

# Challenges for Industrial Product/Service Systems: Experiences from a learning network of large companies

Erik Sundin<sup>1</sup>, Gunilla Ölundh Sandström<sup>2</sup>, Mattias Lindahl<sup>1</sup>, Anna Öhrwall Rönnbäck<sup>1</sup>,

Tomohiko Sakao<sup>1</sup> and Tobias C. Larsson<sup>3</sup>

<sup>1</sup> Department of Management and Engineering, Linköping University, Sweden

<sup>2</sup> Department of Machine Design, School of Industrial Technology and Management, Royal Institute of Technology, Sweden

<sup>3</sup> Division of Functional Product Development, University of Technology, Luleå, Sweden  
erik.sundin@liu.se

## Abstract

In Sweden, manufacturers have a growing need to extend the control of their products in the supply chain. This need is fulfilled by some manufacturers through the use of a product/service system business approach. This paper explores how a group of Swedish manufacturers, working together with academia, have started a workshop series where the most important and topical issues for their integrated product/service offering approaches are dealt with. The large company network studied in this paper faces many challenges in order to achieve a good product/service system business. Much of these challenges are related to changing different peoples' mindset whether it is within the company and/or with external companies and customers. Having a learning network approach of dealing with these challenges has so far been perceived as a good manner of tackling the questions raised within the product/service system providing companies.

## Keywords:

PSS, Integrated Product Service Engineering (IPSE), IPS<sup>2</sup>, Life-cycle thinking, Learning networks

## 1 TRANSITION TO PRODUCT/SERVICE SYSTEMS

Manufacturers today regard service activities as increasingly important; as a result, a number of them are shifting their focus from "product seller" towards "service provider" [1]. Sakao *et al.* [2] conclude that the main drivers for this changed focus are customer connection, customer demand and increased competition.

The transition to product/service systems places new and demanding requirements on product and service development and production, along with new requirements for companies in the way they relate to and build up relationships with customers. Previous authors' research shows that existing product/service offerings are developed by the companies' marketing departments and based on existing products optimized for traditional sale [2-4]. With product/service offerings, the skill to combine different types of products and services into a desired function becomes more crucial. In order to be able to deliver, companies need to continually develop their value chains and the competence of their staff [5, 6]. This also implies that creating increased value for the customer is more in focus [7, 8]. The offering of product and service offerings is not a new concept per se, although it is a new concept for several manufacturing companies. Research shows that the transition from being focused on selling products to becoming a more service-oriented company is a process filled with possibilities and difficulties, to include organizational and financial issues and the ability to manage a new relationship with the customer [3].

In parallel to these trends, concepts such as Functional Sales [9] are readily found, not only as theory but also in practice in several industries. Other related concepts include Total Care Products (Functional Products) [10, 11], which comprises combinations of hardware and support services, Product/Service Systems (PSS) [12],

Integrated Solutions [13], Service/Product Engineering (SPE) [14], and Industrial Product/Service Systems (IPS<sup>2</sup>) [15]. In common to these concepts, service activity is beginning to be increasingly incorporated into the design space, an area which has been traditionally dominated by physical products in manufacturing industries. In this paper, we will further on use the term PSS when describing above concepts.

## 2 OBJECTIVE

The objective of this paper is to present how large manufacturing companies continuously can improve their PSS business through learning networks. How the learning network was organized, and how the companies' current challenges relate to PSS, are also described.

## 3 RESEARCH METHODOLOGY

The authors of this paper have more than eight years' experience in PSS research, in which small, medium and large companies have been involved. The authors' PSS research builds on research performed in different research disciplines, such as: environmental research, product development, remanufacturing and business models for industrialized services.

In the research performed over the years, a plethora of research methods have been used. However, qualitative research interviews [16] have been the most frequent method for collection of primary data. We have interviewed various functions, e.g. those of CEOs, designers, and service developers, but also of customers.

The learning network described in this paper is not really a traditional research project, but rather a way for researchers to contribute to and support companies'

continuous improvement of their work with developing and offering PSS.

In this research, the role of the researchers is in this case toned down; rather, the themes of the network meetings are mainly decided by the companies, and the companies take turns hosting the meetings. The researchers' role is to act as discussion partners and to provide knowledge. From a research perspective, it is very useful to follow the discussions and learn more deeply about the challenges the companies are facing and exploring, or to obtain greater depth in the research topics.

So far a network start-up meeting and two learning network workshops have been held according to Table 1 below:

Table 1. Participants at the learning network workshops

Workshop	Company participants	University participants
Start-up meeting	12	6
First Workshop	8	4
Second Workshop	9	5

The workshops in the network have been well documented, by recording and taking detailed notes of discussions and copies of the companies' presentation slides. The methodology used for the learning network is further described in the following sections.

## 4 A LEARNING NETWORK APPROACH

### 4.1 Theoretical issues are good but...

Much research in the PSS area has been more focused on theoretical issues, and on making conceptual proposals for how PSS can and should work (see e.g. [17]), than practical ones. For example, numerous papers have focused on the theoretical and potential benefits of PSS, e.g. from an environmental, marketing, political economic or societal perspective (see e.g. [1, 18]). However, researchers need to have a strong understanding of practical experiences of PSS, something that requires close interaction with the companies themselves.

In parallel, and already described in this paper's introduction, researchers have developed a large number of concepts and definitions of concepts meaning more or less the same thing. This is in parallel with the number of concepts used in industry, e.g. leasing, rental contracts, and pay-per-service-units (for more details see Lindahl *et al.* [19], which taken together have blurred and obstructed the dialogue, especially with the industry.

The authors' experience is that it is important to be self-critical; i.e., what is important is that which brings the research forward and develops the PSS area. Is that to focus on finding the *one and only concept with the one and totally perfect definition* and to define all theoretical potential benefits with PSS? Our conclusion is not; instead, we have tried to mainly base our research on a close co-operation with companies that already have or are in the process of starting to sell PSS. This has been done in a number of projects, e.g. [1, 20-22].

### 4.2 Principals of a learning network

One way of increasing the interaction between researchers and companies is to engage both parties in a learning network. By doing so, researchers get access to

and in depth knowledge of companies' current business logic and the challenges they are facing.

One of the main benefits of a learning network approach is that it supports organizational change and is useful for modeling development work [23]. The fundamental ideas for a learning network are partly based on the model of "the cycle of experimental learning" by Kolb [24]. That model promotes the practitioners' need to disconnect from an action-experiencing loop by getting support to learn from their experiences through self-reflection, but also by discussing their practice in a more conceptual way and getting input from others. All together, this gives them the possibility to act according to new insights.

In a learning network, company representatives as well as researchers are participants, as illustrated in Figure 1. The company representatives bring in their own experiences and share their knowledge with other company representatives, but also with researchers. The researchers then contribute with reflections, and can provide input based on their knowledge.

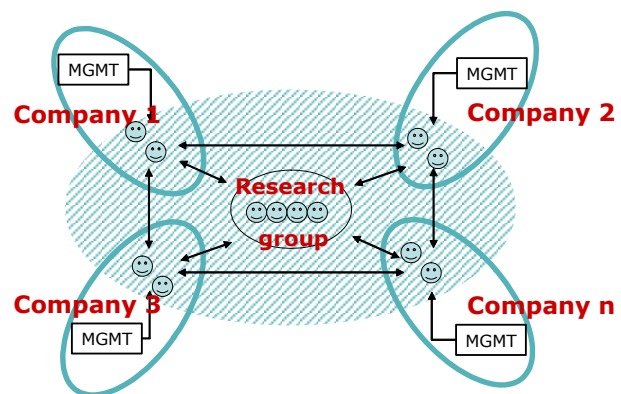


Figure 1. An illustration of a Learning Network [23].

According to Ritzén *et al.* [23], the goals for companies to participate in the Learning Networks are to:

- 1) gain theoretical insights and new knowledge
- 2) share experiences
- 3) have time and space for reflection
- 4) gain motivation to overcome organizational barriers for change
- 5) get support in process management

Learning networks can be used in different ways, enabling researchers to be more or less active in the company's change process.

In a learning network that the IPSE research group performed with SMEs, the purpose was twofold – both to develop the IPSE methodology and to develop the PSS mindset among the companies. In that project, the learning network approach was part of the IPSE methodology for supporting SMEs in understanding and developing integrated product and service offerings.

In the project, a workshop series was developed with focus both on understanding a new business model and learning how that affects the company, including product development and the design of the products. The series consisted of 5 workshops developed by the researchers based on the needs of the companies. The workshop development was an interactive process, and since the companies were divided into three networks, the researcher had time to reflect and make improvements and changes [20].

During the workshops, the researchers participated by discussing different themes with the companies and guiding them in how they could develop integrated

products and service offerings. Participating researchers have also been responsible for the documentation.

At the workshops, knowledge has been shared and transferred between the participating companies and the researchers.

The positive experiences from the learning networks with small companies, along with the expressed need from larger companies, led to a formation of a learning network for larger companies.

## **5 LEARNING NETWORK FOR LARGE COMPANIES FOR CONTINUOUS IMPROVEMENTS**

In our contact with representatives from large, primarily Swedish companies offering PSS, or companies at the starting gate for doing so, they have often expressed that they are feeling quite "lonely". Some reasons expressed for this are e.g.:

- Since PSS is often a quite new phenomenon within their companies, the number of colleagues is often quite small since they are just in the beginning of building up their PSS capacity. In some cases, they have no colleagues to discuss their problems and solutions with.
- PSS is often treated as an "odd duck" by the traditional parts of the organization. One reason for this is that the concept is new and differs from the traditional focus, around which the company's structure often is built upon.
- Since the concept is often new, they also lack history and examples to use when trying to persuade others within the company. Furthermore, since PSS is quite new, an important argument is to be able to point out that there are a number of other companies, in various branches, that also have invested in the PSS area.
- Finally, but not least and related to above, when they are at their companies, they are often very focused on their work and simply lack time for reflection. To meet others with the same type of work stimulates reflection.

Representatives from larger companies have wished for or asked for a forum where they could meet other companies in order to learn from each other, and to build up a network of colleagues since they don't have this within their own organizations. They have further argued that traditional one or two-day seminars with speakers were seldom enough and too speaker oriented, e.g. not really based on the actual needs of the companies

This network was initiated by the authors of this paper and based on the IPSE project's state-of-the-art analysis in combination with that explained in 4.3, namely a need for meeting representatives from other PSS companies. This was seen as a compliment to the work with SME companies. To strengthen the network, the IPSE project's researchers also invited other Swedish PSS researchers to form the group responsible for the PSS network for larger companies developing PSS offerings.

The first activity was to summon a start-up meeting to which the researchers invited interesting and interested companies. The learning network for the large companies had the purpose of supporting continuous improvements.

### **5.1 Network Start-up**

At the first start-up meeting on the 29<sup>th</sup> of November 2007, there were 8 companies represented by 1-2 persons from each company. A number of representatives from other companies were genuinely interested in participating in the network, but for various reasons could not participate. The persons from the companies were, for example, after-sales managers and business developers. In addition, the

companies all had a strong wish to develop their service development and introduce new PSS offerings.

Also, six researchers participated that had different expertise such as eco-design, economics, and development of services and products; however, they all had the mutual interest of the development of products and services.

The aim of the first meeting was to get a deeper understanding about participating companies' expectations, needs and requirements for the network.

The meeting was led by a research funding member with experience and interests in the PSS design research area. After a short introduction from the companies, the main focus was on discussions about the network objective and future workshop themes. The following paragraphs describe the results of these discussions.

### ***Incentives for participating and aim of network***

The companies' aim with service development was expressed as obtaining increased profitability by supporting their customers to increase their value and to reach their goals. All of the participating companies agreed that the perspective of customer value is central in service development. However, the experience of service development varied among the company members, and the field is still somewhat new to them. One of the incentives for participating in the network was to get the opportunity to learn from each others' experiences, thereby avoiding drawbacks and facilitating success. The companies all had challenges to attend to in order to achieve a well-functioning PSS. The network meetings were a place where they could reflect, get inspiration and learn.

A crucial aim for the companies was to obtain knowledge transfer between the companies; this could, for example, include discovering how PSS problems have been tackled by other companies. Furthermore, the problems could be discussed among the participants, and solutions could be found which would make the companies more competitive in their respective markets. The network would be a learning network where knowledge is transferred and new knowledge is developed. The researchers would contribute with a general view of the problem solving, while the companies could provide company-specific data. Besides the knowledge transfers, the network would be an arena for developing new research ideas and developments for new PSSs.

### ***PSS Issues and tentative workshop themes***

At the meeting, future meeting themes were discussed by firstly mapping out the questions the participants wanted to have answered. The questions also represent challenges that the companies were currently facing.

- *How different markets are differentiated regarding prerequisites and possibilities for PSS, i.e. both geographical and product markets?*
- *How can and should product and service development be integrated to increase internal and external efficiency?*
- *How can one earn money on an already installed product base – and how then should offerings and business models be developed?*
- *How can one change the customers view on the value of competence, and get paid for that competence?*
- *What should the actual product/service portfolio look like?*
- *How should the delivery systems for services and offerings be developed?*

- *How can the internal organization be brought on board – and how can one develop concrete visions and motives for developing, marketing and selling more services?*
- *How can new technology be used for service development?*
- *How should the organization, control and salary systems be developed internally and for retailers?*

Furthermore, the incentives for having a PSS business approach were discussed to be manifold, from economic to environmental benefits to the efficient use of physical products. However, it was a consensus among the company participants that it is mainly the business potential of PSS that has been making PSS more interesting to invest in.

Based on the questions that the companies wanted to elucidate, a grouping and listing of coming workshop themes was posted. The themes were discussed in front of all meeting members, and a ranking of importance was made. Based on this ranking, the themes of “**customers and development**” and “**new customer relations**” were selected for the first workshop meeting.

Furthermore, it was decided to have the workshops arranged at the participants’ companies in order to obtain more knowledge about the arranging company’s PSS business and to alternate the travel distances for the participants. The start-up meeting was held at Linköping University in Sweden.

## 5.2 First network workshop

At the first workshop held on the 24<sup>th</sup> of April 2008, there were 8 company participants and 4 researchers. At this time, several company representatives could not join, but all of them were very clear on the fact they wanted to belong to the network and participate in the future.

The hosting company first presented their PSS business approach, followed by the researchers’ presentation of the PSS area of research. In the latter part of the workshop, the topics of **value, price and price setting** and how to **achieve customer value by retrieving correct customer needs** were discussed among the participants, the outcome of which is described below. For this discussion, all participants had prepared presentations of how their companies were tackling these issues. By doing so, the participants learned how certain issues can be solved in a good manner.

As a result of these discussions, it was found that the customer maturity level of having products brought through PSS fluctuated greatly. As an example, the United States was put forward as a country that was far ahead in leasing and financial services. Another important thing that is needed for a successful PSS is to convince the customer that the costs for spare parts is not as high as the costs for stops in production, and/or that the production will not have a high productivity.

Other questions that were raised during the discussion were how to understand the customers’ unconscious needs. An approach that was suggested was to better understand the customers’ customer; this could mean, for example, that the customer perspective would be broader including several new stakeholders.

### **Too few working with service development**

The companies in the network all have relatively large product development organizations. A common situation for them was that service development department was very small and newly established; this meant that it lacked resources. At one of the companies, the relationship

between the ratios of staff working with product development compared to the staff working with service development was 100:3. The companies also put forward the need for product development and service development to have a close relationship and interaction. There was also an agreement that when performing service development, one has to have a much deeper understanding of the customer - and sometimes the customers’ customer - in order to offer the right services.

One of the companies had developed a service fulfillment process showing how the company undergoes the process from how to select and approach customers to how to implement the services and evaluate the performance and costs results and identify improvement areas or possibilities for new types of services.

### **Price setting strategies**

One major challenge for the companies is how to price offerings. A common problem was to decide at what level to bundle offerings. This can be made at a high level, meaning that customers pay a monthly fee, all-included, or by letting the customer choose from different offering modules.

Among the companies participating in the learning network, pricing differed from having a totally open pricing scheme of different modules in an offer to having a monthly fee covering all aspects where the modules’ separate costs are closed. When differentiating the costs, one company used value-based price setting. The company arranged workshops in which they let the customers rank the value of different modules. This has guided the price setting, letting the most valuable parts and modules have a higher price, since the customers value that more and are willing to pay more. This is, however, delicate since the trust of the customers always has to be in focus, and by value-based price setting the trust of the customers needs to be considered. When having value-based costing in maintenance, one aspect to consider is that the cost for standard spare parts is known, and a comparison with other companies is easy to make.

Another company, on the other hand, was very keen on hiding the separate costs for the customer in order to be able to bundle offerings and charge a monthly fee. In this case, the price setting was cost-based. The problem then was to actually have control over, and accurately estimate the costs for different services such as maintenance.

One of the companies did not really sell services, although they did offer and perform a range of services that increased their customers’ efficiency. Rather, they merely used the services as a way for selling more products, and by providing services they could steer the customers into choosing the products with high margins. Having a higher price on the products is also then one way of getting paid for performing the services. The company is in the process of bundling service offerings for the upper market segment, where customers value services and are prepared to pay extra for them. The plan is to shift the focus from the costs for the products to the total costs. A software is currently being developed to conduct these calculations.

### **Changing the mindset of customers**

A great challenge for the companies was to change the mindset of the customers. For one company, the challenge was to make the customer understand that the major costs for the customers does not lie in the costs for maintenance and spare parts, but rather in the costs of having to stop the production or that the product has a lower productivity. Then, the customer gets more into thinking about the value of the services or products used, rather than the costs for the physical product or spare

parts. It was clear that it was a major difficulty to start offering services that used to be bundled into the product price.

### **Changing the mindset of sales force and retailers**

Another challenge found for the future was dealing with the promotion of business ideas to local sale companies in different markets, i.e. how should the internal marketing be conducted successfully?

Some of the companies mentioned that they had difficulties convincing their own sales force and the retailers to really accept and embrace the services concepts. The sales people are used to selling products, and this requires a new way for them to approach the customers.

### **5.3 Second network workshop**

The second workshop was held at the 14<sup>th</sup> of October 2008 there were 9 company participants and 5 university researchers. In comparison to the first workshop a mix of new and old companies and researchers were participating. Also, some companies that were invited to neither the kick-off nor the first workshop wanted to join this workshop. However, since their relations to some of the already participating companies were delicate (customers and/or competitors) these company could not join at this stage.

At this workshop the theme was **how to organize sell and deliver product/service systems**. Preceding this workshop the company participants had prepared short presentations of how they are dealing with these issues at their company. During the presentations discussions were held among the company members with some influence from the general knowledge of the participating researchers. In short the discussions included:

#### **Developing new aftermarket services**

Selling products as PSS included potential to sell more aftermarket services. For example, one company has started to sell service kits and service knowledge in connection to their normal product sales. The company expects good revenue on these kinds of services which would also help them increase the knowledge of how their physical products are used by their customers.

#### **Organization of developing product/service systems**

One of the participating companies admits having the service part of the PSS coming some time later in the development process. However, the service issues have lately been given a higher priority when developing PSS.

Another company reveals not having any relation between the service developers and the product developers. In this case only few are working with service development. However, the company has initiated more focus on the service parts of their PSS. Traditionally technical problems have been solved by technical solutions and not by service solutions. Currently there is a need for methods/tools to collect experiences from the market.

Some of the company participants describe that the organization of service development is not as organized and structured as in the product development. This is an issue that needs attention.

#### **Selling product/service systems**

A company that have had much focus on selling products have now started to see the service parts of the PSS as an competitive edge that gives their customers an added value. This is something their competitors cannot yet provide. Also, the PSS have shown to have a better profit margin than the traditional product sales.

In this area it was also mentioned that it is important for the sales people to have skills in the knowledge of selling PSS to their customer management themselves or to have someone with them at the point of sales who could speak this language. Otherwise, the chances of a PSS deal would decrease much.

Currently many service parts a given away freely as good will. However, these will in the future profitable and come with a price tag. On the other hand one of the participant states: *"it is dangerous to charge for something that previously have been given away for free"*. On this point the network participants do not agree in full.

Furthermore, the second network workshop included some feedback and information from the researchers about on-going research in the area which included a study at the participating companies. These kinds of research involvements during the workshops are not put in focus but add to the knowledge sharing among the company participants and the researchers.

### **5.4 Future network workshops**

From the start-up meeting it was decided to have the workshop series running with workshops twice per year. This was determined to keep the network alive, but without having too many meetings per year. The next and third workshop will be held in March 2009 which theme is not yet determined.

## **6 DISCUSSION**

The discussion below is based on accomplished workshops in the large company network, and in combination with the authors' previous research.

### **6.1 Different purposes for using learning networks**

Learning networks can be used for different purposes. As described in this paper, one type of learning network was part of a research methodology and used for SMEs with limited knowledge and experience in integrated product and service offerings [20]. In the SME-case, the purpose was to build understanding of different business models and to support the companies in developing their business. In that case, each meeting had a pre-defined theme decided by the researchers, and each network meeting was also a workshop meeting where the participants actually worked on a specific task each time that had specific outcomes. The outcomes were then used as input for the next workshop. The researchers' roles were very driven, guiding the companies through a development process and a methodology with a specific number of pre-defined meetings.

The large companies had a greater pre-understanding of the business logic, and the purpose of the meetings was to continuously improve the companies' business. The themes were determined based on the company needs (with strong influence by the companies), and the researchers' role was to act as moderators and participate in discussions, and to provide input and new reflections to the companies.

### **6.2 Choosing participating companies for continuous improvements networks**

When choosing participating companies, it is of course firstly important that they do not have a competitive relationship; if they do, then neither trust nor sharing of knowledge can be achieved.

However, what is not directly obvious is that the companies working with PSS, even though they have different business, have several common challenges related to PSS. It has been noted that the companies

have different types of PSS offerings, and they expressed that in order to get the most use from the network, they would like to be divided into groups with companies with similar situations. This made the large company participants eager to invite other companies in similar situations, something important in order to fertilize their own need to discuss their challenges and obstacles within PSS.

Examples of companies that they wanted to invite were those that had a strong focus on after-sales-related services such as companies with capital-intensive products with long lifetimes. Another category was companies that had more knowledge-intensive services such as advice and supported customers with training and business advice, or companies that used services for selling products. Yet another category of companies were those in a crisis situation, which were forced into changing their business logic for serving the market. The companies have different challenges that they meet.

As mentioned in section 5.3 there could be problems of who to include in this kind of learning network since their relation could be of delicate character. These issues must be considered and if the amount of participating companies are to be broader, covering customers and competitors for some companies the openness and topics needs to be changed to fit the new circumstances.

### **6.3 PSS challenges for large companies**

As indicated by the questions that the companies have risen (see section 5), there is definitely the need for more research within this area. The issues are recognizable and vary from organizational questions to product and service development, customer relationship, how to create and get paid for value creation and how to set up the product portfolio. There is clearly room for various kinds of research areas and expertise. Research needs to be both focused but also interdisciplinary in order to understand the total company picture. The following is a list of PSS-related challenges found through this research:

#### ***How to market PSS?***

One big challenge found at the large companies was to market their PSS in a good manner, both internally in the company group but also to their customers. The PSS business logic is quite different from the product selling-based business logic they and their customers are used to. Customers have problems validating PSS offerings, e.g. since many PSS offerings also cover the use phase and the costs that are generated there. Customers are quite often not used to calculating life cycle costs; by tradition, they are more focused on cost prices. These challenges have also been uncovered through company interviews by other researchers e.g. [25].

#### ***How to develop the PSS?***

Organizing the PSS development have been described by the participating network companies as an difficult task since it is separated by tradition and the company structures for developing products and services are much different. It is a challenge for the PSS developers to achieve an efficient integrated development of the products and services that are to be included in their offerings.

The development teams needs to consist of people of multidisciplinary functions to a larger extent than in e.g. traditional product and/or service development. Also, the life-cycle perspective give opportunities that the PSS providing companies should take care of in a good manner e.g. adapt their product/service design for this purpose. Examples of product design adaptations of products are illustrated by Sundin et al. in [26].

One characteristics peculiar to PSS development may be uncertainty of PSS [25]. Some companies recognize the importance of addressing uncertainty during the whole process of PSS development. Another dimension of divisions should be considered in addition to be able to obtain more optimal way of PSS development, especially in the case of large firms.

#### ***How should the price be set?***

A second big challenge found was how the price of the PSS should be set in a good manner. Some companies needed to get paid for services that previously were given away for free. The price needs to balance with how much the customer value the PSS create at the customer. These issues have also been researched previously by e.g. Rosvall & Rosvall [27].

#### ***How can new technology be used?***

Another challenge found was how new technology can support the development and use of PSS. This could include both development support and monitoring and other life-cycle support. A part of these kinds of support systems have been studied by other researchers, e.g. [26]. This is an area that needs more attention, since few systems are in place (see e.g. [21, 26, 28-30]).

#### ***How to benefit from environmental potentials?***

The authors' previous research have identified and quantified how PSS can decrease negative environmental impact. One aspect (not mentioned by the companies) that has to meet is how to get the companies to be interested in the environmental potential of PSS and include those aspects to fully reach the environmental potential. PSS offering companies' and their customers seems not to be that interested in PSS's environmental potential. The challenge is how to improve customers' interest in order to decrease the environmental impact. Several questions are easily stated: Is there a need for policymakers to step up and take an even closer look at services? Can we as researchers promote environmental issues in more business model approaches? This is an issue that needs to be addressed further.

## **7 CONCLUSIONS AND FUTURE RESEARCH**

Industrial Product/Service Systems is for many companies a new business approach. The large company network studied for this research faces many challenges in order to achieve a good PSS business. Much of these challenges are related to changing different peoples' mindset whether it is within the company and/or with external companies and customers. Also, good solutions to these challenges need to be facilitated.

Having a learning network approach of dealing with these challenges has so far been perceived as a good manner of tackling the questions raised within the PSS providing companies. The companies have learned from each other and as well as retrieved knowledge from research from the researchers. The researchers on the other hand have received a better understanding of the companies' faced reality. This would work as a good base for further research that is needed in the PSS industry.

## **8 ACKNOWLEDGEMENTS**

The authors wish to thank the people from the companies and the researchers participating during the learning network workshop series. Also, the authors express their gratitude to Dr. Margareta Groth at the Swedish Governmental Agency for Innovation Systems (VINNOVA) for moderating the network start-up meeting and for partly financing this research.

## REFERENCES

- [1] Oliva, R. and R. Kallenberg (2003) Managing the transition from products to services. *International Journal of Service Industry Management*, Vol. 14(No. 2): 160-172.
- [2] Sakao, T., N. Napolitano, M. Tronci, E. Sundin, and M. Lindahl (2008) How Are Product-Service Combined Offers Provided in Germany and Italy? – Analysis with Company Sizes and Countries. *Journal of Systems Science and Systems Engineering*, 17(3): 367-381.
- [3] Ölundh, G. (2003) Environmental and Developmental Perspectives of Functional Sales. Licentiate Thesis. Division of Integrated Product Development, Department of Machine Design. Royal Institute of Technology. Stockholm, Sweden: 108.
- [4] Sundin, E., M. Larsson, and A. Nielsen (2005) Design for Functional Sales - A Case Study of Forklift Trucks at BT Industries, in *Proceedings of EcoDesign 05: Tokyo*.
- [5] Söderström, J. (2004) Från produkt till tjänst - Utveckling av affärs- och miljöstrategier i produktorienterade företag. Doctoral thesis. Handelshögskolan. Stockholm University. Stockholm.
- [6] Brännström, O. and B.-O. Elfström (2002) Integrated Product & Service Offerings - Their Rationale and Creation. *International Product Development Conference*. Sophia-Antipolis (near Nice), France: European institute for Advanced Studies in Management.
- [7] Shimomura, Y., K. Watanabe, T. Arai, T. Sakao, and T. Tomiyama (2003) A Proposal for Service Modelling. *EcoDesign 2003*. Tokyo, Japan.
- [8] Sakao, T., Y. Shimomura, E. Sundin, and M. Comstock (Accepted to appear.) Modeling Design Objects in CAD system for Service/Product Engineering. *Computer-Aided Design*.
- [9] Lindahl, M. and G. Ölundh (2001) The Meaning of Functional Sales. *Life Cycle Engineering: Challenges and Opportunities: 8th International Seminar on Life Cycle Engineering*. Varna, Bulgaria: CIRP.
- [10] Alonso-Rasgado, T., G. Thompson, and B.-O. Elfström (2004) The design of functional (total care) products. *Journal of Engineering Design*, 15(6): 515-540.
- [11] Alonso-Rasgado, T. and G. Thompson (2006) A rapid design process for Total Care Product creation. *Journal of Engineering Design*, Vol. 17(No. 6): 509-531.
- [12] Tukker, A. and U. Tischner (2006) *New Business for Old Europe*. Sheffield: Greenleaf Publishing.
- [13] Davies, A. (2004) Moving base into high-value integrated solutions: a value stream approach. *Industrial and Corporate Change*, 13(5): 727-756.
- [14] Sakao, T. and Y. Shimomura (2007) Service Engineering: a novel engineering discipline for producers to increase value combining service and product. *Journal of Cleaner Production*, (No. 15): 590-604.
- [15] Meier, H. and O. Völker (2008) Industrial Product-Service-Systems - Typology of Service Supply Chain for IPS2 Providing. *Manufacturing Systems and Technologies for the New Frontier - Proceedings for The 41st CIRP Conference on Manufacturing Systems*. Tokyo: Springer.
- [16] Kvale, S. (1983) The qualitative research interview - a phenomenological and a hermeneutical mode of understanding. *Journal of Phenomenological Psychology*, 14: 171-196.
- [17] Mont, O.K. (2002) Clarifying the concept of product-service system. *Journal of Cleaner Production*, 10(3): 237-245.
- [18] Tukker, A. and U. Tischner (2006) Product-services as a research field: past, present and future. Reflections from a decade of research. *Journal of Cleaner Production*, 14: 1552-1556.
- [19] Lindahl, M., T. Sakao, and A. Öhrwall Rönnbäck (2009) Business Implications of Integrated Product and Service Offerings, in *CIRP IPS<sup>2</sup> Conference*: Cranfield, UK.
- [20] Lindahl, M., G. Ölundh Sandström, E. Sundin, A. Öhrwall Rönnbäck, and J. Östlin (2008) Learning networks: a method for Integrated Product and Service Engineering – experience from the IPSE project. *41st CIRP Conference on Manufacturing Systems – Manufacturing Systems and Technologies for the New Frontier*. The University of Tokyo, Tokyo, Japan.
- [21] Sundin, E., J. Östlin, A. Öhrwall Rönnbäck, M. Lindahl, and G. Ölundh Sandström (2008) Remanufacturing of Products used in Product Service System Offerings, in *41st CIRP Conference on Manufacturing Systems – Manufacturing Systems and Technologies for the New Frontier*: The University of Tokyo, Tokyo, Japan.
- [22] Ölundh, G. and S. Ritzén (2002) Funktionsförsäljning och produkters miljöaspekter – en studie i tre svenska tillverkningsföretag. *Naturvårdsverket*, ISBN 91-620-5234-9: Stockholm. 40.
- [23] Ritzén, S., A. Zika-Viktorsson, J. Forslin, and M. Engwall (2005) Learning to change – a network approach to engineering management development, in *Proceedings of the International Conference on Engineering Design, ICED 05: Melbourne, Australia*.
- [24] Kolb, D.A. (1984) *Experimental Learning – Experience as the Source of learning and Development*. Englewood Cliffs, NJ, USA.: Prentice Hall PTR.
- [25] Sakao, T. and E. Sundin (2009) Analysis of Integrated Product and Service Offerings from current perspectives of providers and customers, in *CIRP IPS<sup>2</sup> Conference 2009*: Cranfield.
- [26] Sundin, E., M. Lindahl, and W. Ijomah (To appear) Product Design for Product Service Systems - design experiences from three Manufacturing companies from Sweden. *Journal of Engineering Design*.
- [27] Rosvall, L. and K. Rosvall (2001) Prissättning efter kundvärde - Ett paradigmskifte i modern affärsutveckling (in Swedish). Lund: Industrilitteratur.
- [28] Meier, H. (2004) Lifecycle-based Service Design for innovative business models. *Annals of the CIRP*, 53(1): 393-396.
- [29] Sundin, E., O. Tang, and E. Mårtén (2005) The Swedish Remanufacturing Industry - An Overview of Present Status and Future Potential. *Proceedings of CIRP Life Cycle Engineering Seminar -12th edition - LCE-05*. Grenoble, France: Laboratoire 3S.
- [30] Aurich, C., C. Fuchs, and F. DeVries (2004) An Approach to Life Cycle Oriented Technical Service Design. *Annals of the CIRP*, 53: 151-154.