

## **ENABLING PRODUCT-SERVICE SYSTEM DEVELOPMENT USING CREATIVE WORKSHOPS: EXPERIENCES FROM INDUSTRY CASES**

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### **1. Introduction**

Manufacturing industries are undergoing a transition from the manufacturing of products towards the integration of services and providing Product-Service Systems (PSS) [Baines et al. 2007], [Morelli 2002] and [Tukker and Tischner 2006]. When buying a new car today for example, you do not only get the hard product of a vehicle but you can receive several offers that enhances the value of the car such as software products, service deals, insurance packages and applications, making the car not only a product, but a product-service system. PSS delivers more customized solutions since it puts more focus on the use and functionality of the product, rather than the actual product itself [Tukker and Tischner 2006]. PSS can therefore be said to respond more appropriately to the demands of today than existing systems of mass production [Mont 2002].

There are several examples of companies in different industries that are going through, or have gone through this transition. Volvo Group's vision is "*to become the world leader in sustainable transport solutions*" [AB Volvo 2011]. To deliver solutions rather than products changes the perspective within product development since it is the function of the product that is sold rather than the technical dimensions of it. The product is delivered in a package together with software and services, which also needs to be considered during the development of the product.

In the aerospace industry the increasing service integration can be exemplified with TotalCare® offers by Rolls Royce [Baines et al. 2007], where airlines pay for services in a package together with the product. There is an extended value in offering commitment and availability compared to the sale and purchase of a traditional product. However, the industry still focuses on the traditional product concepts where e.g. lifecycle services such as supply of spare parts, repairs and maintenance are additional.

The differences between products and services concerns how they are produced, delivered and consumed [Brezet et al. 2001], which means that the integration of services in manufacturing industries challenges the way established companies work [Mont 2002]. PSS opens up the problem space when the solution to the problem not only concerns designing a product, but also includes design of services. Developing PSS involves integrating expertise from both service and product development.

The aim with this research is to support the transition towards development of PSS in industry. Therefore the purpose of this paper is to contribute to understanding of the challenges companies face in such transition, and to test methods that could support the teams responsible for developing PSS. Creative workshops are an example of such a methodology and therefore the research question for this paper is: *How can PSS development be supported by creative workshop methods?*

In this paper a number of creative methods were selected for testing since they were found to respond to the challenges of developing PSS. The selected methods have then been tested in two actual industrial cases, with teams working on PSS issues at present. The first case is a business-to-business (B2B) company in the aerospace industry and the second is a business-to-consumer (B2C) company in the automotive industry.

## 2. Theoretical framework

In the theoretical framework the challenges in PSS are first identified, followed by an introduction regarding creative problem solving methods.

### 2.1 Product-Service System (PSS)

Products are physical, tangible, concrete artifacts while services on the other hand are intangible [Morelli 2002]. A Product-Service System (PSS) is an integrated combination of products and services. By incorporating additional services to a product, it extends the traditional functionality of the product, and the customer needs are fulfilled by providing functionality or satisfaction rather than selling a product [Tukker and Tischner 2006].

There are many reasons for a company to integrate services into their product concepts. For instance, Baines et al [2007] highlight that PSS is an improvement in total value for the customer. According to Tukker and Tischner [2006] PSS delivers more customized solutions, lowers system costs by more efficient use of product, improves the position in the value chain and hence have the potential to enhance competitiveness of a firm. Reviewing the literature on PSS three main differences between products and services can be identified:

- **Time Perspectives:** Products are first produced, then used, whereas services are produced, and used, at the same time [Morelli 2002]. Product design have long lead time, service design have short lead times, and products are therefore hard to adjust to a changing environment; while services are easy to adjust to a changing environment [Brezet et al 2001].
- **Ownership:** Products and services are conducted by different areas of expertise; products are conducted by product developers and technicians; whereas services are conducted by marketers, business administrators and service providers [Brezet et al 2001]. The ownership of a product is transferred to the customer when the product is sold; whereas the ownership of a service is not generally transferred [Morelli 2002].
- **Design:** PSS focuses on providing value in use to the customer [Baines et al 2007] through both tangible product and intangible services [Morelli 2002]. Therefore PSS have both the hard technical variables of a product (material, dimensions etc.) and the soft variables of services (time, place etc.) [Brezet et al 2001].

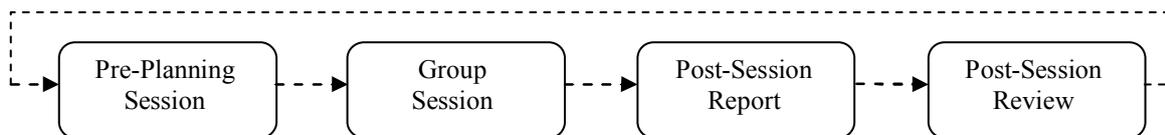
The difference between products and services implies barriers for the development of PSS. [Brezet et al. 2001] point out barriers regarding idea generation, since the innovation of a system is complex and at a higher level of abstraction. Further, they point out that the transition from idea to design can be hard to translate since requirements for both products and services should be included, and the product and service characteristics will influence each other.

### 2.2 Creativity methods

Creativity is according to [Amabile 1998] a combination of expertise, motivation, and creative thinking skills. Important aspects in the work of finding creative solutions are to understand the situation today, to seek future opportunities, and to intelligently create innovations [Foresight and Innovation 2011]. Creativity methods can be used when there is a wish to develop more innovative ideas, and for example stretch or break the present paradigm [McFadzean 1999]. Examples of creativity methods are brainstorming, S-curves, Janus Cones, and Future Users. Brainstorming is a commonly used creative problem-solving method, where the participants should go for quantity, be open to unusual ideas and not criticize, and try to combine and improve ideas [McFadzean 1999]. S-curves (or Progression Curves) can be used to visualize technological and social changes over time, and Janus Cones can be used for looking both backward and forward in time in order to identify

historical events and how timing affects potential future events [Foresight & Innovation 2011]. Future Users explores the potential future of demographically interesting people through making comparisons to similar groups over time [Foresight and Innovation 2011]. Further, prototyping can be used to design new products, services, business models etc. and it helps to resolve complex problems since “good prototypes don’t just communicate – they persuade” [Kelley 2001, pp. 39]. For instance, 3D paper mock-ups can support communicating new concepts using inexpensive material [Foresight and Innovation 2011].

Creative problem-solving methods can be applied in a workshop format. Arranging such workshops for creative solving problems requires excellence in preparations, performance, and follow-up. Therefore, [McFadzean and Nelson 1998] suggest using a four-step model: pre-planning the activity, conducting the problem-solving session, producing a post-session report, and perform a post-review session (Figure 1). They also emphasize the importance of the competence of the facilitator to handle the dynamics in the problem-solving session.



**Figure 1. A model for facilitating a problem-solving session [McFadzean and Nelson 1998]**

### 3. Research approach

This section presents the research approach, including the research setting and the study design chosen in the empirical studies.

#### 3.1 Research setting

The research has been conducted as a cross-case study encompassing empirical studies within two Swedish industrial companies. First, Volvo Aero Corporation (VAC) develops and manufactures components in the aerospace industry, such as engines to military aircrafts, components to commercial aircraft engines, and subsystems for rockets. The company has a history of technology development and has recently moved into a position as a provider of solutions, integrating more services to the product concepts. Second, Volvo Car Corporation (VCC) is an automotive company that develops cars for the global market. VCC is also affected by the raised demands on services related to their products, where for instance the customers want increased connectivity.

The two companies represent business-to-business (B2B) as well as business-to-customer (B2C), and each workshop topic was selected together with each case company, based on the fact that both topics were related to PSS-development. Both workshop topics were already subjects for ongoing development work, however in a need for some vital injections and therefore it was decided to approach the topics with a workshop including creativity methods. Hence, each workshop topic was strongly related to needs of each case company. The topic of the VAC workshop was extended service offers related to the utilization of data collected from the calculations of life consumption of jet-engines. The topic of the workshop at VCC was to create extended service offers to end customers through connecting the product and e.g. social media. An overview of the setting of the workshop cases is found in Table 1.

**Table 1. The workshop cases**

	Workshop 1	Workshop 2
Company	Volvo Aero Corporation (VAC)	Volvo Car Corporation (VCC)
Industry	Aerospace	Automotive
Type of business	B2B	B2C
Number of participants	8	9
Number of facilitators	3	2
Topic	Service offers connected to the Life Tracking System (LTS)	Connected Service Business
Duration	4h	3.5h

Purposive samplings of the participants were made together with the topic owner from each company in order to combine different areas of expertise. The chosen participants can mainly be described as the current working groups reinforced by selected individuals who were specifically interesting for the workshop topic. The workshop topics were chosen from actual problems in the case companies that inherently gave a motivation for engagement in the workshops. Applying creativity methods to support the creative thinking skills were used to achieve creative problem solving. Hence, Amabile's [Amabile 1998] recommendation to combine expertise, motivation and creative thinking skills was aimed for.

The research team consisted of the two authors of the paper, who were taking part in both workshops as facilitators. The first author is employed in VAC and the second author is employed in VCC, which gives an insider/outsider collaboration in both cases. A benefit of an insider/outsider collaboration is the combination of the insider's pre-knowledge of the organization and problem, and a more objective view of the outside researcher. The two workshops were held on the premises of each case company and were performed three months apart.

The needs of the companies affected the choice of methods used in the workshops and the time scale of the workshops. For instance, at VAC there were initial requests to spend time to identify stakeholders and their needs.

### **3.2 Study design**

This research had a practice-centered perspective and on an overall level the researchers used McFadzean and Nelson's [McFadzean and Nelson 1998] model of pre-planning the activity, conducting the problem-solving session, producing a post-session report, and performing a post-review session (Figure 1).

#### *3.2.1 Pre-planning*

In order to find sufficient creativity methods addressing issues that development teams in industry are facing, the research team performed a mapping based on the characteristics of PSS and what was found on creative methods in literature (Table 2). As a base three characteristics of PSS found in literature was used (first column in Table 2). The literature study and discussions with the industry partners identified the challenges and needs of the organizations (second and third columns in Table 2). As a final step in creating a framework, creative methods were chosen for the workshops to address the identified challenges and needs (column four in Table 2).

**Table 2. Framework addressing PSS challenges**

Characteristics of PSS Origin: Literature	Challenges for organizations Origin: Literature + discussions with case companies	Needs of organizations Origin: Literature + discussions with case companies	Methods chosen Origin: Selection made by the research team in the pre-planning phase
Time perspectives	The transition towards PSS challenges the adaptability of the organization	Visualize history and future opportunities	Janus Cones
	The product is produced and used at different times, services are produced at the time they are used	Visualize time	Janus Cones
Ownership	Products and services are developed by different areas of expertise	Distributed participation	Purposive sampling of participants
	PSS reaches many areas and stakeholders	Identify stakeholder and their needs	Identification of stakeholder and their needs
	The designer of the service enables the client/user to participate/co-produce the final solution	Understand the customers/users and their needs	Personas /Future Users
Design	PSS focuses on providing value for both customer and enablers	Identify stakeholders and their needs	Identification of stakeholders and their needs
	PSS focuses on providing value in use to the customers rather than fulfilling technical requirements	Understand customers' needs	Personas/Future Users
	PSS include both the tangible product and intangible services and both hard and soft variables	Visualize value creation	Prototypes

Table 2 was used as an input for the design of the workshop schedules and the selection of methods to be used in each workshop (Table 3). The format and schedule of the two workshops were designed in a similar way.

**Table 3. Workshop schedules including methods**

	Workshop 1	Workshop 2
Introduction	Topic owner pitched the theme of the workshop	Topic owner explained the background to the workshop
Foresight/History	Janus Cones	Janus Cones
Identification of Stakeholder/ Customer and needs	Identification of stakeholders and their needs through brainstorming	Identification of customer needs through Personas/Future Users
Ideation of solution	Brainstorm	Brainstorm
Clustering and sampling	Yes	Yes
Prototype	Lego®	paper, pipe cleaners, corn puffs
Presentation and discussion	of prototypes	of personas and prototypes

### 3.2.2 Workshop session

The two workshops were held approximately according to the planned schedules. The workshops started with an introduction by the facilitators and the topic owner from the company who introduced the topic/background of the workshop. The first method used was Janus Cones in order to visualize a timeline with the history and future of the company's as well as other related areas of the topic. First, the participants wrote on post-its what happened in the past effecting the situation today and placed the post-its according to the time line in the Janus Cone. Second, participants wrote things they thought might happen in the future which was also placed in the Janus Cone timeline.

Because the first workshop was with a B2B company and the second workshop was with a B2C company the choice of methods to 'identify customers and needs' was different. For the first workshop (at VAC) the primarily focus was to identify different stakeholders of the product-service system, the secondary focus was on identifying the needs of these stakeholders. At the second workshop (at VCC) the priority was the opposite; the primary focus was on identifying the needs of a future user rather than finding many different types of future users. In the VAC workshop brainstorm was used to first identify stakeholders and then the needs of the stakeholders. In the VCC workshop the participant were divided into two groups to create Personas of today's customer, past customer and future customers and identify the needs, wants and demands of these Personas/Future Users.

With encouragement to reflect on the results from the previous activities, the workshops continued with brainstorming of solutions that would meet the needs of the stakeholders. The participants were also encouraged to build on each other's ideas, and to explore different opportunities. These different ideas to solutions were then clustered into groups and each cluster was addressed with a theme. The participants then had a discussion regarding what solutions could be done today and what could be done in the future. The participants were then divided into groups where each group picked a group of solutions to develop and prototype in order to visualize, and to present their prototype to the rest of the participants. In the VAC workshop the prototypes were built in Lego®, in the VCC workshop paper, pipe cleaners and corn puffs were used.

The workshops were rounded off with a discussion. The participants reflected upon what was most appealing about the solutions and prototypes, which captured feasibility and innovativeness of the presented solutions. Before they left the premises each participant filled out an individual written feedback form (Table 4). Additionally, the facilitators also made a written individual evaluation of the workshop, which was then discussed in the research team.

**Table 4. The participant evaluation form**

First reflection	Overall impression of workshop (just write down your first reflection)
Content	Describe the results of the workshop
	Did you, personally, get any new ideas – or thinking any new thoughts today?
	How are you going to act on the results of the workshop?
	Was the time well spent participating in this workshop?
Format of workshop	How did you experience the overall agenda of the workshop?
	How did you experience the methods used?
	Did you think the methods were appropriate for service development?
	What in the workshop helped you to understand how to create value for your customer? And Why?
	What could be improved? (What to do more? What to do less?)
	Feedback to facilitators (regarding professionalism, infusing energy etc.)
Any further comments	

Empirical data for the post-session review was collected during the workshop and included documentation from the workshops, as well as evaluations from participants and facilitators made directly after the workshops. Further, the facilitators took photos of the process and the activities, as well as made some notes during the session as input for the post-session review.

### *3.2.3 Post-session report*

After each workshop the facilitators compiled a post-session report that was sent to each case company. The reports encompassed the background of the topic, presentation of the results, descriptions of the working procedures during the workshop, a compilation of the participants' evaluations, and suggestions for the next step for the PSS teams within the companies.

### *3.2.4 Post-session review*

The last step in McFadzean and Nelson's [McFadzean and Nelson 1998] model is to perform a post-review session. In this post-review session the research team compiled evaluations (both from participants and facilitators), as well as the reports to case companies, and analyzed the workshop processes and results. The two cases were first analyzed separately then in a cross-case manner [Eisenhardt 1989], looking for similarities and differences. The research team made an analysis of the two workshops regarding what was better/worse in the preparations and performance of the workshops.

## **4. Experiences from conducted workshops**

This section presents the process in the workshop, the results that came out from the workshops, how the participants evaluated the workshops, and how the selected methods met the challenges of PSS development.

### **4.1 Overall process and results of the workshops**

Both workshops included participants from various departments within the companies and the participants were all in some way connected to the topic. The schedules were tight which kept the momentum going in the workshops. The Janus Cones resulted in a visual timeline of the history and potential future that illustrated the problem situation of today.

The VAC workshop resulted in the identification of different stakeholders (from airplane passengers to material suppliers) together with a large amount of needs connected to these stakeholders. These needs were clustered into theme groups (such as needs related to cost, business opportunities, sustainability, IT functionality, system functionality and safety). The VCC workshop resulted in two Personas of future customers (a buyer of a new car, and a buyer of a used car). Creating Personas/Future Users gave the participants a clear view of needs and demands of the customers.

The brainstorm activities for solutions resulted in a large amount of ideas on solutions to meet the identified future needs of the customer/stakeholders, which were all documented and included in the post-session report. Further, the participants clustered the solutions into groups and each cluster was addressed with a theme. At VAC themes such as partnerships business models, IT services and diagnostics were identified. In the VCC workshop there were also business model and service themes but also a theme related to social media. The feasibility of the solutions were discussed and based on this a number of solutions were selected for prototype building; such as service offers, business models or product-service systems. For example, one group at VCC presented solutions that enable cloud computing to improve fuel consumption, an important product attribute of a car. In addition, the workshops resulted in a broader understanding of the problem area and a shared knowledge between participants from different departments in the companies.

In the first workshop at VAC a break was placed between the brainstorm activity and the clustering of needs. The facilitators noted that the energy within the group was at a lower level after the break and during the clustering. Therefore, in the second workshop the facilitators instead placed the break a little earlier, before the brainstorm activity, in order to keep the high level of energy from the brainstorm during the clustering. However, the facilitators noted a similar drop of energy during the clustering activity in the second workshop.

### **4.2 Participants evaluations**

The participants at both workshops expressed that they were pleased with the workshop and they all considered that participating in the workshops were time well spent. Examples from the overall

evaluation from the first workshop were: “*Creative!*”, and “*Providing useful results*”, from the second workshop were “*High energy*”, “*Creative*”, and “*Interesting methodology*”. The participants found the workshops structured and well facilitated, despite the short timeframe and new methods.

Some participants would have appreciated more time to discuss and evaluate the solutions “*go a bit deeper in the actual conceptualization of a solution*”, while others thought the short timeframe was positive and liked the high pace. The time schedule in the second workshop became somewhat forced, since participants expressed a wish for an earlier end and the facilitators did not want people leave early – before the end of the workshop. However, the shortness of time kept the energy up through the whole workshop. The intention for both workshops was in fact to keep up a momentum. The goal was apparently achieved accordingly to what stated by one of the participants in the first workshop: “*Infusing energy was not needed to a large extent since the exercises were quite quick to perform why it never got boring*”.

The participants at both workshops rated the workshop format and the methods used in positive terms. At the first workshop the Janus Cones method was most appreciated by the participants. At the second workshop the method of creating Personas/Future Users was especially liked: the participants experienced it very positive to keep the customer in focus. The process of clustering solutions could, however, have been performed more smoothly according to the evaluations of the second workshop. From the first workshop, many participants appreciated the cross-collaboration between different people representing different parts of the organization. The participants of the second workshop experienced the possibility to think out of the box, and they all thought they succeeded in getting new ideas. However, in the second workshop it was commented that a more diverse group could have been composed to expand the scope and focus even more on things that was not previously known.

#### 4.3 Utilization of the selected methods

The creative workshops methods tested in this research have in different ways met the challenges of PSS development that the industries were facing. The workshops were analyzed using the framework presented earlier in the paper (Table 2), and the methods were utilized as follows:

- **Janus Cones:** visualized where the team had been, where they are today, how long it has taken them to get there and where they want to go from now. It put the company/team/PSS in relation to the context. It built on fact, which gave relevant estimations about the future. Additionally, the method enabled cross-learning between the participants regarding the history of the subject.
- **Purposive sampling of participants:** enabled knowledge transfer between the participants. Developing PSS requires new constellations of teams concerning expertise in product development, service development as well as marketing. Therefore, it was important to have the right participants from all concerned areas of the organization, even though some might have felt they were outside of “their area”.
- **Identification of stakeholders and their needs:** beyond the common setting, resulted in new perspectives of the problems. However, many stakeholders can be affected by the PSS; which makes it necessary to define the limitations of the problem scope.
- **Personas/Future Users:** focused on creating value for the customer by solving the problem of the future, i.e. neither yesterday’s nor today’s issues. However the facilitators found that there was a risk that the methods would be “too fun” and the team would end up with a cartoon character, and therefore the facilitators made the participants to focus more on the customer needs rather than customer characters.
- **Prototypes:** there were no problems building prototypes and models of services and business models. It did not matter what kind of material that was used, paper and pipe cleaners worked as well as Lego®. The prototypes summarized and visualized many of the ideas that arose during the workshop. Therefore, the presentation and discussions of the prototypes were a good and memorable ending of the workshops, supporting future implementation of the ideas.

Further, the clustering of ideas was the hardest part to facilitate during the workshops. The energy level dropped during the clustering of the ideas and this was independently of where the break was placed related to the clustering activity in the workshop schedule. However, the different levels of

energy are natural, and a drop in energy level is not necessarily a bad thing. Therefore, should the workshop facilitators be prepared that this probably will happen.

## 5. Discussion and conclusions

Guided by the research question “How can PSS development be supported by creative workshop methods?” we tested creative workshop methods to support teams developing PSS in two actual industrial cases of PSS development. This paper on collaborative research therefore contributes to an enhanced understanding of the challenges that industry faces when developing PSS. Based on the findings from the conducted workshops we can say that creative workshops can be seen as an enabler in PSS development (for both B2B and B2C companies) through the creation of a creative environment that enables a common understanding, knowledge transfer and creative ideation.

The challenges of PSS development identified and addressed in this study are based on the differences between products and services as well as the companies’ experiences. These challenges regard the different time perspectives on product and service development, the complex ownership (including many different stakeholders) of the PSS, and the design encompassing both tangible and intangible elements. Both aerospace and automotive industries are characterized by working in established structured processes. This therefore requires to challenge the rules and ways of working and not to let established structures such as traditional organizations and predefined product attribute profiles limit the creation of customer value.

This research points to the fact that creative methods, such as Janus Cones, Personas and Prototyping, are means that contribute in handling the identified PSS challenges. In order to achieve successful employment of such creativity methods in PSS development it is important to ensure that the right participants are present, that the topic is relevant for the participants, and that the design of the workshop suits the specific topic (e.g. choosing appropriate creativity methods for the topic, or reflecting that it is a B2B or B2C topic). Regarding the fluctuations of energy during the workshops, energy drops seems hard to avoid, and perhaps they should not be avoided. Based on the conducted workshops and the energy drop during the clustering, it can be concluded that the energy drop is not related to the placement of the breaks in schedule, rather it is a consequence of the converging nature of clustering activity. Therefore, drop in energy is not necessarily a sign of poor facilitation and a general learning is that the facilitators should be prepared for them, and accept them. Further, in the wrap-up of the conducted workshops the participants raised the issue regarding the risk that the workshops were single occasions: not creating long-lasting effects in the organization. Therefore, it is also important to appoint someone to take charge of the next step in order to ensure ownership over time.

Experiences from the two cases have implications for facilitating workshops regarding PSS development. Especially, it is important to pay extra attention to certain factors when conducting such workshops (compared to product development in a traditional sense):

- The visualization of time perspectives, since the time perspective can differ between products and services, i.e. select a creativity technique enabling this visualization.
- The sampling of participants, since PSS involves expertise from both product development, service development and business development, which can require new constellations within established organizations.
- The focus on customer needs and the creation of customer value, in order to combine the values from both products and services.
- The making of prototypes was successful, even though the facilitators had expected more difficulties prototyping PSS compared to prototyping tangible products.

The qualitative approach of conducting empirical studies in two case companies has inherent limitations, such as the inadequate ability of making generalizations of the results. However, such in-depth studies can definitely provide results that can be interesting for similar settings of PSS development.

This paper does not cover how and if the ideas were implemented and commercialized in the company, which is needed to evaluate the final quality of the PSS ideas. However, arranging creative workshops is one way to address the challenges with PSS; it does not solve the organizational issues

when transferring the established product development organization into a provider of PSS solutions but can be one means to support the individuals in such a transition. Therefore, finding other ways to support individuals over time in such an organizational transition can be an interesting strand for further research. Further, it would be interesting to follow-up the implementation of the PSS ideas erupted in the workshops as a next step in this research.

This research is limited to a few creative methods for workshops, but there are several others. It has also focused on early stages of development. However, interactive workshops set a foundation for the teams' future collaboration in later stages of the development process. Further research could therefore include other methods to support the PSS teams and also in other stages of the development process.

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### **References**

- AB Volvo*, [www.volvogroup.com/group/global/en-gb/volvo%20group/visionmission/pages/vision.aspx](http://www.volvogroup.com/group/global/en-gb/volvo%20group/visionmission/pages/vision.aspx) (retrieved 2011-11-30).
- Amabile, T.*, "How to kill creativity", *Harvard Business Review*, Vol.76, No.5, 1998, pp 77-87.
- Baines, T.S., Lightfoot, H.W., Evans, S., Neely, A., Greenough, R., Jeppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J.R., Angus, J.P., Bastl, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett, H., Martinez, V., Michele, P., Transfield, D., Walton, I.M., Wilson, H.*, "State-of-the-art in product-service systems", *J. Engineering Manufacture*, Vol.221, Part B, 2007, pp. 1543-1552.
- Brezet, J.C., Bijma, A.S., Ehrenfeld, J., Silvester, S.*, "The Design of Eco-Efficient Services", *Design for Sustainability Program, Delft University of Technology*, June 2001.
- Eisenhardt, K.M.*, "Building Theories from Case Study Research", *The Academy of Management Review*, Vol.14, No.4, 1989, pp. 532-550.
- Foresight & Innovation*, <http://foresight.stanford.edu> (retrieved 2011-11-14).
- Kelley, T.*, "Prototyping is the shorthand of innovation", *Design Management Journal*, Vol.12, No.3, 2001, pp. 35-42.
- McFadzean, E.*, "Creativity in MS/OR: choosing the appropriate technique", *Interfaces*, Vol.29, No.5, 1999, pp. 110-122.
- McFadzean, E., Nelson, T.*, "Facilitating problemsolving groups: a conceptual model" *Leadership & Organization Development Journal*, Vol.19, No.1, 1998, pp. 6-13.
- Mont, O.K.*, "Clarifying the concept of product-service system". *Journal of Cleaner Production*, Vol.10, No.3, 2002, pp. 237-245.
- Morelli, N.*, "Product-service systems, a perspective shift for designers: A case study: the design of telecentre", *Design Studies*, Vol.24, No.1, 2002, pp. 73-99.
- Tukker, A., Tischner, U.*, "Product-services as a research field: past, present and future. Reflections from a decade of research", *Journal of Cleaner Production*, Vol.14, No.17, 2006, pp. 1552-1556.

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