercially available tools for use during the product development process. It was found that an astonishingly small amount of these methods and tools were known by the 15 companies; even fewer were actually in use by the companies involved. The literature survey revealed the development over time of various approaches to ecodesign and highlighted both new tools under development, as well as areas of application for these tools. The surveys also made it apparent, which drivers and barriers exist to ecodesign implementation in companies. It was also apparent that many tools had been developed in a vacuum, with respect to knowledge of other existing approaches and industry needs. The survey regarding companies’ readiness, experiences and needs in the area of support for ecodesign implementation focused on a number of areas, as follows: • The level of environmental communication in the organisation i.e. does the organisation have an environmental champion, visible environmental goals or visible environmental reporting? • The organisation of the environmental task i.e. does the company’s management have an environmental agenda, is time allocated for environmental thinking in product development, is there a focus on environmental competencies in the company? • The extent of collaboration and network i.e. to what extent does the company involve external partners or actively engage in networking about the environmental task, are there initiated working groups in the company, are there environmental competencies in the companies project teams? • The types of ecodesign content and activities that the company has or supports i.e. which particular ecodesign tools are used in the company, which methodologies does the company apply for environmental assessment and improvement, are there clear environmental goals for product development? This paper will present and discuss the above empirical findings from the respective cases studies carried out as a part of the project regarding the creation of an ecodesign implementation guide. We will also discuss the issues of periodical renewal and renewed presentation of such guides, in order to ensure sustained activity and implementation of environmental thinking in product development. Finally we will discuss a series of elements for future research and empirical industrial collaboration, based upon the insights gained from this project.

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Proceedings of ICED'09: Design for X, Design to X
The 17th International Conference on Engineering Design, ICED'09, was held August 24-27 2009 at Stanford University, California, USA. The Conference is the flagship event of the Design Society, a society dedicated to contributing to a broad and established understanding of development and design. The ICED series of conferences has a long tradition, which started in 1981 with the first ICED in Rome. A total of 379 papers were presented at ICED’09, each double-blind reviewed by multiple reviewers. The papers included research papers and case studies on a variety of topics concerned with design thinking, theory, and practice, with a premium placed on evidence-based research. The papers are published in a total of ten volumes of Proceedings, in addition to electronic publication. This volume contains 32 papers concerned with Design for X. Design to X, where X can represent a variety of attributes of the designed product or system – manufacturability, reliability, sustainability, efficiency, robustness and so on.

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Produkt/service-system (PSS) casestudie: SCA Hygiene Products A/S

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Reflections on product/service-system (PSS) conceptualisation in a course setting
Product/service-system (PSS) approaches have over the past decade received considerable attention as possible sustainable innovation strategies. This paper presents and reflects upon the background, rationale and experiences behind a PSS design methodology applied with engineering students in a project course for the past five years. The methodology proposes four complementary dimensions of PSS: value proposition, product life cycle, activity modelling cycle and actor network, that all seem to comprehensively describe the essential conceptual design perspectives. Each of these dimensions represents an expansion of the traditional degrees of freedom for designers. It has been observed that the most promising PSS solutions seem to be those where the perspectives in all four dimensions are coherent and mutually support each other.
Service-Oriented Strategies for Manufacturing Firms
This chapter establishes PSS (Product/Service-Systems) approaches in the context of manufacturing firms and their existing product-oriented business. PSS can be seen as a strategy for manufacturing firms to gain competitive advantage in the market, but what market conditions and organisational factors (e.g. structure, processes, capabilities, measurement and reward systems, people and competencies and culture) support service-orientation? The development of PSS is not just a task of initiating a service-oriented development project, but requires careful coordination with business units, customers and partners in business planning and strategy to reap the full benefits. Finally a path to how manufacturers can make the change from product to service-orientation is traced.

Spelling the Domain of Sustainable Product Innovation Research
Bringing scientific disciplines together is increasingly seen as a factor that can strengthen a particular scientific research approach. This has in particular been noted for the field of sustainable product innovation, which builds on disciplines such as Environmental Systems Analysis, Product Development, Product Design, Engineering, Economics and Business Administration, Consumer research and Operations management. With so many scientific fields forming the backbone of sustainable product innovation research, it is no surprise that relevant research furthering sustainable product innovation is done within various scientific domains. This observation fuels discussions on the need to define what is to be regarded...
as part of the sustainable product innovation (SPI) research domain, and what is not. In order to answer this question it is necessary to focus not only on topics, but also on research methodologies used (case study research, explorative research, descriptive or prescriptive research), case studies analysed, and theories used (such as innovation theory, institutional theory, organisational learning, entrepreneurship, technology management, or design theory). A recent survey, carried out under the umbrella of a Nordforsk funded project bringing together PhD supervisors in the Nordic countries, has identified over 200 completed PhD research projects that address research questions relevant within the SPI domain. An initial attempt to map and/or visualise past and present Nordic research into sustainable product innovation has lead to a map proposing five dimensions, which together should describe any piece of research within the SPI domain. Each dimension can further be broken down into three or four levels of contributing aspects. 1. Research aim. Here, a general distinction can be made into prescriptive and descriptive research. Descriptive research usually takes a level of either explanatory research, thick descriptions of societal phenomena, with or without the ambition of theory extension, which can in turn be through for example modeling or hypothesis testing. In contrast, prescriptive research is considerably more popular and can take many forms. Distinctions can be made in audience (companies of different size, consumers, and policy makers), types of outcome (management tools, policies, creativity tools, evaluation tools, etc.) and ambition level (ranging from incremental improvement, product innovation, function innovation, to system innovation). 2. Research method. It is suggested that research in SPI usually depends on either 1) field or case study research, using various techniques such as questionnaires, experiments, interviews and observations, 2) literature research, both on theoretical domains such as organizational theory, institutional theory, actor-network theory, as well as engineering-type literature. 3) action research, which is popular in studying industrial innovation processes in real time, and 4) various types of modeling, including life cycle modeling and various types of economic modeling. 3. Level of analysis. Here, four levels can be distinguished, 1) artefactual (components, products), 2) organizational (institutions, industry sectors, companies, departments, individuals such as designers), 3) technological, and 4) societal, focusing on policy, culture and/or public or private actors. 4. Object of analysis. Here, a number of objects can be distinguished, including processes (management, technical, etc.), phenomena (such as trends or controversies), infrastructures, actors, but also environmental data, policies or product categories. 5. Stage of the product life cycle. Here again, different sub-dimensions can be used to distinguish sublevels, mainly using the life cycle stages of the product itself, or using a developmental focus, distinguishing between fuzzy front analysis, idea and concept generation, detailed design, commercialization, etc.). In order to exploit to the best of our ability existing and future research, it is meaningful to discuss, among other things, how departmental research evolves, and how researchers have extended and elaborated on each others’ theories and scope. Generally departments evolved from studying disciplinary research questions (be it theories of technical systems, theory of dispositions, environmental impact assessment, product disassembly, environmental technologies, and resource efficiency) to more overarching themes, such as superartefactual environmental problems and augmented product thinking, actor- and user thinking, product stewardship, environmental management of industrial systems, integrated product policies, environmental technology transfer, sustainable consumption and corporate social responsibility. A related question is to determine how scientific research on the PhD level has been disseminated by successive generations of students that have obtained their PhD degree. To what extent has knowledge and expertise been transferred from research institutes to, and adopted by, industry, government bodies and NGOs, not least by the researchers themselves. Do LCA researchers end up doing LCAs? Do companies that employ people with PhD degrees benefit from trans-disciplinary scientific insights and expertise? This paper aims to discuss the questions put forward here. The method of analysis is a partial analysis of the extant body of PhD dissertations within the sustainable product innovation field as published in Northern Europe. Focus will be on the Nordic, Dutch and British regions, as research at universities there represents perhaps a unique kind of multidisciplinary, creative school of research, as opposed to a more engineering and quantitative orientation elsewhere in the world. Selected interviews with representatives of this research school that now work academically, industrially, or in policy making, will inform this discussion. The result will be a reflection on what can be regarded as the scientific research domain covering research supporting sustainable product innovation, including learning from historical developments, towards future research strategies and their industrial application.
Strategies for Designing and Developing Services for Manufacturing Firms

Product/service-systems (PSS) are in effect an approach to designing integrated products and services with a focus on both customer activities and product life cycle considerations. Literature offers a range of service-oriented design strategies from product-oriented DfX approaches to more customer-oriented approaches such as integrated solutions and service design. These design strategies are mapped out in relation to how applicable they are to different types of services. Case studies from two industrial companies are used to confront the existing literature in order to begin to understand how manufacturing companies may align their business strategies with their product and service development activities.

Succeeding in Business by Managing Consumption: A more sustainable approach to selling for

The predominant paradigm of industrial systems the past century has been mass production. This allowed products to be designed and manufactured in large quantities at lower costs, faster and of better quality than ever before. The efficiencies of mass production paved the way to mass consumerism that has since spurred global economic wealth and improved the lives of billions of people. Today it is apparent that the effects of the current industrial systems on our natural environment and consequently our own well-being are unsustainable. Manufacturing firms have traditionally succeeded in business by selling as much as they could produce. Designers constantly created new products, factories produced them as fast and cheap as possible and marketing encouraged demand – all contributing to ever increasing levels of natural resource consumption. It was of little concern what happened to the products once they were sold and handed over to the customer. This situation is now changing rapidly, with industry creating environmentally superior products in environmentally superior factories using environmental supply chains. However, if industrial systems are to become sustainable they also need to directly address issues of consumption. The role of design, manufacturing and service delivery may no longer be to sell ‘more stuff’, but to address how people’s needs can be sufficiently fulfilled in a manner which is economically and environmentally sensible – ‘selling less’. This paper provides three cases of manufacturing companies that demonstrates that business can be successful by selling less. The business model of each of the companies actively attempts to reduce their customers’ consumption while increasing customer satisfaction. This has proved to reduce customers’ costs, increased long term relationships to customers and radically reduced the environmental effects.  • Steelcase is the world’s largest manufacturer of office furniture. The development of their products is based on user-centred insights where work, workers and workplaces are studied intensively to create new solutions of furniture, interior architecture and technology. They no longer see it as their role to sell as many chairs and desks, but to work with their customers in finding solutions to workspaces that allow employees to work effectively and satisfactorily. This might actually mean less space and less furniture, but a better work environment and better business results for their customers.  • Vitsœ is a small company based in England. They manufacture a universal shelving system originally designed by Dieter Rams in 1960. The shelving system is designed with longevity in mind and is easy to construct, repair and dismantle allowing the system to be extended, rearranged and moved. All new components of the shelving system are compatible with the original system. Vitsœ discourages their customers to buy more than necessary as they can always add more components at a later stage; this is seen to result in long term commitments between customers and the
company. Half of their business is from existing customers, and considering the durability and long product life, this is very high. • SCA Hygiene Products is a global manufacturer of paper based hygiene products (paper towels, nappies, feminine hygiene products, etc.). They are the world leader in incontinence care. In Denmark the majority of their products for incontinence are sold to health care institutions and nursing homes. Here, in addition to their products, they offer a whole range of services from planning how to achieve improvements in incontinence care, to training and coaching health care personnel on how to best use their products, including monitoring product consumption and intervening when deviations occur. This integrated approach to products and services allows SCA to improve the well-being for the users of incontinence products, the work conditions for health care providing personnel and the total economy for incontinence care for the health care institution. Objectives This paper describes each company and their value propositions and how these were developed, delivered and nurtured in cooperation with customers. This is done on the basis of a framework of product/service-system (PSS) conceptualisation that elucidates four essential perspectives of PSS: - Value perceptions - Product and product life - Customers and customer activities - Actor network Insight into these companies’ business and context is presented in order to show how new, more sustainable, business models and design methods can be developed. Method Case study research is chosen as the research method as it gives deep insight to the research object and its context while allowing analysis of many variable factors (Yin 1994). As the objective is to gain insight in a company’s practice and context, the case studies are qualitative and explorative. All the cases derive from a PhD project on PSS development for manufacturing firms. The information for Steelcase and Vitsoe was gathered by one of the authors as a participant observer in new service development projects with the companies covering 15 months and 4 months respectively. The case on SCA was mainly established through interviews of 8 key employees and 5 customers and observations from company meetings and workshops. In all three cases multiple sources of information were used and findings were presented and discussed with the companies. Results The three case studies presented here provide evidence that a potentially lucrative business strategy for manufacturing firms is to not just sell as much as possible but to address the consumption of their own products and thereby ensure proper use and reduce unnecessary waste of natural resources. All the companies described manufacture fairly low-tech, uncomplicated products but even in this situation, the cases show large savings can be made for the customer by influencing his or her planning and use activities. In each case the delivery of products and services supported a clear strategy to support the customer throughout the total life cycle of the products. It would seem that this approach of production and delivery efficiency combined with consumption sufficiency could hold business potential for many other manufacturers to achieve environmentally and economically sustainable consumption and production.

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Taking up the sustainability challenge: Editorial: APPLIANCE Engineer - The Open Door
It’s no surprise to anyone that environmental issues are becoming ever more prominent and important to understand in the world of appliance development and manufacture. But what have we learned over the past decades, and how much do companies actually understand about designing for environment? And how much can we, or should we, design? What is surprising is that around 90% of the waste associated with the average mechanical or mechatronic product has occurred before end-users even get their hands on it. And if the product bears a plug or a battery, it will probably continue to make its most significant mark on the environment in its use phase—a phase where the manufacturer often has little or no direct influence. Environmental impacts are, of course, caused in all stages of a product’s life, and different products give rise to different types of environmental profiles. But regardless of the nature, size, and time of occurrence of environmental impacts for a product, the vast majority of these have been decided in the early phases of product development. This means the product developer has a great influence on the product’s life cycle and also on the subsequently occurring
environmental impacts. It is here where materials, technologies, and the product's lifetime are fixed. Therefore, it is important that the product developer considers the environment carefully and systematically into the development project, by adopting a life cycle approach to product development. It is essential that environmental stewardship becomes an integral part of the product development process, on a par with other business considerations such as cost, quality, design for manufacture, and so on. Ecodesign is Nothing New Design for environment—or ecodesign, as it's also known—is no longer a new discipline in the field of engineering. The past two decades have seen many efforts from academia and industry alike, toward the consideration of environmental improvement during product development. The result is that there are now hundreds of guidelines, tools, calculators, and consultants available to aid the process of design optimization for environmental improvement. The tough issue, however, is how to integrate these resources into each and every product development process. The answer, of course, is motivation. What will motivate a company to begin applying environmental improvements into its business practices and, therefore, also the products? Beyond the altruistic ideals of a few individual employees, motivation can be found in three main sources: regulation (or the threat hereof), market factors, and innovation opportunities. All three of these sources are very relevant for the necessary implementation of ecodesign, and all three can be extrapolated down to the bottom line, in some way or other. In terms of regulation, there is no question that Europe is currently the leader. A wealth of laws, directives, and draft guidelines are beginning to impact various branches, worldwide, if individual companies are to expect to be allowed to do business with Europe. At the same time, international standards are emerging and maturing, guiding on how to design for better environmental impacts. Market factors that have an impact on companies’ willingness and urgency in designing for the environment include customer demands (especially in B2B value chains), the risk of a bad image (or the chance of a good one), and competitors’ moves in an environmentally improved direction. Of course, there is also the possibility of new markets through newly designed, radically improved environmental products. The Innovation Opportunity The innovation opportunity is the ability to spot the need (e.g., legislation or market factors), the solution potential (e.g., a particular technology, a new customer segment, a radically new business model), and the creative potential inside the company (e.g., creative engineers, experienced business developers, etc.) to realize your goal. The ability to spot and carefully mix these ingredients is surely the key to the success and survival of the modern company. Under the currently intensified focus on human-generated environmental and climate problems, numerous examples of sustainable technologies, products, and system solutions are sprouting up out of industrially driven initiatives, research centers, and universities. Advances in wind and wave power generation, alternative-energy vehicles, fuel cell technology experiments, and zero-energy houses are but a few of many exciting initiatives. A major motivation for these initiatives is the recognition that the goals of environmental and sustainable development can also be conducive to innovation and business creation. What’s the Next Step in Ecodesign Strategy? Motivated? The next step, then, is to begin concrete and focused action toward the creation and implementation of an ecodesign strategy for your business. Map out the life cycle of your product and uncover the environmental hotspots. Identify the key stakeholders connected to the product and try to envisage their contribution to the product’s environmental impact. Scan for new/alternative technologies and test their feasibility next to existing technologies—both technology-wise and business-wise. If your business model discourages environmental improvements (in the product or its usage), consider changing it. Dip down into the global toolbox of ecodesign tools and select the most appropriate tools for your business. There is a great opportunity for businesses to create a new and positive agenda, where the focus is on all the good that companies can do for the environment, society, and economic growth. The individual company has a unique opportunity to utilize its access to free markets, innovative staff, and potentially willing users to generate significant environmental benefits, which, at the same time, satisfy users’ needs and create a market success. Such a positive agenda must, of course, be based on a high involvement of the competencies of the companies’ own employees, as well as those of partners in the value chain. Ecodesign for the appliance industry need not be limited to the product, but extended to the whole process of sustainable business creation.

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The design of Eco Board Games as an umbrella approach to sustainable product design education

The multidisciplinarity and quickly broadening scope of sustainable product design education provide incentives for experimentation with different pedagogical techniques. One of these, involving the development of eco board games, has been used at both the Technical University Denmark and the Norwegian University of Science and Technology. This paper aims to reflect on the experiences, in terms of rationales, learning goals, possible variations of the exercise, delivered course work, and future ambitions.

Transitions in Sustainable Product Design Research

By the early 1990s, sustainable product innovation (or ecodesign, or Design for environment) had gained sufficient critical mass in academic research to be identified as a distinct research area. In the past 15 years, stimulated by a growing environmental concern and awareness in the media, this research area has expanded considerably; from a bunch of opportunistic eco-pathfinders trying to make products better recyclable into acknowledged scientific research regarding technology transfer and commercialisation. This paper proposes that this maturing process took place through a number of transitions; this is illustrated by discussing characteristic aspects of each transition, which together provide a historic account of how academic research into sustainable product innovation had matured. In conclusion, a number of possible future transitions or extensions of the research area are discussed.
Applications of the Theory of Technical Systems: Experiences from the 'Copenhagen School'

This paper uses the development and applications of Hubka’s Theory of Technical Systems (TTS) at DTU as an example of the power of the theory, the necessity of detailing and fitting the theory, and the role of a theory as a basis for research. At the same time the paper is a balance of the influence of Vladimir Hubka and a short historical sketch of the incidental nature of our group’s introduction to Vladimir Hubka, which led to life long cooperation and academic development. Results have been obtained in the areas of DFX, workbench-based design, mechatronics, product development, and multi-product development. Across all these areas we have created a version of TTS with substantial applicability and coherence. This article does not show details on all of the research projects (which may be found in the literature), but it shows directions taken from Hubka’s TTS and the contributions made in academia and through industrially applied research.

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A User Centered Approach to Developing Emergent Technology Products

Current participatory design methods do not allow designers to gain the insight required to develop products with emerging technologies, that is, products that do not have any precedents in the users’ knowledge base and experience. This poses challenges to the designers, as input from users cannot be used too early in the design process, given that users respond best to issues they know or can relate to. This paper presents a case study where a user-centred approach was used to determine when and how to involve users in the design of a TV-enabled mobile telephone. The aim of the study was to identify the main form factor drivers for the design of such a phone. Five possible usage scenarios were identified and five form factors were derived from testing these scenarios, which were subsequently evaluated by potential users, through highly focused feedback sessions. The paper also discusses some methodological issues related to user involvement in the implementation of emerging technologies in the consumer electronics industry.

From product to service orientation in the maritime equipment industry: a case study

In the shipping industry, operational performance of ships and their equipment is crucial to business. Suppliers of machinery and equipment are aware of this situation and see business development potential in setting up service systems that are dedicated to ensuring the performance of their products in operation. In this paper we present a case study of a shipping equipment manufacturer that is currently shifting business focus from manufacturing towards services delivery. Using a modelling scheme to differentiate and categorise different development tasks within the frame of business development towards service oriented business, the case delivers insights into the broader context and product related parameters influencing the options and requirements for service system development.
Nordic Post-Graduate Sustainable Design and Engineering Research from a Supervisor Perspective

The multi- and inter-disciplinary field of sustainable product innovation is rapidly expanding as an arena for scientific research. Universities in Nordic countries can be considered as an exponent of this type of research, with active research groups in, among others, Göteborg, Helsinki, Lund, Lyngby, Linköping and Trondheim. In the context of a Nordforsk funded project, seven second generation PhD supervisors from these universities, who have been active in this field for many years, discuss funding, publication, research traditions, education and supervision practices related to PhD research in this field. A number of recommendations to improve current practices are made, including the mapping currently existing differences in different academic institutions, studying the cross-over learning effects between academia and non-academic partners, and the development of ‘quality indicators’ of research in the SPI domain.

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Successive Transitions in Ecodesign: From the Stopwatch Era to Technology Transfer and Commercialization

In the past 15 years, stimulated by a growing environmental concern and awareness in the media, ecodesign, or design for environment, has expanded considerably as a scientific research area; from a group of opportunistic eco-pathfinders trying to optimise a product's recyclability, into acknowledged scientific research regarding technology transfer and commercialisation. This paper proposes that this maturing process took place through a number of transitions; this is illustrated by discussing characteristic aspects of each transition, together providing a historic account of how academic research into sustainable product innovation has matured. In conclusion, a number of possible future transitions or extensions of the research area are discussed.

A Competence-Based Approach to Sustainable Innovation Teaching: Experiences within a New Engineering Program

Innovation and sustainability are two areas upon which Scandinavian countries place a great deal of attention, in order to maintain strong positions in the global market and strong welfare societies. A current movement in many engineering-related universities in Scandinavia and the rest of Europe is seeing a necessary re-thinking, re-organisation and re-launch of engineering curricula. This movement is underway in response to drastically falling student numbers in the 90's and early years of the current decade, and to a recognition of the need to innovate educational curricula, in order to be able to educate and deliver candidates to modern-day and future industrial companies and organisations. The sustainability focus of many of the Scandinavian universities has often resulted in instrumental contributions to environmental agendas and methodical approaches towards environmental improvements, both through educational curricula and research programmes. This paper presents an initiative from Denmark, showing new interpretations of industrial needs, research insights, educational ideas and identification of core innovative engineering competencies. The new Danish Master of Science engineering programme, Design & Innovation, presents a radically updated set of contents, pedagogical style and learning goals for the education of engineers. The articulation of this new curriculum points to new roles and identities for the professionalism of synthesis and innovation, including a strong focus on sustainable innovation. By focusing particularly on the Design & Innovation programme's fifth semester, which is entitled Innovation for Sustainability, the efforts we have made to renew the educational approach and contents in our engineering teaching will be shown in this paper. This semester has been the object of a research exercise, to affect and observe various approaches to the teaching of design. Particular attention will be paid in this case to competencies, both initiated in the teaching and the evaluated in the students' interpretation of the theoretical contents. The lessons learned from the first three years of this semester's application and teaching to approximately 55 students per year are presented and discussed. After introducing the motivation and background for establishing the education programme, the consideration of competence-based education is described, in the context of design engineering. The whole focus on competencies is central to the ambition of nurturing an innovative approach to sustainability, as described in the case, which focused on relating the contents, context and responsibilities connected to engineering for sustainability. The two course-modules described in the case are
analysed in terms of four views of competency, to enable a discussion of the merits of training competencies in engineering students, rather than just skills. The frame for this paper is the engineering profession and the education of engineers. The English meaning of the word design (to create and synthesise) is employed in this paper.

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A Scandinavian Model of Innovative Product Development

The educational systems in the small Scandinavian countries are open to experiments and new education programmes. This paper presents such an initiative from Denmark, showing new interpretations of industrial needs, research insights, educational ideas and identification of core innovative competencies. We reflect on our efforts to produce a new type of design professionalism, pointing to new roles and identities for the professional-ism of synthesis and innovation. Finally, we round up by articulating what we see as the future pattern of product development, which should be supported already today in our education programmes.
Product/Service-System Development: An Explorative Case Study In A Manufacturing Company

'Product/service-systems' (PSS) are innovation strategies where instead of focusing on the value of selling physical products, one focuses on the value of the utility of products and services throughout the product's life period. This approach enables companies to provide customers with offerings that continuously deliver value and create a strong competitive advantage. PSS attempts to transcend the old industrial credo that value is embedded in products and the consideration of 'cost-quality-time' relates to the physical artefact. While there is increasing interest in PSS, limited research has been done in the design and development aspects of PSS. The objective of this paper is to explore how a global manufacturing company is developing an offering to their customers that is focused on the utility of their products throughout their life time. The paper describes the process of how a company is shifting from selling office furniture to selling the benefit of sustainable office workspace performance - measured in economic, social and environmental terms. By relating the customer's business performance to the activities associated with the use of office workspace the company may enhance the value of their products. This process of re-defining the value of what the company is actually offering to its customers is seen as a key element in PSS development. PSS development is expected to expand conventional product development in new directions, such as new activities, roles and responsibilities, knowledge and competencies, and value network relationships. The implications of this are discussed in relation to the company’s development approach.
A Tool for Conceptualising in PSS development

This paper introduces a tool for conceptualising in the development of product/service-systems (PSS), based upon the modelling of service activities. Our argumentation is built on two previous articles by the same author, previously presented at the 16. Symposium “Design for X” [1] and the 9th International Design Conference [2]. In this contribution, we take the step from a fundamental understanding of the phenomenon to creating a normative exploitation of this understanding for PSS concept development. The developed modelling technique is based on the Customer Activity Cycle (CAC) model by Vandermerwe [3]. Our subsequent development and tailoring of this model has been carried out in repeated applications (and evolution) via a number of projects conducted by Design & Innovation (D&I) engineering students at The Technical University of Denmark (DTU). The documentation of these projects, foremost a recent project in the shipbuilding industry [4], represent the main data source for this paper. The resulting Activity Modelling Cycle (AMC) model has been refined and changed in order to address many of the issues identified as central for PSS development. The model has been found to support the integrated consideration of the customers’ activities, possible PSS offerings and beneficial partnering options (i.e. between different supplier companies) within the delivery value chain.

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Characteristics of Strategies in Product/Service-System Development

The underlying principle in Product/Service-Systems (PSS) strategy is to shift from business based on the value of the transfer of product ownership and responsibility, to business based on the value of utility of the product and services. This paper identifies characteristics of various strategies that may be applied in PSS development. PSS concepts created in projects by third year Design & Innovation students at the Technical University of Denmark (DTU) working with product-life oriented design approaches were reviewed, and the strategies developed were analysed. This identification and mapping of PSS strategy types gives us the opportunity to develop methods and approaches to PSS development, more tailored to specific business strategies.

From LCA to PSS – Making leaps towards sustainability by applying product/service-system thinking in product development

Life Cycle Assessment (LCA) is the standardised and globally recognised tool for quantifying environmental impact of goods and services. A key aspect in LCA is the consideration of whole life cycle systems. The application of LCA in product development inherently comprises the quest for optimisations on all system levels. However, as the act of ecodesign conventionally focuses on physical products, the search for potential optimisations is usually directed ‘downwards’, i.e. towards lower system levels, resulting in optimised components within products rather than optimised products within their surrounding systems. This paper will exemplify that when broadening the ecodesign horizon to environmental product/service-system (PSS) design, there is a better possibility of applying a system-oriented life cycle thinking approach, and therefore a potential to yield extreme improvements towards sustainability.
Teaching and Implementation Models for Sustainable PSS Development: Motivations, Activities and Experiences

The past two decades have seen increasing efforts to consider the potential negative effects of products' manufacture, use and disposal on the local and global environment (Ehrenfeld, 2001). Over this time efforts have been made to relate the goals and ideals of sustainability to the domain of product development, thus adding new dimensions, such as social and moral values, to the original agenda of environmental improvement. The redefinition of the role of the product developer, from environmentally conscious product developer to sustainably aware product developer has led to new insights into the way in which products are developed and used – and to where environmental effects occur in the lifetime of a product. The product developer has thus a more complex role in relation to sustainability, as the focus for improvement of a product may not (and very often does not) lie in the physical artefactual ingredients of the product or the processes used to create it. Rather, the focus for improvement of a product’s environmental performance most often lies in the manner in which the product is used and consumed. A product’s use phase is often environmentally significant, as this is the largest source of environmental impact. A product’s consumption, or rather, a given user’s consumption behaviour is even more important, as this dictates exactly how many use-phases, how many products and how much product redundancy is created, due to the user’s lack of awareness, motivation or ability to consume a product in an environmentally respectful manner (McAloone, 2005). The problem with both use and consumption is that the product developer traditionally has very little power over these two elements: they occur after the product has left the factory and entered into the hands of the user (the consumer). Until the real environmentally harmful phases of a product’s life can be harnessed by the producing company, it is often impossible to make the radical (Factor X) environmental improvements to the product itself that are necessary to maintain an environmental equilibrium (e.g. Rejnders, 1998).

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The Ramifications of Product/Service-Systems on Mechatronic Design
Understanding And Developing Innovative Products And Services: The Essential Elements

Innovation is synonymous with successful development and implementation, and therefore peculiar to innovation is that it has to prove itself on the market before we can deem it innovative. This paper suggests an approach for understanding the principles for innovative products which is based, not on the product itself, but on the activity and the effect on stakeholders. Innovative products are products that contain a difference, with appropriate, valuable and desirable effects induced on the company, consumer and society. The approach is exemplified through a case on the Sony Walkman. When designing products companies should consider the main stakeholders and the effects of products throughout their life cycles that companies should consider.

What Happens to Integrated Product Development Models with Product/Service-System Approaches?

Integrated Product Development (IPD) has traditionally focused on the development activities relating to physical technological artefacts. With the advent of business approaches for manufacturing firms based on providing customers the utility of integrated products and services – a term dubbed ‘product/service-systems (PSS)’ – companies need to extend their activities to include new dimensions of development. Within the paradigm of mass production and consumption, traditional product-oriented business strategies regarded physical technological artefacts (products) as the mediators of customer value. Value was based on the exchange of products between a providing company and a receiving customer. The more products the company could sell, the more revenue it generated. At the point of sale the ownership and responsibility of the product was transferred from company to customer. A customer would buy a product because it represented potential valuable benefits. Several researchers [MOR-03] have pointed to the problems of this business strategy as: 1) it links companies’ economic growth with the consumption of natural resources; 2) it delegates the responsibility of a product’s use, maintenance and disposal to customers that are often oblivious to proper behaviour, as well as, 3) it allows little opportunity for customers to influence the design to best suit their individual needs and preferences. PSS approaches are business strategies where companies provide value to customers by supporting and enhancing the utility of products throughout their entire life cycle. This strategy represents a range of opportunities for companies that may ameliorate some of the problems listed above.
A short course in sustainable product development: Models, methods and mindsets

This short course in sustainable product development models, methods and mindsets is designed to fit into the Unical course on Engineering Design Methods. Three modules (called "seminars") will guide you through. The demands for sustainable development. Professional methods for analysing and changing products' environmental profiles. A new approach to product service system development, where the physical product becomes an incidental aspect in the final offering to the customer.

Gaining insight into innovation: The efforts of the SYNOPSIS group

Industrial integration of environmental issues into the organisation: Past, present & future challenges

The past two decades have seen increasing efforts to consider the potential negative effects of a product's manufacture, use and disposal on the local and global environment. Over this time two main schools of research practice have emerged: an analytical school of practice, targeted at the accounting and evaluation of environmental impacts of a given product or process; and a synthesis-oriented school of practice, targeted at the creation of environmentally improved products or processes, based upon life-cycle insight into the actual use and orientation of existing products on the market. These two schools of environmental research practice are mirrored in the way in which industry approaches environmental
problems. Since the definition in 1987 of Sustainable Development efforts have been made to relate the goals and ideals of sustainability to the domain of product development, thus adding new dimensions, such as social and moral values, to the original agenda of environmental improvement. The increasing responsibility of the product developer, from environmentally conscious product developer to sustainably aware product developer has led to new insights into the way in which products are developed and used – and to where environmental effects occur in the lifetime of a product. The role of the product developer is thus more complex in relation to sustainability, as the focus for improvement of a product may not (and very often does not) lie in the physical artefactual ingredients of the product or the processes used to create it. Rather, the focus for improvement of a product’s environmental performance most often lies in the manner in which the product is used and consumed. A product’s use phase is often environmentally significant, as this is the largest source of environmental impact. A product’s consumption, or rather, a given user’s consumption behaviour is even more important, as this dictates exactly how many use-phases, how many products and how much product redundancy is created, due to the user’s lack of awareness, motivation or ability to consume a product in an environmentally respectful manner. The problem with both use and consumption is that the product developer traditionally has very little power over these two elements; they occur after the product has left the factory and entered into the hands of the user (the consumer). Until the real environmentally harmful phases of a product’s life can be harnessed by the producing company, it is often* impossible to make the radical (Factor X) environmental improvements to the product itself that are necessary to maintain an environmental equilibrium (*except for in the case of new technology introduction). Over recent years, a handful of companies have begun to take control over (and accept responsibility for) a larger portion of their products’ life-cycles. Where there are examples of companies taking control over larger product life areas for reasons other than environmental, there are a few examples where environmentally-based product-life ‘takeovers’ have been with environmentally-founded goals in mind. Thus the practice of Product-Service-System (PSS) development is born.

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- **Organisations**: Engineering Design and Product Development, Department of Mechanical Engineering
- **Authors**: McAloone, T. C. (Intern)
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- **Title of host publication**: Engineering design and the global economy : 15th International conference on engineering design
- **Volume**: CD-ROM
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- **Main Research Area**: Technical/natural sciences
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- **Sustainable design, Product development, Ecodesign, Product life, PD methods, Product/Service-Systems**

### Innovation in Product Development: Notes for course 41829
The course on Innovation in Product Development attempts to identify and understand the nature of innovation and product development and their important factors. The course takes both a theoretical and a practical approach and employs a mix of lectures, project work and group discussion. Format The core of the course is based upon case-studies, videos, lectures from industrial guests and related textbooks. A range of topics are focused upon in the various sections of the course and through a combination of lectures, class discussions and presentations from the students, we try to reach deep insight. Course content The following aspects of innovation in product development are considered: - Humans and products - Needs and products - Product life - Teams creating products - Products creating business - Product development models - Organising product development - Product development tools - The future of product development.

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- **Organisations**: Department of Mechanical Engineering
- **Authors**: McAloone, T. C. (Intern), Restrepo-Giraldo, J. D. (Intern)
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- **Innovation, PD methods, Design for X, Product and service development, Product life cycle design, Product/service-system, Product/Service-Systems, PSS, Service design**
- **Source**: orbit
- **Source-ID**: 185290
- **Publication**: Education › Compendium/lecture notes – Annual report year: 2005
New opportunities and responsibilities with PSS

The ever increasing integration of the global economy and adaptation of information and communication technologies is changing the way companies conduct business. Companies today are focusing more on how to develop innovative solutions to attract customers, to fit and individualise products and compete on the global market. One innovation strategy that has attained increasing attention the past years is transforming business from being based on the sale of goods to business based on offering a combined product/service system that continuously provides value to the customer. This approach has been dubbed “product/service-systems (PSS)”. The term is related and shared with other terms such as “functional economy”, “functional (total care) products”, “market offer development” and “service engineering”. PSS Research

Over recent years a growing number of studies and research programmes have been conducted on the issue of product/service-systems. These studies usually analyse the potential of integrated solutions to reduce the environmental impacts of human consumption activity or optimise a company’s ability to cope with the influences arising from the emerging globalisation of economic and business activities. Research issues As we move into the exploration of the field of research we call PSS, we discover some of the following issues: Product perspective vs. Service perspective - What are the differences between a service perspective and a physical product perspective in organisation and management of the development process? - What are the new dimensions in the service oriented perspective? PSS and the market: - How can we align the interests of PSS provider and customer? - What are the roles of stakeholders in the development of PSS? - How can companies make use of the many opportunities that a PSS strategy promises? Developing PSS in companies: - How do we design PSS in companies? - How does PSS affect the design approach in companies? - What do the business models that transform the relationship between purchase and use of solutions look like? And how can we support the development of them? Partnerships in PSS: - Who should develop PSS in organisations? - How are the relationships managed amongst partners in a value creating collaboration in PSS? PSS in relation to sustainability: - How does the increase of product responsibility in PSS affect companies’ business operations? - Can we count on PSS for sustainable development?

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Authors: McAloone, T. C. (Intern), Lauridsen, E. H. (Intern), Jørgensen, M. S. (Intern)
Publication date: 2005

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Ecodesign, Product life, PD methods, Environment, Innovation, Lifecycle, Product development
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Source-ID: 185291
Publication: Education › Compendium/lecture notes – Annual report year: 2005

PSS: An approach to sustainable innovation

General information
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Organisations: Department of Mechanical Engineering
Authors: McAloone, T. C. (Intern)
Publication date: 2005
Short lecture series in sustainable product development: Models, methods and mindsets
Three lectures in sustainable product development models, methods and mindsets should give insight into the way of thinking about the environment when developing products. The first two lectures will guide you through: Environmental problems in industry & life-cycle thinking. Professional methods for analysing and changing products’ environmental profiles. Sustainability as a driver for innovation.

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State: Published
Organisations: Department of Mechanical Engineering
Authors: McAloone, T. C. (Intern)
Publication date: 2005

Sustainable product development through a life-cycle approach to product and service creation: An exploration of the extended responsibilities and possibilities for product developers
Over recent years, a few companies have begun to take control over (and accept responsibility for) a larger portion of their products’ life-cycles. Where there are examples of companies taking control over larger product life areas for reasons other than environmental, there are a handful of examples where environmentally-based product-life ‘takeovers’ have been with environmentally-founded goals in mind. Thus the practice of Product-Service-System (PSS) development is born. This paper describes PSS development, an approach to new business definition and development that gives a number of new possibilities to the company, ranging from the re-invention of core business, through gaining customer loyalty, expanding the customer base, and importantly, to the possibility of removing some of the traditional environmental problems connected to the consumption behaviour of users. PSS is new as an industrial practice and as a research discipline, and we still lack overview in order to be able to understand how to design a PSS. For example, who should sit in the project team for the creation of PSS concepts? No longer merely a team of engineers… A PSS requires an orchestration of a complex network of stakeholders, both in- and outside of the company, in order to deliver an augmented product to the customer in a satisfactory manner – and to be able to sustain this satisfaction throughout the whole company-customer relationship. We can prepare ourselves for a significant change in the way that traditional product manufacturing companies deliver their product to their customers – especially in the western world, where companies no longer can expect to compete on a global market with respect to cost, quality or time. It is our hypothesis, that if carried out
correctly (aided by professional methods and approaches) the shift from the development, sales and provision of discrete, physical products, to the practice of functional sales, provided as a product of PSS-development, will give radical environmental improvements. This paper will make first suggestions about a set of methods and approaches towards PSS.

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Main Research Area: Technical/natural sciences
Conference: Eco-X : Ecology and Economy in Electronix, Vienna, Austria, 01/01/2005
Consumer behaviour, PSS, Product/service-systems, Market trends, Ecodesign, Product life, PD methods, Communities, Product development, Product/Service-Systems
Source: orbit
Source-ID: 185288
Publication: Research - peer-review › Article in proceedings – Annual report year: 2005

**Design For Utility, Sustainability And Societal Virtues: Developing Product Service Systems**

There are a number of theories that describe the necessary improvements in global environmental performance in order to maintain status quo in our ecosystem. These theories are far reaching in their ambitions, and it is not immediately apparent as to how we should be able to achieve, for example, a factor 20 improvement in our environmental performance. One attempt, however, has recently emerged, which combines the product as an artefact with the service that the product provides to the user. Through the combination of these two facets, the company retains ownership of the physical artefact and adds a responsibility and influence upon everything that the product gives rise to in its life; its usability, environmental and social virtues. This enables a series of potential improvements to the product’s performance throughout its lifecycle. The ideal of product service system (PSS) development is that all three stakeholder groups – customer, company and society – benefit from the service systems related to each one of these dimensions, rather than simply one of the above. There are existing examples of the enhancement of business and market share by focusing on PSS, but this is often not a result of upfront strategy and ambitious goals. In our paper we attempt to identify the nature of such a multiple definition of PSS, the link to proper understanding of value and utility and innovative approaches for PSS-oriented product development. This paper will expand on the phenomenon of PSS in the belief that a proper understanding of PSS will give us the design degrees of freedom necessary to create radical innovation. The article draws upon existing product development and PSS theory and models and experiences from projects carried out with both industrialists and students. We intend to demonstrate a series of important arguments through this paper that support PSS consideration in industry.

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Publisher: Faculty of Mechanical Engineering and Naval Architecture
Main Research Area: Technical/natural sciences
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Ecodesign, PSS, Product life, PD methods, Environment, Lifecycle, Product development, Sustainable design
Source: orbit
Source-ID: 155671
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

**Images of Innovation: An Ontological Approach (Keynote speech)**

Innovation perceived as the front-end activities to product development projects is a frequent research topic. However, since innovation research is a relatively young and unconsolidated field, these studies tend to originate from different domains, and represent a wide spectrum of viewpoints. This diversity results in the published findings of the studies to be circulated and recognised mainly in their original domains, and points at the necessity of synthesising the knowledge that
exist in innovation research communities locally. The aim of this paper is twofold: first, to discuss the diversity in research activities related to product innovation; second, to discuss the industrial implication of this research diversity. From a research perspective innovation is generally perceived as the front-end activities to product development projects. However, since innovation research is a relatively young and unconsolidated field, these research studies tend to originate from different domains, and represent a wide spectrum of viewpoints. To have their research result published the individuals or groups need to narrow their focus which leads to a huge diversity and as yet no established protocols with which to facilitate comparison and accumulation of findings between research communities. This diversity results in the published findings of the studies being circulated and recognised mainly within their original domains, and points to the necessity of synthesising the knowledge that exists in innovation research communities to be useful for a wider community. From an industrial perspective the narrow focus and lack of comparison between research findings strongly contradicts the need to establish comprehensive understandings of the nature and control variables of the innovation process. The problem related to the innovation challenge of the industrial manager can be described as being a configuration problem with a high number of variables, having contradictory influence on the total performance. In general, industrial managers need a rich and transparent repertoire of views (images), so as not to be imprisoned by any particular one. This might explain the success of books such as Mintzberg et. al. Strategy Safari and Gareth Morgan’s Images of Organizations. The latter has given inspiration to the title of this paper.

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Publisher: Faculty of Mechanical Engineering and Naval Architecture
Main Research Area: Technical/natural sciences
Conference: 8th International Design Conference, Dubrovnik, Croatia, 17/05/2004 - 17/05/2004
Innovation, PD methods, Tools
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Styrkelse af innovation i produktudvikling: opfrodring til dialog

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Organisations: Department of Mechanical Engineering
Authors: McAloone, T. C. (Intern), Andreassen, M. M. (Intern)
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Event: Abstract from IPU-KT, Technical University of Denmark, Lyngby, Denmark, .
Main Research Area: Technical/natural sciences
Innovation, PD methods
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Publication: Research › Conference abstract for conference – Annual report year: 2004

Sustainable Product Development Through a Life-Cycle Approach to Product and Service Creation (Keynote speech)
The past two decades have seen increasing efforts to consider the potential negative effects of a product’s manufacture, use and disposal on the local and global environment [1]. Over this time two main schools of research practice have emerged: an analytical school of practice, targeted at the accounting and evaluation of environmental impacts of a given product or process; and a synthesis-oriented school of practice, targeted at the creation of environmentally improved products or processes, based upon life-cycle insight into the actual use and orientation of existing products on the market. These two schools of environmental re-search practice are mirrored in the way in which industry approaches environmental problems. Since the definition in 1987 of Sustainable Development [2] efforts have been made to relate the goals and ideals of sustainability to the domain of product development, thus adding new dimensions, such as social and moral values, to the original agenda of environmental improvement. The redefinition of the role of the product developer, from environmentally conscious product de-veloper to sustainably aware product developer has led to new insights into the way in which products are developed and used and to where environmental effects occur in the lifetime of a product. The role of the product developer is thus more complex in relation to sustainability, as the focus for improvement of a product may not (and very often does not) lie in the physical artefactual ingredients of the product or the processes used to create it. Rather, the focus for improvement of a product’s environmental performance most often lies in the manner in which the product is used and consumed. A product’s use phase is often environmentally significant, as this is the largest source of environmental impact. A product’s consumption, or rather, a given user’s consumption behaviour is even more
important, as this dictates exactly how many use-phases, how many products and how much product redundancy is created, due to the user's lack of awareness, motivation or ability to consume a product in an environmentally respectful manner. The problem with both use and consumption is that the product developer traditionally has very little power over these two elements; they occur after the product has left the factory and entered into the hands of the user (the consumer). Until the real environmentally harmful phases of a product's life can be harnessed by the producing company, it is often impossible to make the radical (Factor X [3]) environmental improvements to the product itself that are necessary to maintain an environmental equilibrium (*except for in the case of new technology introduction).
Implementation of Life Cycle Assessment (LCA) in the Development of Products

General information
State: Published
Organisations: Engineering Design and Product Development, Department of Mechanical Engineering
Authors: Bhander, G. S. (Ekstern), Hauschild, M. (Ekstern), McAloone, T. C. (Intern), Schenck, R. (ed.) (Ekstern)
Publication date: 2003

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Ecodesign, Product life, PD methods, Tools
Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2003

Implementation of Life Cycle Assessment (LCA) in the early stages of product development
The paper aims to outline the problems for the designer in evaluating the environmental benignity of the product from the outset and to provide the designer with a framework for decision support based on the performance evaluation at different stages of the design process. The overall aim of the paper is to provide an understanding of the environmental issues involved in the early stages of product development and the capacity of life cycle assessment techniques to address these issues. An Environmentally Conscious Design method is introduced and trade-offs are presented between design degrees of freedom and environmental solutions. Life cycle design frameworks and strategies are addressed. The paper collects experiences and ideas around the state-of-the-art in eco-design, from literature and personal experience and further provides eco-design life cycle assessment strategies. The result of the paper is a definition of the requirements for performance measurement techniques and a performance measurement environment necessary to support life cycle evaluation throughout the evaluation of early stages of a product system.

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Implementing Life Cycle Assessment in systems development.

Today's industry is being forced to consider the environmental performance of its products concurrently with traditional requirements such as quality, price or functional performance. The Life Cycle Assessment (LCA) technique has been identified as a powerful tool to calculate environmental impacts derived from products and system, and calculate resource consumptions. However, the complexity of LCA poses restrictions to its use in current product and system development given the need for a reduction in product development cycle time which is needed to meet the increasing competitive pressures and the rapid changes in markets for many products. The overall aim of the paper is to provide an understanding of the environmental issues involved in the early stages of product development and the capacity of life cycle assessment techniques to address these issues. The paper aims to outline the problems for the designer in evaluating the environmental benignity of the product from the outset and to provide the designer with a framework for decision support based on the performance evaluation at different stages of the design process. The overall aim of this paper is to produce an in-depth understanding of the barriers to implementation of LCA by developers of products, and of the opportunities for introducing environmental criteria in the design process through meeting the information requirements of the designer on the different life cycle stages, producing an in-depth understanding of the attitudes of practitioners among product developers to the subject area, and an understanding of possible future directions for product development. An Environmentally Conscious Design method is introduced and trade-offs are presented between design degrees of freedom and environmental solutions. It also discusses a number of possibilities which can be introduced in the design stage compared to the other life cycle stages of the product system. The paper collects experiences and ideas around the state-of-the-art in eco-design, from literature and personal experience and further provides eco-design life cycle assessment strategies. The paper reviews the current environmental evaluation practices with respect to product life cycles. As a number of deficiencies in LCA are identified, strategies are presented to provide a solution to many of the deficiencies. The result of the paper is a definition of the requirements for performance measurement techniques and a performance measurement environment necessary to support life cycle evaluation throughout the evaluation of early stages of a product system.

Innovation in Product Development: Notes for course 41629

The course on Innovation in Product Development attempts to identify and understand the nature of innovation and product development and their important factors. The course takes both a theoretical and a practical approach and employs a mix of lectures, project work and group discussion. Format The core of the course is based upon case-studies, videos, lectures from industrial guests and related textbooks. A range of topics are focused upon in the various sections of
the course and through a combination of lectures, class discussions and presentations from the students, we try to reach deep insight. Course content The following aspects of innovation in product development are considered: - Humans and products - Needs and products - Product life - Teams creating products - Products creating business - Product development models - Organising product development - Product development tools - The future of product development

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Innovation, PD methods, Tools
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Krav til den succesfulde udvikling af mekatroniske produkter: relevante forskningsresultater for mekatronikudviklere

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PD methods, Tools
Source: orbit
Source-ID: 25737
Publication: Research › Article in proceedings – Annual report year: 2003

Product Life Design: Notes for course 41627
The course in product life design is designed to give an understanding of the phenomena of life cycle and product life thinking, the role of product design in fitting to product life systems and thus achieving sound product life perspectives. The course aims at developing an ability in the student to formulate specifications, synthesise and evaluate design proposals related to given product life systems. Training is also given in dealing with tools and principles for life cycle design (DFX). Course content The following aspects of life cycle design are considered: - Life cycle, stakeholders, resource- and ecological specifications, life cycle-oriented quality, whole life costs. - Product life systems, "the meeting", relational properties, the role of the human operator. - Modelling of the product and the product life cycle, computer modelling. - The score model, Integrated Product Development, Life Cycle Engineering, Concurrent Engineering. - The importance of the product concept, explicit life phase concepts. - Modelling of meetings, "universal virtues", simulation. - Product modelling, Product Data Management, life cycle databases, design history, documentation. - The structure and the content of the DFX-tools, the course of DFX.

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Ecodesign, Product life, PD methods, Tools
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Publication: Education › Compendium/lecture notes – Annual report year: 2003
Sustainable Environment and Health for 21st Century: Implementation of LCA in development of products and systems

The overall aim of the paper is to provide an understanding of the issues involved in implementation of life cycle assessment/costing in product and system development. The paper aims to produce an in-depth understanding of the barriers to implementation of LCA by developers of products and systems, and opportunities for introducing environmental criteria; produce an in-depth understanding of information requirements for the designer, and improvement potentials and resources in product manufacturing, use, recycle and end-of-life process; produce an in-depth understanding of the attitudes of practitioners among product and system developers to the subject area, and an understanding of possible future directions for product development; participate actively in development and documentation of methods for Improvement Assessments in LCA internationally; integrate CAD-LCA systems in the early stages of the product development; develop a methodology for aggregating environmental impact scores and resource consumption scores into a single score based on the EDIP methodology and Actual Life Cycle Costing.

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Ecodesign, Product life, PD methods, Tools
Source: orbit
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Usability, sustainability and society: Development of product service systems

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Ecodesign, PSS, Product life, PD methods, Tools
Source: orbit
Source-ID: 25738
Publication: Research › Article in proceedings – Annual report year: 2003

Creating sustainable students through project-based teaching

Design for Sustainability is difficult! Not least because there are few, if any operational definitions of sustainability that will allow us to move beyond speculation to planning and action for radically new ways in which to satisfy our needs at vastly reduced environmental and social loads [WCED, 1987]. This paper describes a case study, where 27 students from 19 different countries and 12 educational backgrounds were subject to an intensive two-week course on sustainability and innovation. The case describes a number of interesting points, regarding both the subject of sustainability and innovation and also in terms of the teaching/learning method applied. In this case study sustainability is described as being the driver for innovation, in so much as it is necessary to create radically different solutions, if one is to achieve solutions that have a factor 4, 10 or 20 [Reijnders, 1998] less impact on the environment. The intensive nature of the course described in the case study allowed for a whole project approach to be applied, where important teaching elements were encapsulated in project tasks, thus making the material and methods learned directly relevant and applicable to the project as it unfolded. The case study is backed up with a series of other experiences [Andreasen et al., 2000], where new methods of teaching are developed and tested, and where the creation of a mindset is seen as the overriding factor for success when working with such problem formulations as creating sustainable products through radical innovation. Key results from this case study have since been applied in other teaching (both within the university and to industry), and have helped to further insight into how to apply Design for Sustainability in practice.
Defining product service systems

There are a number of theories that describe the necessary improvements in global environmental performance in order to maintain status quo in our ecosystem [1, 2]. These theories are far reaching in their ambitions, and it is not immediately apparent as to how we should be able to achieve, for example, a factor 20 improvement in our environmental performance. One attempt, however, has recently emerged, which combines the product as an artefact with the service that the product provides to the user. Through the combination of these two facets, the company retains ownership of the physical artefact and instead provides what the customer really wants the actual functionality from the product. This enables a series of potential improvements to the product’s performance throughout its lifecycle. The ideal of product service system (PSS) development is that all three stakeholder groups customer, company and society benefit from the service systems related to each one of these dimensions, rather than simply one of the above. There are existing examples of the enhancement of business and market share by focusing on PSS, but this is often not a result of upfront strategy and ambitious goals. We attempt to identify the nature of such a multiple definition of PSS, the link to proper understanding of value and utility and innovative approaches for PSS-oriented product development. This paper will expand on the phenomenon of PSS in the belief that a proper understanding of PSS will give us the design degrees of freedom necessary to create radical innovation. The article draws upon existing product development and PSS theory and models and experiences from projects carried out with both industrialists and students.

Design typology and design organisation

The idea of focusing upon the creation of a design typology was articulated by [Andreasen & Wognum 2000] and detailed by [Andreasen & Wognum 2001]. The aim was to propose a typology, which could serve as identification of design types and design research contributions. For a long period the design research society has recognised normative procedural models of designing as being a reasonable answer to the question: How do designing proceed? The reasoning behind the models, from which the design methodology model by [Pahl & Beitz 1995], may be seen as a characteristic one, was a mix of human problem solving-, design management-, and artefact nature-reasoning. Critique has been raised to that type of models as being neither explanatory nor instructive. If we accept these models as merely being pragmatically "stepping-stone" explanations of what happens during designing, it is interesting to observe, that these models are presented as guidelines for "new to the world"-situations. They do not take into account, that in any normal design situation, the designers have been there before, i.e. they have experiences from similar tasks, knowledge domains, procedures etc. For explaining our approach to the creation of a design typology, we use a metaphoric picture of the design situation: "We design on dirty blackboards". The designer has always reusable patterns, which may be used as support, if we carefully
do not wipe the blackboard clean. The false assumption in the current design models is, that the blackboards are clean. By assuming that, we also loose our possibility to explain how designing is possible. The core question concerning our typology is as follows: What is the set of views upon designing, we have to establish for obtaining a sufficient set of explanations? Or: What is the set of different theories or models delivered from research and practice, necessary for explanation?

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Publisher: Faculty of Mechanical Engineering and Naval Architecture
Main Research Area: Technical/natural sciences
Conference: 7th International Design Conference, Dubrovnik, Croatia, 14/05/2002 - 14/05/2002
PD methods, Constraints, Design types, Requirements, Specification
Source: orbit
Source-ID: 62528
Publication: Research - peer-review › Article in proceedings – Annual report year: 2002

Ecodesign
General information
State: Published
Organisations: Engineering Design and Product Development, Department of Mechanical Engineering
Authors: McAloone, T. C. (Intern)
Publication date: 2002

Host publication information
Title of host publication: Encyclopaedia of Life Support Systems (EOLSS)
Place of publication: Oxford, England
Publisher: UNESCO
Main Research Area: Technical/natural sciences
Ecodesign, PD methods
Source: orbit
Source-ID: 191185
Publication: Research - peer-review › Book chapter – Annual report year: 2002

Towards a multidisciplinary understanding of product innovation: the Synopsis network project
The product development research area has evolved from the area of engineering design, based upon the recognition that important aspects such as need, market, business, innovation of the company, technology management, etc. fuse together to form a field of competencies, containing its own professionalism and a need for clarification and research. In the 1980’s, Danish industry was introduced to the concept of Integrated Product Development (IPD) [1]. IPD has acted as a guide to industry ever since, highlighting the need to concurrently address the product, production and market situations when developing products, and providing a structured framework into which product design should fit. Fifteen years later, industry has developed and moved on, so that IPD no longer fits ideally to many industries’ actual product development activities [2]. There are many reasons for these changes, and industry again needs a new vision for a product development framework, that fits to the nature of industry today and the future. A group of researchers in Denmark have joined together, in recognition of the fact that product development and increasingly innovation, a term often used interchangeably with the term product development is in need of deeper understanding if we are to support and continue to enjoy world class product development-based industry in Denmark. Not surprisingly, the group of researchers consists of a broad range of professional backgrounds, from mechanical engineering, through manufacturing, psychology, anthropology, social science and operations management. The group of researchers is formally organised as a research network project, supported and part-funded by the Centre for Industrial Production at Aalborg University. The project, called "Synopsis", has a number of aims and foci, with the goal of steering an exploration of the current state-of-the-art and future needs of product innovation in Danish industry. Due to the network’s multi-disciplinary nature it is not always possible, nor is it desirable to attempt to force one unified view of product innovation. We have therefore defined a set of "images of innovation" which describe the subject from each our viewpoints. The ultimate goals of the network project are to produce: 1. A framework/reference system describing companies’ innovation activities, based upon national and international research findings 2. A vocabulary with which to be able to describe product innovation from one industry type to the next 3. A map of Denmark, showing the significant stakeholders connected to product innovation 4. A transfer of knowledge gathered from the project into teaching material and case studies, both for academia and industry. This paper describes the background for the Synopsis project in detail and reports on the results achieved to date.
Towards the actual implementation of ecodesign in industry - the "haves" and "needs" viewed by the European ecodesign community

Over the past decades a great deal of information on ecodesign principles, methodologies, tools, case studies, product data, training and teaching material has become available. However, we still lack a catalogue of successful examples that show how ecodesign is integrated in every-day business. This especially applies to large industries such as the electronics industry, which has traditionally been a major subject for ecodesign-related research across European universities. Although many large companies have established environmental departments, the dissemination and further implementation of ecodesign principles beyond these departments is observed to be problematic. This paper discusses and further elaborates on the results of a discussion, which arose at an ecodesign workshop, arranged at the Design 2002 conference in Dubrovnik. In the paper the authors attempt to establish a platform for further activities to foster the implementation of ecodesign in industry. In this elaboration, the paper defines a number of research avenues that, so far, have not been part of common research approaches in the European Ecodesign Community, and are of great validity for the research community.

Udvikling af produktservicesystemer

Udvikling af produktservicesystemer
Confronting product life thinking with product life cycle analysis

Industry is increasingly being confronted with the need to consider the whole life cycle effects of its products, in order to make environmental improvements of any significance. There is a danger that naive environmental decisions are made, due to apparent lack of data or actual lack of insight. This paper describes a case study, where a class of students was presented with a product from the Danish company, Danfoss A/S, and given the task of carrying out an initial environmental evaluation of the product. This evaluation consisted of both a "life cycle check" and an exercise where the students were to "read" the environment out of the product, in order to systematically, quickly and efficiently come to some design recommendations for the company. The phrases "LCA" and "product life thinking" will be described and differentiated and a pattern identified for their cooperative effect in use.
Environmental Priorities in Strategic Product Development

Reports progress of the Design for Environmental Decision Support (DEEDS) project, gives the project's aim as the development of appropriate tools and methods for eco-design for use in the electrical/electronics sector. Bases development of the tools and methods on the results of a survey of 19 companies in the target sector. Reviews the available eco-design methodologies, e.g. life cycle assessment (LCA), quotes employee’s of the surveyed companies regarding the companies' use of eco-design, and of environmental champions within product divisions and design teams. Presents a four-step eco-design framework consisting of analyse, report, prioritize and improve steps, at both strategic and operational levels. Tests the framework by application in an Electrolux subsidiary producing vacuum cleaners, tabulates LCA results for one product and its constituents and components. Concludes that prioritizing is the most critical stage.

General information

State: Published
Organisations: Department of Control and Engineering Design, Cranfield University, Sheffield Hallam University, Manchester Metropolitan University
Authors: Simon, M. (Ekstern), Poole, S. (Ekstern), Sweatman, A. (Ekstern), Evans, S. (Ekstern), Bhamra, T. (Ekstern), McAloone, T. C. (Intern)
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Main Research Area: Technical/natural sciences

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Scopus rating (2015): SJR 1.853 SNIP 2.146 CiteScore 4.11
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.768 SNIP 1.826 CiteScore 3.51
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Scopus rating (2013): SJR 1.368 SNIP 1.957 CiteScore 3.78
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Scopus rating (2012): SJR 1.283 SNIP 1.869 CiteScore 3.53
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.154 SNIP 1.472 CiteScore 2.46
ISI indexed (2011): ISI indexed no
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Scopus rating (2010): SJR 0.948 SNIP 1.266
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Industrial Application Of Environmentally Conscious Design

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Organisations: Department of Control and Engineering Design
Authors: McAloone, T. C. (Intern)
Number of pages: 199
Publication date: 2000

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Place of publication: London
Publisher: Professional Engineering Publishing Limited
Original language: English
Main Research Area: Technical/natural sciences
Ecodesign, Product life, PD methods, Innovation, Nordic PhD research, Research supervision, Sustainable product design
Source: orbit
Source-ID: 174344
Publication: Research - peer-review › Book – Annual report year: 2000

On the teaching of product development and innovation
Danish industrialists point out, that the importance of product development and innovation in industry is strongly growing, but the focus upon the way we are working is weakening. Therefore there is concern about the necessary number of students and their abilities in the design area. Current efforts related to the teaching of design will be reported in the following.

General information
State: Published
Organisations: Engineering Design and Product Development, Department of Mechanical Engineering
Authors: Andreasen, M. M. (Intern), McAloone, T. C. (Intern), Hansen, C. T. (Intern)
Publication date: 2000

Host publication information
Title of host publication: Proceedings of International Workshop Education for Engineering Design
Place of publication: Pilsen
Publisher: EED
Main Research Area: Technical/natural sciences
Conference: International Workshop Education for Engineering Design, Pilsen, 01/01/2000
Teaching, Engineering Design, Product Development, Innovation, Research based learning, Learning based teaching, Innovation, PD methods, Decision support
Electronic versions:
Towards a New Framework for Product Development

In the mid-1980s, Andreasen and Hein first described their model of Integrated Product Development. Many Danish companies quickly embraced the principles of integrated product development and adapted the model to their specific business and product context. However, there is concern amongst many Danish companies that Integrated Product Development no longer provides a sufficient way of describing industry’s product development activity. More specifically, five of these companies have supported a programme of research activities at the Technical University of Denmark, which seeks to develop a new framework for product development. This paper will describe the research approach being taken, present some initial findings, and outline a vision of a new working approach to product development.

Where's eco-design going?

Thirteen years after the Bruntland Report, we have had time to read and digest and postulate about what is required to make the many small steps towards something which we call sustainability. In those years we have come great distances. We know how to systematically seek for solutions to environmental problems. We use the lessons learned from these systematic attempts to construct methods for preventing the problems from occurring in the first instance. Further to this, some environmental ‘leaders’ are beginning to make pro-active attempts at using the environmental credentials of their products as the corner-stones for their businesses. When we consider finding solutions to discreet environmental problems, we now have many tools and techniques, and these issues are relatively easily addressed – at least we know where the problems lie. When we talk about learning from these problems and developing repeatable methods, we are making good progress in this area too – we have ideas about how to prioritise and organise our efforts. If we are to move to thinking about how to be pro-active with our efforts and design-in more to our products than just snap-fits and expect more back from our customer than just complaints, we should look to some different areas for guidance. We could look at the domain of quality, to learn about how to get closer to the customer and the product and the product’s life-cycle. We could look at innovation theory, to see how to be clever about the things that we do to our products, and how we ‘package’ them as a complete need-fulfilment. But how can we be sure that we’re on the road to sustainability? Thirteen years later and we have theories such as Factor 4, Factor 10 and Factor 20. We have seen sustainability broken down into eco-centric and techno-centric, strong sustainability and weak sustainability. Is it really possible to have these shades of green? This paper puts together some experiences and ideas around the state-of-the-art in eco-design, from both literature and personal experience and hopes to ask where, perhaps, we should be heading.
A Framework For Product Development

General information
State: Published
Organisations: Department of Control and Engineering Design
Authors: McAloone, T. C. (Intern), Robotham, A. J. (Intern)
Pages: 83-98
Publication date: 1999

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Title of host publication: Critical Enthusiasm: Contributions To Design Science
Place of publication: Trondheim/Lyngby
Publisher: NTNU/DTU
Main Research Area: Technical/natural sciences
Conference: Critical Enthusiasm: Contributions To Design Science, Lyngby, 01/01/1999
Innovation, PD methods, Core front end, Decision making, Fuzzy front end, New product development, Tool adoption,
Tools requirements
Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

An Eco-Design Model Based On Industry Experience

General information
State: Published
Organisations: Department of Control and Engineering Design, Cranfield University, Manchester Metropolitan University
Authors: Evans, S. (Ekstern), McAloone, T. C. (Intern), Bhamra, T. (Ekstern)
Publication date: 1999

Host publication information
Title of host publication: Proceedings of 6th International Seminar On Life Cycle Engineering
Place of publication: Kingston, Ontario
Publisher: CIRP
Main Research Area: Technical/natural sciences
Ecodesign, Innovation, Core front end, Decision support, Fuzzy front end, Fuzzy logic, Genetic algorithms, New product development
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Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Integrating Environmental Decisions into the Product Development Process: Part 1 - The Early Stages

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State: Published
Organisations: Department of Control and Engineering Design, Manchester Metropolitan University, Cranfield University
Authors: Bhamra, T. (Ekstern), Evans, S. (Ekstern), McAloone, T. C. (Intern), Simon, M. (Ekstern), Poole, S. (Ekstern), Sweatman, A. (Ekstern)
Pages: 329-333
Publication date: 1999

Host publication information
Title of host publication: Proceedings of the First International Symposium On Environmentally Conscious Design And Inverse Manufacturing
Place of publication: Tokyo
Publisher: IEEE Computer Society Press
Main Research Area: Technical/natural sciences
Integrating Environmental Decisions into the Product Development Process: Part 2 - The Later Stages

General information
State: Published
Organisations: Department of Control and Engineering Design, Manchester Metropolitan University, Cranfield University
Authors: Poole, S. (Ekstern), Simon, M. (Ekstern), Sweatman, A. (Ekstern), Bhamra, T. (Ekstern), Evans, S. (Ekstern), McAloone, T. C. (Intern)
Pages: 334-337
Publication date: 1999

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Place of publication: Tokyo
Publisher: IEEE Computer Society Press
Main Research Area: Technical/natural sciences
Conference: 1st International Symposium On Environmentally Conscious Design And Inverse Manufacturing, Tokyo, Japan, 01/02/1999 - 01/02/1999
Ecodesign, Product life, PD methods, Environment, Innovation, Miljø, Miljørigtig produktudvikling
Source: orbit
Source-ID: 172425
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Using Empirical Data To Build An Advisory Tool For Ecodesign
Many product manufacturers are now implementing eco-design principles, albeit to varying degrees. It is these degrees of variance that were of particular interest in the research presented in this paper. Based on the hypothesis that there exists no single systematic approach to eco-design, which allows for the consideration of environmental issues in every stage of the product development process, an exploratory study sought to identify the various stages that companies travelled through when implementing eco-design principles. The electrical/electronics industry was the chosen subject for the study. Results from this empirical research revealed that there is a common sequence of events that many companies go through when integrating eco-design into their product development processes, as presented in the model of eco-design integration in this paper. This sequence of events would be easily recognised by change management practitioners. Further to the common sequence of change in the companies, it was found that there were also common issues which companies aimed to improve when attempting to learn more about eco-design. Plotting the model of eco-design integration against the common issues it was possible to develop a tool that was useful for industry, allowing companies to chart their progress in the eco-design issues of greatest concern to themselves. The 'eco-design advisor' presented here is the result of the development of the model into a tool.

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Organisations: Department of Control and Engineering Design, Cranfield University
Authors: McAloone, T. C. (Intern), Evans, S. (Ekstern)
Pages: 52-55
Publication date: 1999

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Publisher: IEEE Computer Society Press
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Main Research Area: Technical/natural sciences
Conference: 1st International Symposium On Environmentally Conscious Design And Inverse Manufacturing, Tokyo, Japan, 01/02/1999 - 01/02/1999
Ecodesign
Electronic versions:
McAloone.pdf
Ecodesign Navigator: A key resource in the drive towards environmentally efficient product design

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Organisations: Department of Control and Engineering Design, Manchester Metropolitan University, Cranfield University
Authors: Simon, M. (Ekstern), Evans, S. (Ekstern), McAloone, T. C. (Intern), Sweatman, A. (Ekstern), Bhamra, T. (Ekstern), Poole, S. (Ekstern)
Number of pages: 151
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Main Research Area: Technical/natural sciences
Ecodesign, Product life, Barriers and drivers, Clusters, MV, Open innovation
Source: orbit
Source-ID: 172422
Publication: Research - peer-review › Book – Annual report year: 1998

Environmental priorities in strategic product development

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Organisations: Manchester Metropolitan University, Cranfield University
Authors: Simon, M. (Ekstern), Poole, S. (Ekstern), Sweatman, A. (Ekstern), Evans, S. (Ekstern), Bhamra, T. (Ekstern), McAloone, T. C. (Intern)
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Publisher: BSE
Main Research Area: Technical/natural sciences

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Source: orbit
Source-ID: 188962
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Industry Experiences of Environmentally Conscious Design Integration: An Exploratory Study
This research has explored environmentally conscious design in the electrical/electronics industry sector. In this new and rapidly evolving field, existing research has not yet sought to understand the causes of success and the problems experienced when companies have integrated environmental considerations into the design process. The findings in this thesis emerged from one in-depth study and a transatlantic industry survey, interviewing twenty four practitioners. A framework of factors affecting environmentally conscious design was derived from this research and a model of environmentally conscious design integration developed which describes the industry’s experience of integrating environmental considerations into the design processes.

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Organisations: Engineering Design and Product Development, Department of Mechanical Engineering
Authors: McAloone, T. C. (Intern)
Number of pages: 180
Success in environmentally conscious design: How is it achieved and maintained?

As Environmentally Conscious Design (ECD) is growing in importance and an increasing amount of companies are beginning to introduce it into their product development processes, it is interesting to try and establish how companies have made it work. As this concept is still new for many organisations it is difficult to predict exactly what constitutes successful ECD. As part of the DEEDS research project at Cranfield University it was therefore decided to conduct a series of in-depth interviews in thirty companies from the electronic/electrical sector in the UK, Central Europe and USA. The analysis of these interviews has shown two major research findings. Firstly decisions that have a major environmental impact are largely made in the pre-specification stages of the product development process. Secondly, it is recognised that most companies have developed an information supply system to support ECD and have used people identified as environmental champions to do this. This paper explores the significance of these two findings and highlights the way in which other organisations can learn from these results.

To what extent are DFX principles really used when developing environmentally sensitive products?

Research shows that over the past five years, industry has improved its understanding of the need to consider the environmental impacts of its products. As a result companies are now beginning to incorporate environmental decisions into their design processes. It has been observed that companies follow a general pattern of change in order to continuously improve their eco-design capabilities. Many methods can be used to ensure that environmental considerations are included in the design process, some which may be complimentary to the existing process of design, and some which may contradict existing design practices. This paper explores the use of DFX principles during eco-design. Literature describing the use of DFX principles in eco-design is reviewed and used to investigate empirical evidence from designers in the electrical/electronics industry.
How Good Is Your Environmental Design Process?: A Self Assessment Technique

Increasing consumer, regulatory and competitive pressures mean that companies are now seeking to deliver products that are not only of higher quality and lower cost, but which also have a reduced environmental affect. This paper presents the results of research conducted within companies in Europe and North America. The research has identified a number of factors that were felt to be significant to the companies' successful implementation of environmentally conscious design. A set of questions are posed throughout the paper to demonstrate a technique for designers to assess their environmental knowledge and readiness.

Organisational Requirements For Achieving Environmentally Conscious Design

This chapter presents a model representing the requirements for achieving Environmentally Conscious Design, describing the different stages that organisations pass through, from minimum to maximum achievement. Research has found that when basing work purely on design theory it is easy to become channelled into thinking that the optimum representation of the environmentally conscious design process must be represented in the form of another classical design model, with inputs and outputs acting at various stages of the design process. However from detailed study into two organisations and interview of up to twenty other organisations, it has been found that the actual 'doing' of environmentally conscious design is just a small, albeit important part of a larger framework of motivators and actuators of Environmentally Conscious Design (ECD). This has formed the basis of a survey in the electrical/electronics industry sector which illustrates the different approaches and successes in achieving ECD. By analysing the comments and experiences of designers and design teams involved in environmentally conscious design it is has been possible to construct a framework of factors affecting ECD. This framework has facilitated the development of a model illustrating the way in which organisations need to change if they are to achieve optimum ECD.
A Pragmatic Approach to Managing Product Life-Cycles

If we were to visit a landfill site ten years ago, we might find products being disposed of that were 20 or 25 years old. Visiting a landfill site today we would find the same products being disposed of which are around 10-15 years old. What can we expect to find on a landfill site in another ten years’ time? If we compare today’s retired products with those of ten years ago, what did we learn over that period about their design? What will we learn by visiting the same landfill site in ten years time, of the products that we are designing today? Furthermore have companies addressed these questions? According to draft legislation manufacturers may have to take back their products at the end of their lives, and take responsibility for the costs associated with the collection, recycling and disposal of used electronic appliances. The UK Government has stated in the past that its preferred option concerning electronic waste is to let market forces encourage product take back. However the Government has admitted that if producer responsibility does not occur, then it may consider legislation. In parallel to this some form of legislation may arise from the EC, which could be very similar to that proposed in Germany. Hence, as take back legislation increasingly places responsibility for product End Of Life (EOL) on the manufacturer who produced the products originally, companies will have direct incentives to design products that are recyclable in order to reduce the costs of landfill disposal. (Or perhaps products will be made to be re-usable, to completely offset the cost of landfill by retaining the value-add within the products.) Design is likely to play a key role in reducing the costs of recycling. Interestingly some innovative companies are already taking back EOL products to their financial advantage. In the USA, for example, DEC recycles tens of thousands of computer monitors each year at a unit cost of between $3 and $6.50 because this approach is cheaper than the costs of landfill. Furthermore in the UK companies are beginning to consider the whole life-cycle of their products; not just getting the product to market, but also taking an interest in what happens to the product for the rest of its life. However the problem with environmental decisions is that they require input from a broad background of knowledge. Also, when considering the many products that a company manufactures over a number of years, the information required to cover this range over many product life-cycles would be tremendous. If such moves are to be made by industry there is a clear need for an accessible base of data, which is capable of interpreting this data into sound information to the designer and to all involved in retaining value throughout every stage of the life-cycle of a product. This paper discusses research carried out between Cranfield University and Hotpoint, where the life-cycle of a product was studied and modelled using a spreadsheet-based computer modelling tool. By modelling everything from the manufacture and assembly of the washing machine, through shipping, in-field service, return and recycling, recommendations could be made about alternative ways in which to manage the life-cycle of the washing machine so as to improve its overall environmental and economical performance.

General information
State: Published
Organisations: Cranfield University, Hotpoint Ltd
Authors: McAloone, T. C. (Intern), Evans, S. (Ekstern), Weeks, J. (Ekstern)
Publication date: 1996

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Title of host publication: Proceedings of Conference on Integration in Manufacturing (IIM)
Place of publication: Galway, Ireland
Publisher: ESPRIT
Main Research Area: Technical/natural sciences
Conference: Conference on Integration in Manufacturing, Galway, Ireland, 01/01/1996

Bibliographical note
Ecodesign; Product life; Network management; Network-based development; Organisational theory; Product/Service-Systems; PSS development
Source: orbit
Source-ID: 188955
Publication: Research - peer-review › Article in proceedings – Annual report year: 1996

From Product Designer To Environmentally Conscious Product Designer
In recent years there has been a growing interest in making products more environmentally benign. Until now public policy has focused mainly on industrial waste streams and end-of-pipe problems and paid little or no attention to the design and development stage of a products life-cycle. Product designers are in a unique position within the product development process and through design have an unrivalled opportunity to address environmental issues. Problems arise when designers who already work to constraints such as cost and function, have to make complex value judgements and deal with the real uncertainties which surround many environmental decisions. It is unrealistic to expect designers to become environmental experts in their own right but there is now a responsibility on designers to be aware of the environmental problems which are particular to the area in which they work. Along with this responsibility comes the need for relevant information and strategies through which this information may be integrated into decision making at the design stage.
Through careful design we can break habits generated by our industrial economy. The question is: “What do designers have to do in order to play this crucial role and help break these habits?”

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Organisations: Sheffield Hallam University, Cranfield University
Authors: McAloone, T. C. (Intern), Holloway, L. P. (Ekstern)
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Title of host publication: Proceedings of Applied Concurrent Engineering Conference 1996 (ACE96)
Place of publication: Seattle, USA
Main Research Area: Technical/natural sciences
Conference: Applied Concurrent Engineering Conference 1996, Seattle, USA, 01/01/1996

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Ecodesign; Product life; PD methods; Barriers for PSS; Maritime industry; Organizational issues for PSS; PSS development; Servitization;
Source: orbit
Source-ID: 188956
Publication: Research - peer-review › Article in proceedings – Annual report year: 1996

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**Integrating Environmental Decisions Into Design: Encouraging A Move Towards Sustainable Product Development**

In recent years there has been a growing interest in making products more environmentally benign. New environmental standards require that companies not only account for their actions environmentally, but also provide some evidence as to how they intend to achieve improved environmental performance. Until now public policy has focused mainly on industrial waste streams and end-of-pipe problems, paying little or no attention to the design and development stage of a product’s life-cycle. Product designers are in a unique position within the product development process to have the opportunity to address environmental issues. However, considering that we are only just beginning to realise the benefits of acting in an environmentally responsible manner, (let alone understand the problem fully), designers face the dilemma of having to make long-term environmental decisions before they can begin to appreciate the consequences of their actions. Designers are now expected to produce goods that are ‘sustainable’, ‘green’, or ‘eco-friendly’ without first having understood the full breadth of the terms. (Indeed if they were to look into how to be ‘sustainable’ they would soon be bowled over by the term’s many interpretations.) This paper discusses some of the observations made during an industrially-based research project that is being carried out by two UK universities. The two industrial partners to the project manufacture goods in a global marketplace and have diverse product ranges. In the age of the global marketplace the design of the simplest product often involves liaison between many manufacturers and suppliers across the world, thus making the product development process more complex. If suitable environmental choices of components and materials from suppliers are to be possible, it is imperative that these decisions be made at exactly the right time in the design process and by the correct people.

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**Integrating Environmental Decisions Into The Design Process**

Environmental concerns now have a firm footing in many organisations. With the introduction of new environmental standards we can expect environmental practices to be adopted in much the same way as has been seen with quality issues; with requirements being initiated by the larger organisation and then passed down the supply chain until a broad
spectrum of organisations are operating to a set of standards. We are, however, still at the stage where the environment is not fully understood as an issue. Is this issue a problem that must be dealt with (often at minimum inconvenience), or an opportunity from which we can all reap benefits? Organisations are facing the dilemma of making long-term environmental decisions before they can begin to understand the ramifications of their actions. They must also prepare their products and processes to be adaptable to a whole host of issues that may or may not become mandatory. How can an organisation advocate to be working towards sustainable development before they even understand the breadth of the term? Indeed, there are many interpretations of sustainability; how can an organisation hope to be operating to everyone's expectations? This paper outlines research work that is being carried out by two UK universities and with two electrical/electronic product manufacturers. By gaining a sound understanding of where key decisions are made during the design process, we can address the many environmental issues and attempt to fit them into a model of the design process. It is imperative that the correct level of information is available to the already busy designer, so as to be as useful as possible without being too time consuming to feasibly become part of their daily routine - this issue of is one of the key motivators of the research. The research has been split into two main areas: observation ("learning by watching"); and implementation ("learning by doing"). Preliminary findings from the observation research carried out within the companies are presented.

**General information**

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Publisher: CIRP, Verlag Industrielle Organisation  
Main Research Area: Technical/natural sciences  
Conference: 3rd International Seminar On Life Cycle Engineering, Zürich, Switzerland, 18/03/1996 - 18/03/1996

**Bibliographical note**

Ecodesign; Product life; PD methods; Miljørigtig produktudvikling  
Source: orbit  
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Publication: Research - peer-review › Article in proceedings – Annual report year: 1996

**Integration Of DFE Tools With Product Development (Keynote speech)**

In recent years there has been a growing interest in making products more environmentally benign. Until now public policy has focused mainly on industrial waste streams and end-of-pipe problems and paid little or no attention to the design and development stage of a product's life-cycle. With the increasing threat of legislation and pressure from consumers, companies are quickly having to incorporate environmental considerations into their practices without first having a full understanding of the subject. There seems to be no time to gradually learn about environmental issues; the answers must be ready immediately. Product designers are in a unique position within the product development process and through design have an unrivalled opportunity to address environmental issues. Problems arise however when designers, who already work to tight constraints, have to make complex value judgements and deal with the real uncertainties which surround many environmental decisions. It is unrealistic to expect designers to become environmental experts in their own right but there is now a responsibility on designers to be aware of the environmental problems which are particular to the area in which they work. Along with this responsibility comes the need for relevant information and strategies through which this information may be integrated into decision making at the design stage. Until recently the most that many companies have been able to do is to appoint an environmental co-ordinator and to support the mechanism to increase awareness within the organisation. This has been successful in providing single-issue environmental solutions and in raising general environmental interest and awareness in the company. World-wide, industry has some pockets of expertise in the practice of environmentally conscious design but to date little research has been conducted to build models of decision making in this commercially significant area. By building and testing a model of decision making for environmentally conscious design we can increase the quality and validity of the tools developed to support both designers and design management, and so increase both environmental and economic performance for companies. At the end of the day, if environmental considerations are to be successfully implemented into the design process they must be understood by, and fit into the practices of the product designer. Preliminary findings from a research project in this area (entitled "DEEDS") will be presented to explain how this method of incorporation is being trailed in two companies.

**General information**

State: Published  
Organisations: Cranfield University  
Authors: McAloone, T. C. (Intern)  
Publication date: 1996

**Host publication information**
Meeting The Challenges Of Environmentally Conscious Product Design By Taking An Economic Life-Cycle View

Incorporating environmentally sound decisions into product design is a new challenge for designers. Designers are practiced in cost-based decision-making in order to produce high quality products that are on-time to market and cost effective, but until recently have not had cause to consider the environmental consequences of their products. If environmental concerns are to be successfully brought into the product design process they must be quick and simple to incorporate; if the method of embodiment of environmental concerns into design is alien to the designer or cumbersome to carry out, it will not be adopted. The concept of Life-Cycle Economics (LCE) is explored in terms of how it can be used to aid designers to choose where to begin reducing the environmental impact of a product, whilst still retaining a sound economical balance during design. The mechanism for carrying out the analysis is described. A case study is illustrated where LCE considerations were applied in the electrical/electronic domestic appliance industry to assess the negative environmental impact of a product. Recommendations are made of how the negative environmental impact of the product could be reduced, whilst also reducing its production and in-service costs and increasing its profitability at end-of-life.

The Application Of Computer Simulation To Economically Justify The Design Of A Life-Cycle Approach

Proposed German legislation concerning electronic waste states that manufacturers will have to take back their products at the end of their lives, and be responsible for the costs associated with the collection, recycling and disposal of used electronic appliances. The UK Government has stated in the past that its preferred option concerning electronic waste is to let market forces encourage product take back. However the Government has admitted that if producer responsibility does not occur, then it may consider legislation. In parallel to this some form of legislation may arise from the EC, which could be very similar to that proposed in Germany. Hence, as take back legislation increasingly places responsibility for product End Of Life (EOL) on the manufacturer who produced the products originally, companies will have direct incentives to design products that are recyclable in order to reduce the costs of landfill disposal. Design is likely to play a key role in reducing the costs of recycling. Interestingly some innovative companies are already taking back EOL products to their financial advantage. In the USA, for example, DEC recycles tens of thousands of computer monitors each year at a unit cost of between $3 and $6.50 because this approach is cheaper than the costs of landfill.
The Challenges Of Environmentally Conscious Design

The design process is understood to be an area of great opportunity for companies to implement new ideas and practices. With the first 20% of the design process fixing up to 80% of a product’s attributes, this is not surprising. Until recently we have primarily seen environmental pressures dealt with reactively by manufacturing companies who have been forced to “clean up” their product and their manufacturing processes and attempt to recycle their products at the end of their useful lives. However, a key opportunity for product manufacturers to proactively reduce environmental impact is in the design process. Industry is responding to this opportunity by seeking tools and methods to support Environmentally Conscious Design (ECD), with some companies already performing ECD, albeit with crude tools.
Designing Sustainable Circular Business Models on Product/Service-Systems

Department of Mechanical Engineering
Period: 15/06/2017 → 14/06/2020
Number of participants: 4
Phd Student:
de Pádua Pieroni, Marina (Intern)
Supervisor:
Hildenbrand, Jutta (Ekstern)
McAloone, Tim C. (Intern)
Main Supervisor:
Pigosso, Daniela Cristina Antelmi (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Understanding and Implementing Design for Biodegradability
Bachelor thesis project about designing for biodegradability.

Department of Mechanical Engineering
Engineering Design and Product Development
Period: 01/02/2016 → 17/06/2016
Number of participants: 2
Supervisor:
Meijer, Ellen Brilhuis (Intern)
McAloone, Tim C. (Intern)

Project

Sustainability Practice Theory and practice of soft side requirements of organizations that determine successful implementation of Design for sustainability

Department of Management Engineering
Period: 01/10/2015 → 30/09/2018
Number of participants: 4
Phd Student:
Ali, Faheem (Intern)
Supervisor:
Bey, Niki (Intern)
McAloone, Tim C. (Intern)
Main Supervisor:
Boks, Casper (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Stipendie fra udlandet
Project: PhD

Using Integrated Sustainable Product Development for the development of a Green Fibre Bottle for Carlsberg

Department of Mechanical Engineering
Period: 01/08/2015 → 31/07/2018
Number of participants: 5
Phd Student:
Meijer, Ellen Brilhuis (Intern)
Supervisor:
Pigosso, Daniela Cristina Antelmi (Intern)
Howard, Thomas J. (Intern)
Olsen, Stig Irving (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet

Relations
Activities:
Integrating Product and Technology Development: A Proposed Reference Model for Dual Innovation
Project: PhD

Building a business case for ecodesign implementation based on a system dynamics simulation model
Department of Mechanical Engineering
Period: 01/02/2015 → 31/07/2018
Number of participants: 3
Phd Student:
Rodrigues, Vinicius Picanco (Intern)
Supervisor:
Pigosso, Daniela Cristina Antelmi (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Science Without Borders, Brasi
Project: PhD

Product/Service-System Design from a Life Cycle Costing Perspective
Department of Mechanical Engineering
Period: 01/02/2014 → 21/09/2017
Number of participants: 6
Phd Student:
Pagoropoulos, Aris (Intern)
Supervisor:
Maier, Anja (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)
Examiner:
Laurent, Alexis (Intern)
Andersen, Ingrid Marie Vincent (Intern)
Isaksson, Karl Ola (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Product/Service-System Design from a Life Cycle Environmental Perspective
Department of Mechanical Engineering
Period: 01/12/2013 → 16/04/2018
Number of participants: 6
Phd Student:
Kjær, Louise Laumann (Intern)
Supervisor:
Pigosso, Daniela Cristina Antelmi (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)
Examiner:
Olsen, Stig Irving (Intern)
Evans, Stephen (Ekstern)
Goedkoop, Mark (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Udvikling af Produkt/Service-systemer i nye forretningsområdet og virksomheder

Department of Mechanical Engineering
Period: 01/05/2012 → 11/12/2015
Number of participants: 5
Phd Student:
Andersen, Jakob Axel Bejbro (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)
Examiner:
Broeng, Jes (Intern)
Larsson, Tobias Christoffer (Ekstern)
Thoben, Klaus-Dieter (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.

Relations
Publications:
PSS Support for Maritime Technology Ventures: From Exploration to Methodology and Theory
Project: PhD

Træfsikkerhed i produktudvikling gennem brugercentreret design: En undersøgelse af teori og praksis

Department of Mechanical Engineering
Period: 01/04/2012 → 25/02/2016
Number of participants: 6
Phd Student:
Christensen, Martin Ebro (Intern)
Supervisor:
McAloone, Tim C. (Intern)
Main Supervisor:
Howard, Thomas J. (Intern)
Examiner:
Mortensen, Niels Henrik (Intern)
Söderberg, Rikard (Ekstern)
Thornton, Anna (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: ErhvervsPhD-ordningen VTU

Relations
Publications:
Applying Robust Design in an Industrial Context
Project: PhD
Implementing Environmental Improvements through Product Development

This project focuses on aiding companies in the actual implementation of ecodesign, through best practice case studies and guidelines. It is a continuation of the earlier "MPU" project.

Engineering Design and Product Development

Department of Management Engineering
Period: 01/06/2011 → 31/12/2011
Number of participants: 4

Ecodesign
Acronym: iMPU
Project ID: 81198

Howard, Thomas J. (Intern)
Nielsen, Rasmus (Intern)

Project Manager, organisational:
McAloone, Tim C. (Intern)
Bey, Niki (Intern)

Financing sources
Source: Forskningsprojekter - Miljø- og Energiministeriet
Name of research programme: Forskningsprojekter - Miljø- og Energiministeriet
Amount: 499,550.00 Danish Kroner

Eco-Innovation Exchange Workshops : DASTI Bi-Lateral Network Projects

This proposal aimed to strengthen the research collaboration between the Center for Design Research at Stanford University (hereafter referred to as "CDR") and the Department of Management Engineering at the Technical University of Denmark (hereafter referred to as "DTU") in the field of sustainable product and service innovation, by adopting a collaborative, action-research approach to methodology implementation in international industrial companies. We ran a short workshop series, consisting of three intensive industry workshops, each with its own time for preparation and subsequent reflection/analysis. For the first two workshops (held in USA), we partnered up with two research-active, USA-based companies, Panasonic and Steelcase, who acted as the industrial participants for the workshops. Both CDR and DTU have a history of research collaboration with both of these companies and had therefore well-established connections inside both organisations. Previous collaborations include interviews, in-depth studies, student projects and workshop orchestration within a strategic area for the respective companies. The third workshop was be held in Denmark, where we invited three Danish companies to join the discussions and exercises, to-gether with Panasonic and Steelcase. This project focused on two main research phenomena, sustainability and innovation, and aimed to begin to uncover the connections between the two in an industrial setting. It was our working hypothesis that sustainability demands for a globally active, industrial organisation can lead to innovative solutions in terms of business development opportunities. Also, it was our hypothesis that an organisation striving towards innovation will increasingly need to live up to the key requirements of sustainability. In the context of product development, sustainability has been an area of focus for some time now. The past two decades have seen many efforts from academia and industry alike, towards the consideration of sustainability during product development. The result is that there are now hundreds of guidelines, tools, calculators and consultants available to aid the process of design optimisation for sustainability. However, the project team's and other researchers' studies show that companies' uptake of these many tools is sparse. In terms of innovation, there are a
plethora of theories and schools of thought regarding industrial innovation. These theories can be roughly classified in three main areas of technology-driven innovation (new things make new markets), user-driven innovation (seen from a traditional lead-user viewpoint) or idea-driven innovation (with focus on the creativity of the individual entrepreneur). In this project we made the first attempts at establishing a focus on sustainability-driven innovation. Our scientific research base was on the above-mentioned fields.

Engineering Design and Product Development
Department of Management Engineering
Stanford University
Panasonic R&D Company of America
Steelcase Inc.
Lego Group
Coloplast Danmark A/S
Velux A/S
Period: 01/03/2011 → 31/12/2011
Number of participants: 14
Eco-innovation, Ecodesign, Service innovation
Acronym: EIEW
Project ID: 81104
Contact person:
Junqua, Jean-Claude (Ekstern)
Nahikian, Angela (Ekstern)
Owens, Kevin (Ekstern)
Faltum, Jes (Ekstern)
Skals, Peter (Ekstern)
Andreassen, Karen (Ekstern)
Project participant:
Bey, Niki (Intern)
Mougaard, Krestine (Intern)
Restrepo-Giraldo, John Dairo (Intern)
Leifer, Larry (Ekstern)
Steinert, Martin (Ekstern)
Toye, George (Ekstern)
Faludi, Jeremy (Ekstern)
Project Manager, organisational:
McAloone, Tim C. (Intern)

Financing sources
Source: Forskningsrådene - Andre
Name of research programme: Forskningsrådene - Andre
Amount: 359,572.00 Danish Kroner
Project

Et rammeværk til konceptualisering og specifikation af PSS designs - Netværksbaserede udviklingsmodeller

Department of Mechanical Engineering
Period: 01/07/2010 → 28/01/2016
Number of participants: 6
Phd Student:
Mougaard, Krestine (Intern)
Supervisor:
Howard, Thomas J. (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)
Examiner:
Maier, Anja (Intern)
Rönnbäck, Anna Öhrwall (Ekstern)
Storga, Mario (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering

Relations
Publications:
A framework for conceptualisation of PSS solutions: On network-based development models
Project: PhD

Organisation for PSS delivery and management structures for PSS performance
Department of Mechanical Engineering
Period: 01/05/2010 → 29/01/2016
Number of participants: 2
PhD Student:
Malthesen, Line Neugebauer (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Product/Service-Systems in the Maritime Branch
Private financial support for a PhD project in the area of Product/Service-System Design in the Maritime branch.

Engineering Design and Product Development
Department of Management Engineering
Period: 01/05/2010 → 31/08/2013
Number of participants: 1
Product/Service-Systems (PSS), Service Innovation, Maritime Industry
Project ID: 81097
Project Manager, organisational:
McAloone, Tim C. (Intern)

Financing sources
Source: Forsk. Private danske - Fonde
Name of research programme: Forsk. Private danske - Fonde
Amount: 1,675,000.00 Danish Kroner
Project

A framework for PSS development in a branch with long-lived, complex products
Department of Management Engineering
Period: 01/04/2010 → 31/08/2011
Number of participants: 2
PhD Student:
Nielsen, Teit Anton (Intern)
Main Supervisor:
McAloone, Tim C. (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Innovation Consortium PROTEUS: PROduct/service-system Tools for Ensuring User-oriented Service
The Innovation Consortium, PROTEUS, is working to jointly develop new knowledge about how after-sales service can be effectively integrated into business development and industrial organisations, so as to become a source of revenue, rather than a cost to the company. The participants in PROTEUS are interested in understanding, through examples, how to
effectively and systematically integrate service development into their product development and business creation processes. State-of-the-art: Current literature on Product/Service-Systems (PSS) includes examples of procedures for the integration of product and service features in product development, but these approaches do not consider a number of key areas for business, such as the commercial considerations, the strategic organisational issues, or the possibilities of collaboration across the value chain. PROTEUS is in a unique position to begin to address some of these issues on a whole branch.

Engineering Design and Product Development
Department of Management Engineering
Institute for Product Development
Copenhagen Business School
Danish Maritime Institute
Noreq Acta A/S
Emerson (Damcos)
Hempel A/S
Klinger
Lloyd’s Register ODS
MAN B&W Diesel A/S
Novenco Firefighting
Pres-Vac
YIT Corporation Ltd.

Aalborg Industries A/S
Period: 15/02/2010 → 15/08/2013
Number of participants: 8
Product/Service-Systems (PSS), Service Innovation, Maritime Industry
Acronym: PROTEUS
Project ID: 81095
Project participant:
Howard, Thomas J. (Intern)
Mougaard, Krestine (Intern)
Malthesen, Line Neugebauer (Intern)
Project Manager, organisational:
McAlone, Tim C. (Intern)
Bey, Niki (Intern)
Hsuan, Juliana (Ekstern)
Ahm, Thorkild (Intern)
Braat, Jenny (Ekstern)

Financing sources
Source: Forskningsrådene - Andre
Name of research programme: Forskningsrådene - Andre
Amount: 19,074,951.00 Danish Kroner

The 18th International Conference on Engineering Design, ICED11 : Impacting Society Through Engineering Design
ICED11 Theme: Impacting Society Through Engineering Design Design has a central role in bringing engineering and technology to practical use. We have chosen, therefore, that ICED11 will focus on balancing the societal impact of engineering design. Message from the Chair On welcoming you to the eighteenth International Conference on Engineering Design, ICED11, it can safely be stated that engineering design research is firmly established as a strong research discipline. As design researchers, design practice is our research object and industry companies are our research laboratories. Based on our observations, discussions and participation in design activities, we gather knowledge and insights and crystallise these into both academic models and practical methods. Our customers are students, training to be the product developers and innovators of the future, and industrialists, engaging with us to get insight into tools and methods, which fit to their practices and empower them to meet the challenges of global competition. The theme we have chosen for ICED11 is Impacting Society through Engineering Design. Design has a central role in bringing engineering and technology to practical use. We are expecting that each of the papers and presentations at the conference will provide
its own contribution to the ICED11 theme. We're delighted to see the variety and the quality of contributions that our colleagues from the design research community have submitted to ICED11. In its 30 year history this is the first time that an ICED conference has returned to the same city, "Wonderful Copenhagen". In the Danish official 'Year of Design' the city is the perfect conference location, hosting the highest quality design, ranging from industrial design, through stunning architecture, to a dynamic engineering design industry, which has extensively backed ICED11. We have taken great care to create a conference showing leading edge research into engineering design and product development practice and to provide a lively backdrop for knowledge exchange and research discussion. Our goals with ICED11 have been to place particular emphasis on industry participation, provocative and relevant keynote speeches, maximum time for debate and discussion, and space to go in to depth, via the SIG workshops. And all this with a Danish flavour, which we hope you find welcoming, fun and "hyggelig"! Welcome to ICED11!

Engineering Design and Product Development

Department of Management Engineering
Period: 01/01/2010 → 31/12/2011
Number of participants: 2
Engineering design, International Conference, Design Society
Acronym: ICED11
Project ID: 81142
Project participant:
Howard, Thomas J. (Intern)
Project Manager, organisational:
McAloone, Tim C. (Intern)

Financing sources
Source: Udenfor rammen
Name of research programme: Ukendt
Amount: 3,000,000.00 Danish Kroner

The Transport Innovation Network (TINV) is a national, cross disciplinary network aimed at the Danish Transport sector. The primary objectives of TINV are to create synergy, encourage match-making and generate research and development projects between stakeholders in the transport sector and research- and educational institutions, as well as related sectors such as energy and infrastructure. Denmark’s competitive position depends on the technological leadership of the transport sector. Accordingly, it is paramount for the Danish transport sector to be able to draw on the latest technology knowledge and research. Through a number of sub-activities, TINV works to gather the different players across the transport scene with the aim of creating synergy, identifying the need for new technologies and initiating projects between our members to ensure development and implementation of these. The Danish shipbuilding industry has traditionally focused on delivering products to their customers, based on the longevity and high technical/functional qualities of their physical artefacts. But as with most industries, the continuing market globalisation in the shipbuilding industry both opens opportunities, in terms of a rising number of potential customers and represents threats, due to the growing number of competitors worldwide. Maritime component manufacturers are experiencing a growing demand from customers with respect to after-sales service, and they also see a great business opportunity in becoming more systematic about their integrated product/service development activities.

Engineering Design and Product Development

Department of Management Engineering
Period: 01/07/2009 → 31/12/2010
Number of participants: 2
Product/Service-Systems (PSS), Service Innovation, Maritime Industry, Transport Innovation
Acronym: TINV
Project ID: 81031
Project participant:
Mougaard, Krestine (Intern)
Project Manager, organisational:
McAloone, Tim C. (Intern)

Financing sources
Source: Forskningsrådene - Andre
Name of research programme: Forskningsrådene - Andre
Amount: 736,762.00 Danish Kroner

Project
Transportens Innovationsnetværk: Aktivitet A8: Integrerede Produkt/Service-Systemer

Department of Management Engineering
Period: 01/06/2009 → 31/05/2010
Number of participants: 2
Product/Service-Systems (PSS)
Acronym: TINV
Project ID: 81031
Project participant:
Mougaard, Krestine (Intern)
Project Manager, organisational:
McAlone, Tim C. (Intern)

Financing sources
Source: Forskningsrådene - STVF
Name of research programme: Forskningsrådene - STVF
Amount: 267,440.00 Danish Kroner

Metodisk konstruktion af produkter

Department of Mechanical Engineering
Period: 01/01/2009 → 27/08/2013
Number of participants: 5
Phd Student:
Torry-Smith, Jonas (Intern)
Main Supervisor:
Mortensen, Niels Henrik (Intern)
Examiner:
Johannesson, Hans L. (Ekstern)
McAlone, Tim C. (Intern)
Riitahuhta, Asko (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Environmental improvement through product development

Companies in Denmark and abroad are working increasingly to reduce human impacts on the environment and nature. At the same time there must still be a large focus on the creation of value for customers and consumers. This development gives rise to a huge potential for Danish companies, to create new business opportunities, where sustainable development and value creation are integrated early in the design of new products and services. There is a great opportunity for businesses to create a new and positive agenda, where the focus is on all the good that companies can do for the environment, society and economic growth. Such an agenda must, of course, be based on a high involvement of the competencies of the companies’ own employees, as well as those of partners in the value chain. The Danish Environmental Protection Agency and the Confederation of Danish Industry are cooperating on this project with DTU and IPU, to promote and aid the establishment of such a new agenda. Focus is placed on how products and services can be designed so not to harm humans, the environment and nature. The project’s main result will be a Guide to environmental improvement through product development. The Guide will give inspiration and a stepwise approach to integrating positive environmental effects into companies’ design and product development processes. The Guide is intended primarily to aid product developers who have the task of building environmental thinking into the product development process. However environmental staff, industrial designers, manufacturing staff and others can also benefit from reading the Guide. The project will start with a review of the environmentally-oriented methods used and product development activities carried out in Danish and international companies, as well as experience gained through a series of workshops with Danish companies. This project is financed through the Danish Environmental Protection Agency’s company funding scheme.

Engineering Design and Product Development
Department of Management Engineering
Institute for Product Development
Dansk Industri
PhD Supervision Collective for Sustainable Product innovation

Sustainable Product Innovation (SPI) is a young but rapidly expanding research field, especially in the areas of environmental product assessment and design for environment. It has evolved from end-of-life focused approaches towards prevention through cleaner production and eco-design. In industry too a number of pro-active companies changed their controlling and complying posture in the direction towards a more preventive and strategic attitudes on environmental issues. The emphasis on environmental issues thereby shifted over the years from a more technical approach towards more organisational aspects of sustainable design. Whereas in recent years, the balance between ecological and economical considerations have been subject of research, a growing attention for social matters has resulted in this becoming a third component of what is now understood to be design for sustainability. Thus, sustainable product design is product development in which the three aspects of the ‘triple bottom line’ -- the economical, environmental and societal sides of design (or profit, planet and people) -- are increasingly taken into account. The first academic scholars that, in the mid 1990s, earned their PhD degrees in this field were often supervised by professors without any academic upbringing in this field. Generally, these professors had backgrounds in traditional technical, natural science or social disciplines, in either academia or industry. This also meant that these pioneers did their research in the context of a variety of disciplines and scientific environments, without the ability to rely on a common research culture, norms, methodologies, a large body of previous research, or even a network. In many ways, research in sustainable product innovation in the period 1992-2002 was of a grounded and explorative nature. The scholars who earned their PhD degrees in this field five to ten years ago, are today’s supervisors of PhD research. These people do have the academic background and network in the field, but are often young and relatively unexperienced in supervising PhD students. Regular courses in scientific research and supervision training may offer tools to develop general PhD research supervision skills, but likely, such skills are to benefit from systematic consideration of experiences from fellow supervisors. This view is strengthened by the fact that, as Sustainable Product Innovation is still a relatively small field and multidisciplinary of nature as well, academic activities in these fields are often housed in environments that only provide one perspective, such as mechanical engineering, chemical process technology, industrial economics, machine design, product design, industrial ecology, or business management. Therefore PhD candidates as well as their supervisors are often surrounded by only few colleagues (or sometimes none) those meet the same academic challenges, e.g. building further on a research tradition, making use of previous departmental research results, using similar theoretical frameworks and similar networks.

Engineering Design and Product Development

Department of Management Engineering
Institute for Product Development
Norwegian University of Science and Technology
Chalmers University of Technology
Helsinki School of Economics
Lund University
Linköpings Universitet

Period: 01/08/2007 → 01/04/2008
Number of participants: 7
Project ID: Ingen DTU Projektnr. men NordForsk ref. 070038
Project participant:
McAloone, Tim C. (Intern)
Baumann, Henrikke (Ekstern)
Bey, Niki (Intern)
The objectives of this project are to examine and identify the driving factors behind innovation, to involve and tap into all potential stakeholders in society and to leverage good practices and new measures into national and regional innovation policies. Activities carried out within the project include an identification of all potential innovators in society, from school children to advanced research laboratories and from the curious human being to front-runners among innovative enterprises. Innovators of all levels will be brought together and public-private innovation partnerships will be promoted. The aim is to enable an exchange of experiences and attitudes towards creativity, promote new constellations of collaboration and enhance inventiveness within and across business sectors, scientific fields, education, public sectors and virtual communities.
Foresight for Innovators
Department of Management Engineering
Period: 01/05/2005 → 02/03/2011
Number of participants: 6
Phd Student: Munnecke, Max (Intern)
Supervisor: Jørgensen, Ulrik (Intern)
Main Supervisor: Lenau, Torben Anker (Intern)
Examiner: McAlone, Tim C. (Intern)
Hekkert, Paul (Ekstern)
Morelli, Nicola (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Modellering af strategier til service orienteret produktudvikling
Department of Management Engineering
Period: 01/05/2005 → 30/06/2010
Number of participants: 6
Phd Student: Tan, Adrian Ronald (Intern)
Supervisor: Andreasen, Mogens Myrup (Intern)
Main Supervisor: McAlone, Tim C. (Intern)
Examiner: Lenau, Torben Anker (Intern)
McMahon, Christopher Alan (Ekstern)
Weber, Christian (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut/centerfinansieret
Project: PhD

Udvikling af en metodisk tilgang til skabelse af bæredygtige produkt/service-systemer
Department of Management Engineering
Period: 01/02/2005 → 02/09/2009
Number of participants: 5
Phd Student: Matzen, Detlef (Intern)
Main Supervisor: McAlone, Tim C. (Intern)
Examiner:
Nielsen, Susanne Balslev (Intern)
Evans, Stephen (Ekstern)
Larsson, Tobias Christoffer (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD
Referencearkitektur for produktplatforme og produktionsprocesser

Department of Management Engineering
Period: 01/09/2004 → 09/06/2010
Number of participants: 6
Phd Student:
Pedersen, Rasmus (Intern)
Supervisor:
McAloone, Tim C. (Intern)
Main Supervisor:
Mortensen, Niels Henrik (Intern)
Examiner:
Hildre, Hans Petter (Ekstern)
Kyvsgaard Hansen, Poul (Intern)
Johannesson, Hans L. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU, Samfinansiering
Project: PhD

SPACES

SPACES

Department of Management Engineering
Department of Mechanical Engineering
Period: 01/12/2002 → 01/12/2007
Number of participants: 8
Project participant:
Broberg, Ole (Intern)
Jørgensen, Michael Søgaard (Intern)
Yoshinaka, Yutaka (Intern)
Lindegaard, Hanne (Intern)
Lenau, Torben Anker (Intern)
McAloone, Tim C. (Intern)
Project Manager, organisational:
Jørgensen, Ulrik (Intern)
Clausen, Christian (Intern)

Financing sources
Source: [Ordinær drift UK 10]
Name of research programme: [Ordinær drift UK 10]
Project

SYNOPSIS : Udredningsarbejde vedrørende et rammesystem for Integreret Innovation i Produkt-, System- og Serviceudvikling

Engineering Design and Product Development

Department of Mechanical Engineering
Period: 01/01/2002 → 31/12/2004
Number of participants: 7
Project ID: 75312
Project participant:
Andreasen, Mogens Myrup (Intern)
Clausen, Christian (Intern)
Hansen, Claus Thorp (Intern)
Boelskifte, Per (Intern)
Hein, Lars (Intern)
Jørgensen, Ulrik (Intern)
Project Manager, organisational: 
McAloone, Tim C. (Intern)

Financing sources
Source: Forskningsprojekter - Andre ministerier og styrelser
Name of research programme: Forskningsprojekter - Andre ministerier og styrelser
Amount: 1,500,000.00 Danish Kroner

SYNOPSIS

Department of Management Engineering
Manufacturing Engineering
Department of Mechanical Engineering
Period: 01/12/2000 → 01/06/2006
Number of participants: 4
Project participant: 
Jørgensen, Ulrik (Intern)
Yoshinaka, Yutaka (Intern)
Project Manager, organisational: 
Clausen, Christian (Intern)
McAloone, Tim C. (Intern)

Financing sources
Source: Forsk. Andre statslige danske i øvrigt
Name of research programme: Forsk. Andre statslige danske i øvrigt
Amount: 400,000.00 Danish Kroner

Product/service-systems
This research project describes the efforts made in the direction of service-oriented product development, and has phd-projects, final year projects, industry research collaboration and teaching activities within it.

Department of Mechanical Engineering
Period: 01/01/2000 → 01/01/2014
Number of participants: 5
Acronym: PSS
Project participant: 
Andreasen, Mogens Myrup (Intern)
Tan, Adrian Ronald (Intern)
Matzen, Detlef (Intern)
Bey, Niki (Intern)
Project Manager, organisational: 
McAloone, Tim C. (Intern)

Financing sources
Source: Udenfor rammen
Name of research programme: Ukendt

Activities:

Sustainability-Driven Innovation through Product-Service Systems (External organisation)
Period: 20 Dec 2012
Tim C. McAloone (External examiner)
Department of Mechanical Engineering
Characterisation of best practices in eco-design for the training of engineering designers: Summary of dimensions, methods, tools and activities (External organisation)
Period: 11 Oct 2012
Tim C. McAloone (Participant)
Department of Mechanical Engineering

Ecodesign Implementation for complex industrial systems: From scenario-based LCA to the definition of an eco-innovative R&D projects portfolio (External organisation)
Period: 28 Sep 2012
Tim C. McAloone (External examiner)
Department of Mechanical Engineering

Charting of ecodesign experiences, needs and perspectives
Period: 20 Sep 2012
Tim C. McAloone (Keynote speaker)
Department of Mechanical Engineering

Product/Service-Systems Design from an Engineering Perspective
Period: 19 Sep 2012
Tim C. McAloone (Keynote speaker)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
Guest lecture to Taiwanese delegation at CIID, Denmark

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Product/Service-System Strategies, Design and Markets
Period: 9 Sep 2012
Tim C. McAloone (Speaker)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
Lecture in seminar series: "Seminars across Design, Production and Service Systems"
Links:
http://podcast.llab.dtu.dk/feeds/seminars-across-design-production-and-service-systems/ (Video of lecture)

Related event
Seminars across Design, Production and Service systems
09/10/2012 → …
Kongens Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

Open innovation practices in a cluster context: A Medicon Valley case study
Period: 29 Aug 2012
Tim C. McAloone (Keynote speaker)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
Guest Lecture for "Network for Point of Care: from Idea to Market"

Related event
Network for Point of Care: From Idea to Market
29/08/2012 → …
Hørsholm, Denmark
Activity: Talks and presentations › Conference presentations

NordDesign 2012
Tim C. McAlone (Participant)
Department of Mechanical Engineering
Engineering Design and Product Development

Related event
NordDesign 2012
22/08/2012 → 24/08/2012
Aalborg, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
Ecodesign workshop
Tim C. McAloone (Organizer)
Department of Mechanical Engineering
Engineering Design and Product Development

Related event
Ecodesign workshop: Natura
25/06/2012 → 29/06/2012
São Paulo, Brazil
Activity: Attending an event › Participating in or organising a conference

Strategic approaches to product/service-systems: Strategy, design and practice
Period: 5 Jun 2012 → 6 Jun 2012
Tim C. McAloone (Lecturer)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
Guest lecture, Ruhr-Universität Bochum, Germany

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Teaching, learning and creativity (UDTU): Examples from the lecture theatre – and the design studio
Period: 27 May 2012
Tim C. McAloone (Speaker)
Department of Mechanical Engineering
Engineering Design and Product Development

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

12th International design conference
Period: 21 May 2012 → 24 May 2012
Tim C. McAloone (Participant)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
Speaker, chairman, keynote speaker, member of scientific committee

DESIGN 2012

Related event
12th International design conference
21/05/2012 → 24/05/2012
Dubrovnik, Croatia
Activity: Attending an event › Participating in or organising a conference
Ecodesign Maturity Model: a framework to support companies in the selection and implementation of ecodesign practices (External organisation)
Period: 14 May 2012
Tim C. McAloone (Participant)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
PhD examination committee, University of São Paulo, Brazil

Body type: PhD Committee
Degree of recognition: International

Related external organisation

Ecodesign Maturity Model: a framework to support companies in the selection and implementation of ecodesign practices
Activity: Membership › Membership in review committee

PSS Workshop Series
Period: 11 May 2012
Tim C. McAloone (Participant)
Department of Mechanical Engineering
Engineering Design and Product Development

Related event

PSS Workshop Series: BTH, Sweden
10/05/2012 → 11/05/2012
Karlskrona, Sweden
Activity: Attending an event › Participating in or organising a conference

PROTEUS-Workshops
Period: 20 Mar 2012
Tim C. McAloone (Organizer)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
PROTEUS Stormøde

Related event

PROTEUS-Workshops: Stormøde 4
20/03/2012 → ...
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

Environmentally conscious design of medical devices (External organisation)
Period: 13 Mar 2012
Tim C. McAloone (Chairman)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
PhD examination committee, Cambridge University, UK

Body type: PhD Committee
Degree of recognition: International

**Related external organisation**

**Environmentally conscious design of medical devices**
Activity: Membership › Membership in review committee

**Creating a business plan**
Period: 6 Mar 2012
Tim C. McAloone (Lecturer)
Department of Mechanical Engineering
Engineering Design and Product Development

**Description**
Guest lecture to course on Innovation in product development

**Related external organisation**

**Unknown external organisation**
Activity: Talks and presentations › Conference presentations

**Cranfield IMRC PSS Dissemination Day**
Period: 22 Feb 2012
Tim C. McAloone (Participant)
Department of Mechanical Engineering
Engineering Design and Product Development

**Description**
Cranfield’s Innovative Manufacturing Centre’s Product-Service Systems (PSS) Dissemination Day

**Related event**

**Cranfield IMRC PSS Dissemination Day**
22/02/2012 → 22/02/2012
Cranfield, United Kingdom
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**A Value-centric Decision Making Framework for Maintenance Services Outsourcing (External organisation)**
Period: 21 Feb 2012
Tim C. McAloone (Chairman)
Department of Mechanical Engineering
Engineering Design and Product Development

**Description**
PhD thesis examination, Cranfield University

Body type: PhD Committee
Degree of recognition: International

**Related external organisation**

**A Value-centric Decision Making Framework for Maintenance Services Outsourcing**
Activity: Membership › Membership in review committee

**The Future of Eco-Innovation**
Period: 19 Jan 2012 → 20 Jan 2012
Tim C. McAloone (Participant)
Department of Mechanical Engineering
Engineering Design and Product Development

**Description**
The Future of Eco-Innovation: The Role of Business Models in Green Transformation
OECD/European Commission/Nordic Innovation Joint Workshop

**Links:**
http://www.oecd.org/innovation/green

**Related event**
The Future of Eco-Innovation: The Role of Business Models in Green Transformation
19/01/2012 → 20/01/2012
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Product/service-systems design and engineering: at Human Factors in Service Engineering Course, San Jose State University, USA**
Period: 14 Nov 2011
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

**Description**
Place: San Jose State University, USA

**Related external organisation**
Unknown external organisation
Activity: Talks and presentations › Conference presentations

**Sustainable Product/Service Innovation: at BiD Seminar, Berkeley Institute of Design, USA**
Period: 1 Nov 2011
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

**Description**
Place: Berkeley Institute of Design (BiD) Lab, USA

**Related external organisation**
Unknown external organisation
Activity: Talks and presentations › Conference presentations

**Eco-Innovation in the Value Chain; 1: at "Engineering for the 21st Century", University of São Paulo**
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

**Description**
Place: University of São Paulo, Brazil

**Related external organisation**
Unknown external organisation
Activity: Talks and presentations › Conference presentations
**Product/Service-Systems as an Innovation Competency: Theory, Cases and Reflections**

**Period:** 11 Oct 2011  
**Tim C. McAloone (Speaker)**  
**Department of Management Engineering**  
**Engineering Design and Product Development**

**Description**  
Place: IBM Almaden, San Jose, USA

**Related external organisation**

**Unknown external organisation**  
Activity: Talks and presentations › Conference presentations

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**Sustainable Product/Service Innovation (DesignX): From Buzzword to Business**

**Period:** 28 Sep 2011  
**Tim C. McAloone (Speaker)**  
**Department of Management Engineering**  
**Engineering Design and Product Development**

**Description**  
Place: DesignX Forum, Stanford University, USA

**Related external organisation**

**Unknown external organisation**  
Activity: Talks and presentations › Conference presentations

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**18th International Conference on Engineering Design: Impacting Society Through Engineering Design**

**Period:** 15 Aug 2011 → 19 Aug 2011  
**Tim C. McAloone (Organizer)**  
**Department of Management Engineering**  
**Engineering Design and Product Development**

**Description**  
Impacting Society Through Engineering Design Design has a central role in bringing engineering and technology to practical use. We have chosen, therefore, that ICED11 will focus on balancing the societal impact of engineering design. Message from the Chair On welcoming you to the eighteenth International Conference on Engineering Design, ICED11, it can safely be stated that engineering design research is firmly established as a strong research discipline. As design researchers, design practice is our research object and industry companies are our research laboratories. Based on our observations, discussions and participation in design activities, we gather knowledge and insights and crystallise these into both academic models and practical methods. Our customers are students, training to be the product developers and innovators of the future, and industrialists, engaging with us to get insight into tools and methods, which fit to their practices and empower them to meet the challenges of global competition. The theme we have chosen for ICED11 is Impacting Society through Engineering Design. Design has a central role in bringing engineering and technology to practical use. We are expecting that each of the papers and presentations at the conference will provide its own contribution to the ICED11 theme. We’re delighted to see the variety and the quality of contributions that our colleagues from the design research community have submitted to ICED11. In its 30 year history this is the first time that an ICED conference has returned to the same city, “Wonderful Copenhagen”. In the Danish official ‘Year of Design’ the city is the perfect conference location, hosting the highest quality design, ranging from industrial design, through stunning architecture, to a dynamic engineering design industry, which has extensively backed ICED11. We have taken great care to create a conference showing leading edge research into engineering design and product development practice and to provide a lively backdrop for knowledge exchange and research discussion. Our goals with ICED11 have been to place particular emphasis on industry participation, provocative and relevant keynote speeches, maximum time for debate and discussion, and space to go in to depth, via the SIG workshops. And all this with a Danish flavour, which we hope you find welcoming, fun and “hyggeful”! Welcome to ICED11!

**Links:**
http://www.iced11.org (EXT-OA)

**Related event**
5th Annual New Product Development Strategies Conference; 5
Period: 8 Jun 2011 → 10 Jun 2011
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Description
This 5th annual marcus evans conference will offer a unique focus on advanced NPD strategies, with significant attention to understanding the consumer trends, internal and external linkages in NPD and to gain competitive advantage through sustainable innovation. This conference will help you to assess global opportunities and to launch winning products through advanced tools and methodologies.

Related event
5th Annual New Product Development Strategies Conference; 5: Achieving Profitability by Perfecting NPD Process and Balancing the Need of Speed and Innovation
08/06/2011 → 10/06/2011
Amsterdam, The Netherlands
Activity: Talks and presentations › Conference presentations

Strategic approaches to product/service-systems design: Guest lecture, Ruhr-Universität Bochum
Tim C. McAloone (Guest lecturer)
Department of Management Engineering

Related external organisation
Ruhr-Universität Bochum
Bochum, Germany
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Transport Innovation Network
Period: 24 May 2011
Tim C. McAloone (Participant)
Department of Management Engineering

Description
Transport Innovation Network (TINV): Advisory Group Meeting
Place: TINV, Copenhagen, Denmark

Related event
Transport Innovation Network: Advisory Group Meeting
24/05/2011 → 24/05/2011
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Teaching, learning and creativity (UDTU): Examples from the lecture theatre – and the design studio
Period: 13 May 2011
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

**Description**
Place: Technical University of Denmark

**Related external organisation**

**Unknown external organisation**
Activity: Talks and presentations › Conference presentations

**Welfare Technology (VelTek)**
Period: 12 Apr 2011
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

**Related external organisation**

**VVS og EL-tekniske Leverandørs Brancheforening**
Denmark
Activity: Talks and presentations › Talks and presentations in private or public companies and organisations

**Ecodesign: Tools, Cases and Future Scenarios**
Period: 31 Mar 2011
Tim C. McAloone (Lecturer)
Department of Management Engineering
Engineering Design and Product Development

**Related external organisation**

**BK Medical**
Denmark
Activity: Talks and presentations › Talks and presentations in private or public companies and organisations

**Sustainable Design: Experiences and reflections from research, teaching and consultancy**
Period: 28 Feb 2011
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

**Related external organisation**

**TU-München, Germany**
Activity: Talks and presentations › Talks and presentations in private or public companies and organisations

**PROTEUS: Product/service innovation in the maritime branch**
Period: 7 Dec 2010
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

**Related external organisation**

**Danish Maritime Association, Copenhagen, Denmark**
Activity: Talks and presentations › Talks and presentations in private or public companies and organisations
Product Development Day (PU-Dagen)
Period: 1 Dec 2010
Tim C. McAloone (Organizer)
Department of Management Engineering
Engineering Design and Product Development
Links:

Related event

Product Development Day (PU-Dagen): Product Development and Productivity
01/12/2010 → 01/12/2010
Technical University of Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Product/service-system design strategies
Period: 16 Nov 2010
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation

Linköping University
Sweden
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Teaching, learning and creativity (UDTU): Examples from the lecture theatre – and the design studio
Period: 12 Nov 2010
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Description
Place: Technical University of Denmark

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Decision Support for Sustainable Value Chains – DecSUS 2010-2013 (Event)
Period: 20 Oct 2010
Tim C. McAloone (Reviewer)
Department of Management Engineering
Engineering Design and Product Development

Description
Decision Support For Sustainable Value Chains (DecSUS); 1: Advisory Group Meeting

Place: Blekinge Tekniska Högskolan, Sweden
Links:
http://www.bth-collaboration.se/~decsus (EXT-OA)

Related event
Management: Creating results together with others
Period: 20 Sep 2010 → 22 Sep 2010
Tim C. McAloone (Participant)
Department of Management Engineering
Engineering Design and Product Development

Description
Management: Creating results together with others

Place: Technical University of Denmark

Related event
Management: Creating results together with others
20/09/2010 → 22/09/2010
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Strategic approaches to product/service-systems
Tim C. McAloone (Keynote speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation
University of Tartu
Estonia
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Innovation with perspective
Period: 9 Aug 2010
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation
The Copenhagen School of Marine Engineering and Technology Management
DK 2800, Kgs. Lyngby, Denmark
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Sustainable Design (MMT): How well prepared are we, methodically speaking?
Period: 8 Apr 2010 → 9 Apr 2010
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation
Aalborg University
A.C. Meyers Vænge 15, 2450 Copenhagen SV, Aalborg, Denmark
Activity: Other
Sustainable Design: Taking the challenge into product development
Period: 25 Mar 2010 → 26 Mar 2010
Tim C. McAloone (Keynote speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation
University of Zagreb
Croatia
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Workshop on sustainable product service system development (EAFIT)
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related event
Workshop on sustainable product service system development (EAFIT)
10/08/2009 → 13/08/2009
EAFIT, Colombia
Activity: Talks and presentations › Conference presentations

Implementing Sustainable Design Strategies
Period: 24 Jun 2009
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation
Danfoss AS
Denmark
Activity: Talks and presentations › Talks and presentations in private or public companies and organisations

Meeting the challenges and opportunities of sustainability through mechatronic product development (IMechE): UK Mechatronics Forum Prestige Lecture
Period: 14 May 2009
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation
Institution of Mechanical Engineers
1 Birdcage Walk, Westminster, SW1H 9JJ, London, United Kingdom
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Motivation and tools for ecodesign
Period: 23 Oct 2008
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related event

Motivation and tools for ecodesign
23/10/2008 → 23/10/2008
Danish Standards Association
Activity: Talks and presentations › Conference presentations

Can innovation processes be standardised?
Period: 8 Oct 2008
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related event

Can innovation processes be standardised?: Inspiration from industry cases
08/10/2008 → 08/10/2008
Danish Enterprise and Construction Authority
Activity: Talks and presentations › Conference presentations

Innovation i energisektoren
Period: 20 Aug 2008
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related event

Innovation i energisektoren: Informationsmøde om energiforskningsprogrammerne 2008
20/08/2008 → 20/08/2008
Energinet.dk, Fyn, Denmark
Activity: Talks and presentations › Conference presentations

Product/service-systems
Period: 19 Feb 2008
Tim C. McAloone (Speaker)
Department of Management Engineering
Engineering Design and Product Development

Related external organisation

Norwegian University of Science and Technology
Trondheim, Norway
Activity: Other

Marketings role and involvement in product development
Period: 17 Jan 2008
Tim C. McAloone (Lecturer)
Engineering Design and Product Development
Department of Management Engineering

Related event

Marketings role and involvement in product development: When and how?
17/01/2008 → 17/01/2008
Design Society Advisory Board (External organisation)
Period: Aug 2007 → …
Tim C. McAloone (Participant)
Department of Mechanical Engineering
Engineering Design and Product Development

Description
The Design Society is an international non-governmental, non-profit making organisation whose members share a common interest in design. It strives to contribute to a broad and established understanding of all aspects of development and design, and to promote the use of results and knowledge for the good of humanity.

The Advisory Board advises, guides and supports the Board of Management in developing and furthering the aim and objectives of the Society. It does this by bringing forward for consideration by the Board of Management any item of business or topic pertinent to the Society. Recommendations made by the Advisory Board are not binding on the Board of Management.

The Advisory Board consists of the President or President’s nominee and up to twenty seven members of the Society. The members of the Advisory Board are elected democratically by the members of the Society at the General Meeting, which is called every two years during ICED conferences. The normal term of an Advisory Board member is six (6) years with opportunity for one further term.
The Advisory Board is managed by a Chair, who is responsible for organising the annual meeting of the Advisory Board. The Chair is elected by the members of the Advisory Board. The office of the Chair is limited to two terms of two years.

Body type: Research Association
Degree of recognition: International
Links:
http://www.designsociety.org

Related external organisation
Design Society Advisory Board
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Press clippings:

Ecodesign: A Challenge for Product Developers: Interview with Eco-designer Tim McAloone
Tim C. McAloone
01/10/2010
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Ecodesign: A Challenge for Product Developers: Interview with Eco-designer Tim McAloone
01/10/2010
Sweden, Print
http://www.mypaper.se/show/semcon/show.asp?pid=345278646566178&page=30
EXT-OA
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Virksomheder skeptiske over for vugge til vugge
Tim C. McAloone
16/10/2009
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Virksomheder skeptiske over for vugge til vugge
16/10/2009
Denmark, Print
http://ing.dk/artikel/103210-virksomheder-skeptiske-over-for-vugge-til-vugge
EXT-OA
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Sæt serviceudviklingen i system
Tim C. McAloone
07/05/2009
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Sæt serviceudviklingen i system
07/05/2009
Denmark, Print
http://ing.dk/artikel/98467-saet-serviceudviklingen-i-system
EXT-OA
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Produktservice kan skrue op for virksomhedernes indtjening
Tim C. McAloone
07/05/2009
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Produktservice kan skrue op for virksomhedernes indtjening
07/05/2009
Denmark, Print
http://ing.dk/artikel/98462-produktservice-kan-skrue-op-for-virksomhedernes-indtjening
EXT-OA
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Fra skrald til guldgrube
Tim C. McAloone
30/03/2009
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Fra skrald til guldgrube
30/03/2009
Denmark, Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Fremtidens sofa under miljølup
Tim C. McAloone
16/02/2009
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Fremtidens sofa under miljølup
16/02/2009
Det er gratis at tænke miljø ind i produktet
Tim C. McAloone
05/12/2008
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Det er gratis at tænke miljø ind i produktet
05/12/2008
Denmark, Print
http://ing.dk/artikel/93915-det-er-gratis-at-taenke-miljoe-ind-i-produktet
EXT-OA
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development

Miljøforbedringer gennem produktudvikling betaler sig
Tim C. McAloone
01/12/2008
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Miljøforbedringer gennem produktudvikling betaler sig
01/12/2008
Denmark, Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development

Press / Media

Kunde og leverandør har fælles interesse i partnerskaber – Interview med Tim McAloone
Tim C. McAloone
01/11/2008
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Kunde og leverandør har fælles interesse i partnerskaber – Interview med Tim McAloone
01/11/2008
Denmark, Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development

Press / Media

Små virksomheder er afhængige af internationale netværk
Tim C. McAloone
06/06/2008
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Små virksomheder er afhængige af internationale netværk
06/06/2008
Denmark, Print
http://ing.dk/artikel/88726-smaa-virksomheder-er-afhaengige-af-internationale-netvaerk
EXT-OA
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Klimåøkonomien kræver nye forretningsmodeller
Tim C. McAloone
26/05/2008
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Produkter til den tredje miljøbølge
Tim C. McAloone
23/05/2008
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Den tredje miljøbølge
Tim C. McAloone
23/11/2007

Description
Note: in Ingeniørens produktudviklingsmagasin
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Det faste forhold som forretningsmodel
Tim C. McAloone
29/01/2007
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Design skal få verden til at bære over med os
Tim C. McAloone
Design skal få verden til at bære over med os
22/12/2006
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

En bæredygtig kontorstol
07/11/2006
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Miljømærker fortæller kun den halve sandhed
23/09/2006
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Globalt treholdsskift øger effektiviteten
26/05/2006
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Verdens 20 Mest Innovative Virksomheder
03/04/2006
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media
Verdens 20 Mest Innovative Virksomheder
03/04/2006
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

DTU i spidsen for miljørigtig konstruktion
17/03/2006
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Sustainability as a driver for innovation
13/11/2005
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Livskvalitet driver fremtidens milliardindustrier
12/09/2005
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media
Nye opfindelser på rekordtid
Tim C. McAloone
06/06/2005
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Nyt center skal nytænke produktudvikling
Tim C. McAloone
11/04/2005
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Produktudviklingslandkortet placerer kompetencerne
Tim C. McAloone
01/12/2004
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

DTU har lavet landkort over dansk innovation
Tim C. McAloone
28/08/2004
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Det er muligt at gøre en forskel
Tim C. McAloone
27/08/2004
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)
Det er muligt at gøre en forskel
27/08/2004
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Jagten på innovationen
Tim C. McAloone
27/08/2004
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Jagten på innovationen
27/08/2004
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Bilfabrikker som forbillede for produktudvikling
Tim C. McAloone
02/05/2004
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Bilfabrikker som forbillede for produktudvikling
02/05/2004
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Alarmerende behov for nye udviklingsmetoder
Tim C. McAloone
28/02/2003
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Alarmerende behov for nye udviklingsmetoder
28/02/2003
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media

Produktudvikling der støver
Tim C. McAloone
28/09/2001
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Produktudvikling der støver
28/09/2001
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media
Miljø-design kræver ny strategi
Tim C. McAloone
26/05/2000
Department of Management Engineering, Engineering Design and Product Development

Media contribution (1)

Miljø-design kræver ny strategi
26/05/2000
Print
Tim C. McAloone
Department of Management Engineering, Engineering Design and Product Development
Press / Media