

# **FROM PRODUCT DESIGNER TO PSS DESIGNER – HOW TO EDUCATE ENGINEERS TO BECOME PSS DESIGNERS**

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## **ABSTRACT**

Today's universities teach conventional product design for mechanical engineers and service engineering for business administration students. This separated thinking and teaching of design categories does not fit to the offers actually existing at the market. Taking a closer look at these offerings, there are little pure product or pure service offers but most of them are so called product service systems (PSS). Originated in the area of eco design, PSS have been researched now for more than a decade. And a rising number of offers that are perfect examples for PSS, e.g. car sharing, show the relevance of this topic for the society. Moreover the concept of PSS is regarded to be a key for achieving development goals like dematerialization as well as raising use intensity of a product and lead towards more sustainable consumption.

Furthermore most of the offers that look like a pure product can be identified as PSS at a second glance because usually there is at least some service element within the offer. However, usually the product designers had no clue about the concept of PSS and how to handle the service element within an integrated development.

This paper aims to present fundamental basics of PSS, to provide theoretical knowledge about the concept and design of PSS to enable product designers to broaden their view. And moreover enable them to handle so called product design tasks, which in fact are PSS design.

*Keywords: PSS, PSS design, eco design*

## **1 INTRODUCTION**

The requirements of rising levels of consumption and the growing world population lead to new challenges for designers. Due to limited resources and a rising awareness of problems like climate change there is a need for reviewing our consumption habits. To a certain level new technologies are able to buffer the effects, but in the long run a dematerialization of consumption is required [1].

The concept of product service systems (PSS) is regarded to be the answer to that problem [2].

A PSS can be defined as "a marketable set of products and services capable of jointly fulfilling a user's need" [3]. They cover a range of different combinations of product and service that is exemplified in the eight types of PSS by Tukker in Figure 1. It is important to point out that developing PSS does not automatically lead to the potential benefits, but that these qualities have to be designed into the PSS [4]. Therefore designers need to be enabled to access the full potential of PSS by substantial knowledge and the opportunities given by an explicit PSS design process compared with common product design. Though the potential of PSS have been researched and stated out in numbers of research projects [5, 6] the education in universities still focuses on teaching product design.

Therefore the aim of this paper is to present fundamental basics of PSS and PSS design to enable product designers to understand the concept and the resulting differences between product design and PSS design. Moreover the paper is supposed to be an initial point for designers to understand the topic of PSS and move on into the different aspects by following the cited literature towards a deeper knowledge.

## 2 FUNDAMENTALS OF PRODUCT SERVICE SYSTEMS

### 2.1 Service vs. product

Although even banking and insurance are sometimes named “product”, it is crucial for PSS design to separate the definitions. For the product part Goedkoop et al. define with humour:

*"A product is a tangible commodity manufactured to be sold. It is capable of falling onto your toes and of fulfilling a user's need" [3]*

In contrast, services can be characterized with the definition of Grönroos:

*"The most important characteristic of services, and probably the only really unique one, is the fact that services are processes, not things. Other characteristics such as the fact that consumption and production are partly simultaneous activities and that customers participate in the service production process follow from the process characteristic." [7]*

There are some more constitutive characteristics that are important to describe services [8]:

*Perceived risk and individuality.*

The perceived risk is much higher when it comes to services, than for products. It depends mainly on the fact that it is easier to assume the value and quality of a tangible product that can be tested, than of a service. But this perceived risk is also raised by the individuality of services that is influenced by the provider as well as by the customer.

### 2.2 Product service system vs. product

The service characteristics presented in section 2.1 turn into characteristics of parts of the PSS. E.g. the integration of the external factor could be a property of the customer if a laundry PSS is regarded and even the customer herself could be the external factor when it comes to transportation.

With the combination of product and service as a system, providers are able to present a broader range of supplies to cover different types of customer needs. These can cover the full range from product based offers to functional results where the customer does not need to have interaction with the product. This is displayed by the eight types of PSS by Tukker in Figure 1.

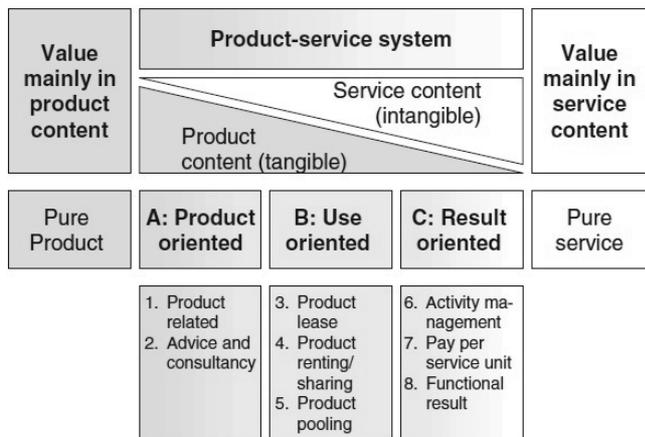


Figure 1. Main and subcategories of PSS [9]

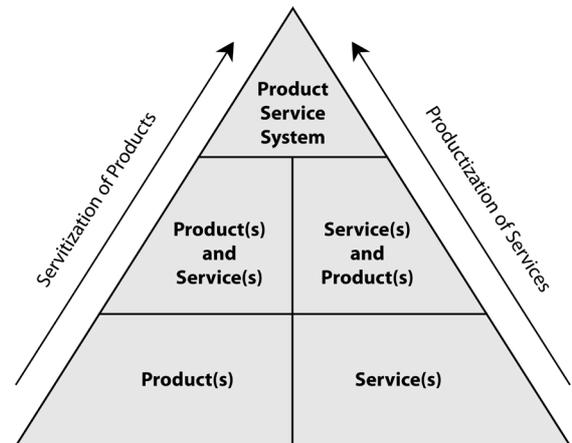


Figure 2. Evolution of the Product-Service-System concept [10]

In Figure 2, Baines et al. describe the evolution from separated product and service consideration towards integrated development of PSS. This needs to be facilitated by suitable methods and tools.

A significant difference between products and PSS is that products are manufactured to be sold to customers but the concept of PSS offers a variety of other scenarios, e.g. the eight types of PSS by Tukker as presented in Figure 1. These scenarios imply a variation in the distribution of property rights, a concept raised in the area of economic theory to describe the rights and duties one has towards a property. In the following, a separation into different types of property rights as well as resulting duties based on Hockerts [11] and Furubotn/Pejovich [12] is presented:

- |  |   |
|--|---|
| 1. The right to retain profits                 | → The duty to cover losses                      |
| 2. The right to maintain and operate a product | → The obligation to maintain a product          |
| 3. The right to dispose of a product           | → The duty to pay for the disposal of a product |
| 4. The right to exclude others                 |   |
| 5. The right to use a product                  |   |

These differentiations can be used as a flexible concept to support the design process by adjusting the classification towards a more PSS-compatible segmentation and thus support the design of concept variants and the understanding of their differences among the designers [13].

The new institutional economy offers a range of other interesting concepts that help to understand and create PSS e.g. transaction cost theory or the assumption of asymmetric information [14]. These theories and assumptions can be used to facilitate PSS design [15].

## 2.3 Surrounding conditions

In the area of PSS development it is crucial to regard the system boundary and set it carefully to support the design process and keep the PSS manageable. The example of mobile phones underlines this. A mobile phone PSS does not only consist of two people calling as presented in 3 but is a complex system as exemplarily visualized in Figure 4.

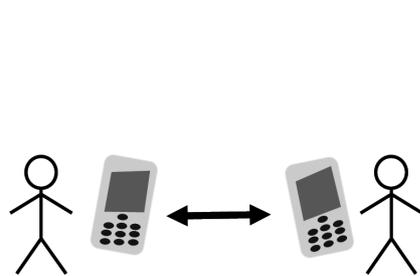


Figure 3. Two participants calling

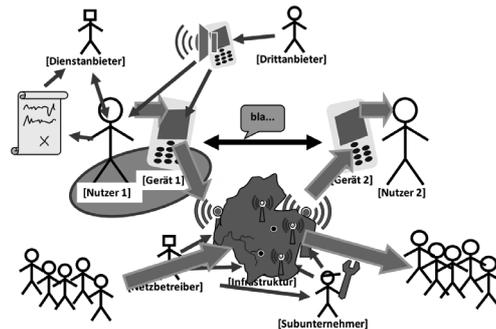


Figure 4. Illustration of a mobile phone network

This illustrates the importance of a clear definition of the system boundary for the design task as well as to arrange well defined interfaces to enlarge the offering. The iPhone with its appstore is a impressive example how successful a PSS can be with well defined interfaces to enable others to provide features for the original PSS.

The mobile phone example also illustrates that for the success of PSS sometimes the infrastructure is a key for the supply. Close to the infrastructure there is also the topic of networking effects that can be pointed out by the mobile phone example. No provider would build the infrastructure of a mobile network for only two customers. The demand of a critical minimum of participants often is a barrier as described in section 2.5.

## 2.4 Potentials

PSS are described as „an excellent vehicle to enhance competitiveness and to foster sustainability simultaneously“[9]. PSS enable providers to have a closer relation to their customers and a higher flexibility to conduct changes in their offerings to fit the customers’ needs.

One of the most cited potential of PSS is the dematerialization of the provided value or at least a significant decrease of material consumption [10].

The environmental potentials can be underlined with a remarkable example: It is assumed that one car in a car sharing fleet could replace 4-10 personal cars, depending on the use intensity [16]. It is easy to imagine the resources that can be saved by not producing up to 9 cars. On the long run PSS are supposed to lead towards a sustainable society with a significant environmental improvement (see Figure 5) to face the problems cited in the introduction.

If environmental improvement is a top goal for product redesign as well as new product development, the designers need to be facilitated to be able to reach that goal. Therefore it is important to be able to approximate the potentials of a well designed PSS, e.g. by case study reviews, that reveal these potentials. To exploit these potentials, it is essential to educate the designers, as well as decision makers, with knowledge about the range of solution variants that include PSS to be able to choose the best fitting solution for the development task. Moreover it is important to research and teach methods and tools to handle PSS design tasks, to transfer the knowledge from science to praxis.

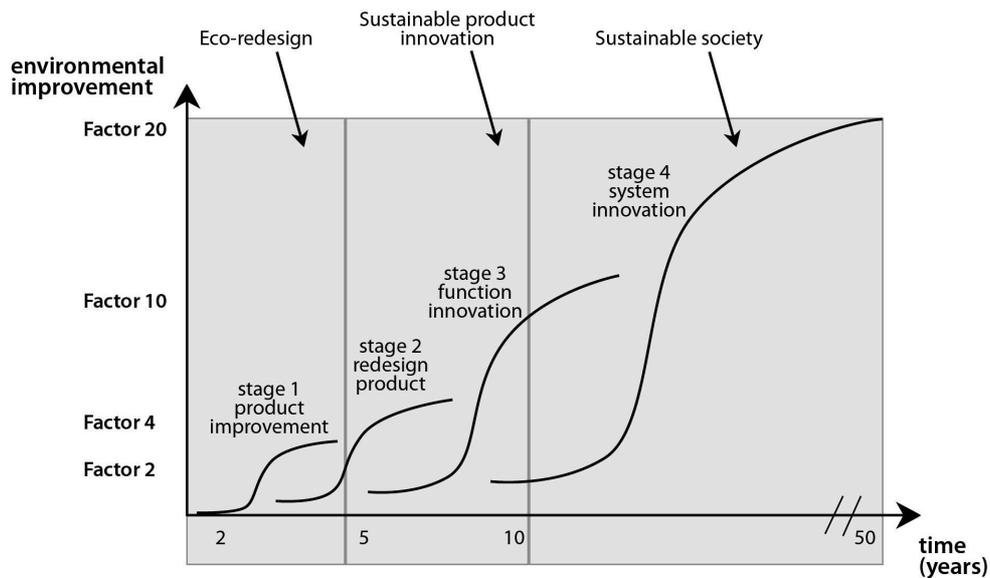


Figure 5. Sustainability improvements [17]

## 2.5 Barriers and Drivers

It is important to take into account that customers do not behave like a value maximizing *homo economicus* but are limited in their decisions by so called bounded rationality [14]. Moreover people tend to overrate e.g. the flexibility of owning a private car and at the same time neglect the cost advantages of car sharing. This correlates with social habits like the social prestige of an expensive car or the reluctance to share with others.

Though legislation is already considered for product design, e.g. when it comes to material or safety restrictions, it can be a special challenge for PSS design. As systems like car sharing are a new phenomenon that has not been considered in legislation, there is a paragraph that prevents cities from reserving parking lots for car sharing vehicles. Though the positive effects of car sharing are documented, there is still a veto against changing the legislation [18].

Networking effects can be barriers as well as drivers. For PSS offers like car sharing or launderettes it is crucial to have a minimum of participants. This can prevent PSS from being established because the risk to not reach these participant numbers for economic success could be high.

On the other side networking effects can be a driver for PSS e.g. when car sharing providers cooperate with public transport and have a wide network of sharing stations. This pulls new customers into the system that enable the provider to make more cars available and get better conditions at public transport etc.

## 2.6 Main differences between PSS design and product design from a product designers point of view

The design task in PSS design is no longer just the physical product, but includes the whole system with product and service components. Therefore all characteristics of services and system design need to be considered. This leads to an extension of the system boundary from the edge of the physical product to a broader system including services, but also infrastructure and even complex networks of participants. This leads to more complex interfaces and a necessity to understand requirements of the other components.

The concept of PSS includes the opportunity to focus on customer value in the development process and extends the space of potential solution concepts. Referring to the PSS categories of Tukker (see section 2.2) it is possible to provide functional results that are – from the customers' point of view – independent from a specific product and distribute to the provider the total control over the product.

## 3 PSS DESIGN METHODS AND TOOLS

Though PSS are a subject of research for more than a decade there is still a need for methods and tools to support PSS design [10]. In contrast to product design or pure service engineering there are few models capable to display the design task due to the complexity of the elements within a PSS. In the

following the PSS Layer method and PSS Blueprinting are presented to give a rough overview of existing attempts to handle this complexity in the design process.

### 3.1 PSS Layer method

The PSS Layer method by Müller et al. [19] provides different layers for the design phase to cover all aspects of the design task.

These layers include the customer's view with a *Needs* and a *Value* layer. A number of so called design layers, covering *Deliverables*, *Life-Cycle-Activities*, *Actors*, *Core products*, *Periphery*, *Contract*, *Finance* and the *Option* to add specific layers for the design task to support the designer. A scheme displaying the layers can be used to support design creativity in group processes. This layer method can accompany different phases of the design process.

### 3.2 PSS Blueprinting

PSS blueprinting displays an episode of a PSS in a systematic scheme. The presented scheme in Figure 6 is based on the scheme by Schendel et al. [4]. The usage of episodes in this model provides an overview of a specific phase in the PSS life cycle.

The PSS Episode is defined as “encompassing a sequence of events in the use phase of the PSS, which together fulfil a need of the recipient (= provide a function to the recipient) [4]”.

This enables designers to analyze episodes to provide the intended value as well as episodes that are needed to cover dysfunction like a flat tire. Markers can be used to point out activities or functions that e.g. contain a risk or need an initiative.

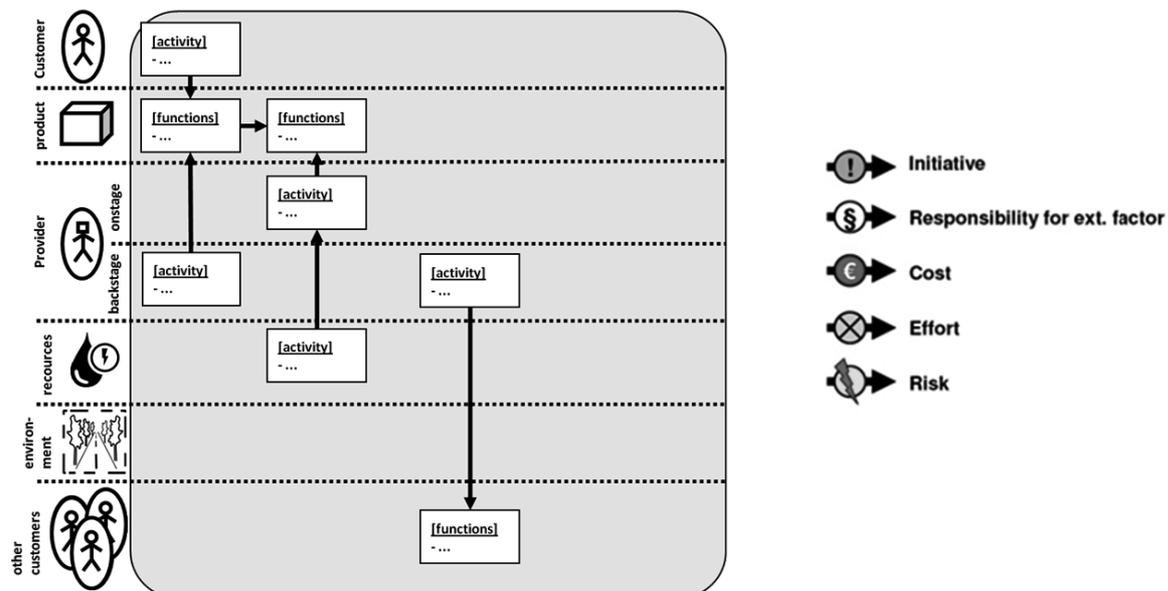


Figure 6. Blueprinting scheme with markers to point out activities and functions

The method of blueprinting can be used to create and display PSS variants e.g. by variation of the property rights [14].

## 4 CONCLUSIONS AND OUTLOOK

The concept of PSS is more than an extension of ordinary product development but a chance to revolute consumption. PSS provide enhancement in ecologic as well as economic aspects for customers and providers. To fully exploit the potentials of PSS it is crucial that a common understanding of characteristics of PSS is established among designers. Moreover it is important to provide methods and tools for designers to handle the design task to support a business-wide implementation of PSS [10].

The potential ecological effects of PSS have been stated. To assure that the offers provide these benefits it is important to develop assessment tools to make these effects transparent [20] as well as methods and tools to exploit the ecologic potential. And furthermore transfer them into general development process in praxis by integration in the general design education of engineering students.

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