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SERVICE AS A MEANS OF COMMUNICATING USER VALUE AND ENVIRONMENTAL BENEFITS IN ECODESIGN

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1. Introduction

It may be obvious that designing products which are not used eventually should be avoided. However, in design of products in general and Ecodesign in particular, there are many examples of products which are not accepted by customers or users. In years past, products with high quality did sell and were indeed utilized, especially when specifications for products needed or desired by customers were clear. However, in recent years this has become no longer valid in a number of industrial sectors. Automatic understanding and interpretation of products are not necessarily expected between different life cycle stages such as design and usage. Customers and users then need some complementary information. Therefore, it is beneficial for designers to have measures to provide needed information so that designed products will be utilized in the end. One reason for this may be a shift from quality to value in what customers appreciate. Companies nowadays compete on value provided to customers. This means that there is high degree of freedom in deploying a product concept into various product structures. However, little research is available on value provision in the design community.

On the other hand, there is growing interest in services in the manufacturing industry, and products are increasingly provided together with services in many cases, often called Product/Service Systems (PSS) [McAloone and Andreason 2004, Tukker and Tischner 2006]. Some research and practices on PSS design have been reported as well. However, few researchers have investigated the different roles of services. In some research on PSS design, services are generally regarded as a constituent for customers to receive value [Alonso-Rasgado et al. 2004, Sakao and Shimomura 2007]. However, little research has addressed the communication aspect of services.

To fill in these two gaps, and specifically in the context of Ecodesign (environmentally conscious design), the paper attempts to highlight the importance of an aspect of service: communication to compensate some information for customers or users, which is in some cases intended to be persuasion. The paper aims at i) reconfirming the benefit of an already-proposed framework [Sakao and Fargnoli 2010], ii) proposing to add one more element to the framework that is useful in forming an Ecodesign Strategy and iii) analyzing its implications for design and management. To do so, it extends the existing framework by incorporating a service aspect, which is the main focus of the paper. The extended framework is applied to an example of a product that is combined with a service analysing usage of the product, and its implications for design and management are analyzed. It should be emphasized that much insight provided in the paper can be applied to product design in general, not only to Ecodesign.The remainder of the paper is as follows. Section 2 analyses existing literature in the areas of Ecodesign and PSS. Section 3 proposes the new framework, while Section 4 applies it to a product used in toilets. Section 5 discusses the implications on design and management, and Section 6 concludes the paper.

2. Literature analysis

2.1 Ecodesign and value

Ecodesign (environmentally conscious design) has been gaining attention in various industries, and a number of methods to support Ecodesign have been developed. One serious problem with most Ecodesign methods available at present is thier difficulty to embed competitiveness in products just by following current Ecodesign methods, as is suggested by [Stevels 2005]. Many of the environmental properties of products supported by these methods are becoming established in response to regulation or legislation that manufacturers must comply with. Thus, most Ecodesign methods help manufacturers satisfy necessary conditions, but are not sufficient for competitiveness in the marketplace.

Partly based on this problem, a concept of Ecodesign Strategy has been proposed [Sakao and Fargnoli 2010]. It must be emphasized that the word "strategy" here was intended to mean "the approach that manufacturers adopt for the purpose of selling their ecodesigned products". In Ecodesign Strategy, value is a vitally important aspect, since value lies at the core of business activities and all design activities should be based on it. Here, value can be economic, functional, or emotional. Note that this paper follows the definition by [Zeithaml 1988] which says that perceived value is a consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given.

2.2 Service as a part of design parameters in PSS

PSS (Product/Service Systems) is a value proposition through products and services, including its network and infrastructure [Tukker and Tischner 2006]. Designing PSS can be interpreted as a discipline enhanced from Ecodesign [McAloone and Andreason 2004]. For the last decade, the design research community has begun to tackle PSS design according to the importance of service. Some articles explicitly address service activity as a part of design parameters, i.e. as an instrument to provide value (e.g. [Alonso-Rasgado et al. 2004, Sakao and Shimomura 2007]). This is a significant change in the way of looking at services in design; design parameters used to be dominated by parameters of physical products, while service activity was a measure to keep the given product function and mostly add-on.

However, the insights available so far on how service contributes to proposed value remain at a generic level, and little literature has revealed the different roles of services. For instance, little research has addressed the communication aspect of services, i.e. the aspect of information provision. This is an interesting issue, especially in cases of products requiring information as introduced in Section 1.

2.3 Communication with customers and users in Ecodesign and PSS

There are a number of practices for providing environmental information of products to customers and users. For instance, different types of environmental labels are utilized for products on the market, and recently labels for carbon footprints are gaining attention. However, little research addresses the more specific intention of communication: persuading customers. As one of the few examples, a framework has been proposed toward design management [Sakao 2009], where the parameters to be controlled exist in how to design products as well as how to communicate product properties to the customers depending on the types of environmental characteristics.

In the PSS area, Krucken and Meroni have argued for the importance of communication [Krucken and Meroni 2006]. They developed a framework of materials for communication, e.g. to explain the problem and solution. Their aims include exploring the interest of possible integrative partners in a solution idea by outlining the idea in its highlights, and by underlining the possible benefits in joining the solution-oriented partnership. However, this is not discussed in the context of design.

In order to address persuasion of customers, understanding customer behaviour is crucial as fundamental information. Customer (or user) behaviour is obviously an important element to look at in order to arrive at sustainable consumption and production, because the customer (or user) is an essential actor. Recognition of this importance seems to be widespread. For example, a consumer-

electronics manufacturer, Philips, has widened its Ecodesign process to include supply chain, end-of-life, and consumer behaviour, as well as product [de Caluwe 2004]. Nevertheless, there have been few investigations into how designers should incorporate customer behaviour into Ecodesign.

3. Proposed framework

3.1 Overview

The proposed framework here is extended from an existing one, adopted within Ecodesign Strategy [Sakao and Fargnoli, 2010], which includes value, customer, system, function/component, and environmental characteristics as five crucial elements in Ecodesign. One important feature of this framework is that environmental characteristics are organically connected to other elements. It is crucial that every item is identified, if available. In addition, there must be a systematic connection and no contradictions between items.

A newly added element in the proposed framework is *service activity*. As described in Section 2.2, service is now recognized as an important design element as well. This paper particularly points out one type of meaning of service, persuading customers.

3.2 Six elements in the framework

The six elements are explained in this section with more emphasis particularly on the newest one,service activity.

Value

Value is a vitally important aspect, since value lies at the core of business activities and all design activities should be based on it. Here, value can be economic, functional, or emotional. Especially in ecodesign, value is crucial, since the emotional value of an environmental property depends on the characteristics of the customers.

Customer

Following the necessity of value, it is immediately necessary to address characteristics of customers. This paper points out the importance of discrimination of different types of customers, especially direct customers and users. Also important is to keep the link between each of the listed values and each of the customers, since measures for different customers should depend on their value.

System

As explained above, the product's system should also be considered. Here, "system" means a composition of the product and its surrounding products, including users' activities. The system concept should be a part of ES, because the design of the system at an early stage can affect decision making at later stages.

Function and Component

These are needed as they play an important role in traditional engineering design as well.

Environmental characteristics

It is taken for granted that environmental characteristics are important in ES and constitute a fundamental input to the ecodesign activities.

Service activity

Service activity here refers to activities fulfilled by service providers for users of the product with the function and component defined above. It can be classified into three types: service before, during, and after the product usage. Service before the usage includes install and consulting activities. Those during usage include monitoring services. Examples of services during and after the usage are inspection/maintenance and take-back, respectively. From these examples, consulting and monitoring services are of particular interest in the paper, since they consitute communication to customers.

3.3 Service and environmental characteristics

Service activities in general have different types of potential to contribute to decreasing the environmental impacts. For instance, maintenance prevents damages on machines to be propagated and contribute to prolonging the duration of the product life. Take-back functions as a base for part

reuse. However, the paper focuses on the services provided in order to persuade customers. Two reasons why persuading customers is relevant and important in Ecodesign are described below.

1. Incorporation of life cycle perspective

Ecodesign has the life cycle perspective; thus, a solution from Ecodesign is sometimes superior *only* when it is evaluated with the life cycle perspective. However, this needs some explanation to customers and/or users. This is why persuading service is called for.

2.Adoption of new technology

Ecodesign sometimes adopts new technologies. This is in general more applicable to cases with a substantial increase on environmental performance. When customers consider a product with a technology unfamiliar to them, it is likely that they hesitate to invest in such a product. This is when persuading service is effective. Note that this is generally valid for cases of product design adopting new technologies, i.e. not only for Ecodesign.

4. Case study

4.1 Overview

The Ecodesign Strategy (ES) framework has been applied to the product DuoSpol, a water-saving device for use in households such as large apartment houses and individual homes. The purpose of the study includes reconfirming the benefits of the existing framework [Sakao and Fargnoli 2010] with a product on the market through in-depth, bi-directional dialogue with the product developers at the company. Another objective is validating the effectiveness of the newly added element, service activity.

The company developing and selling this product is NGL Teknik AB, situated in Linköping the southeast of Sweden. It has six employees and was established in 1983, and develops and sells several other technological devices to reduce water consumption as well. The main customers are large real estate companies, and the NGL Technology is now becoming one of the standard solutions among Swedish real estate owners. Data needed to make the analysis was provided by the company in 2009 in the form of product information sheets, technical specifications, demonstrations and personal correspondence via the CEO of NGL Teknik AB, Jacob Norling, who is also responsible for development of the product.

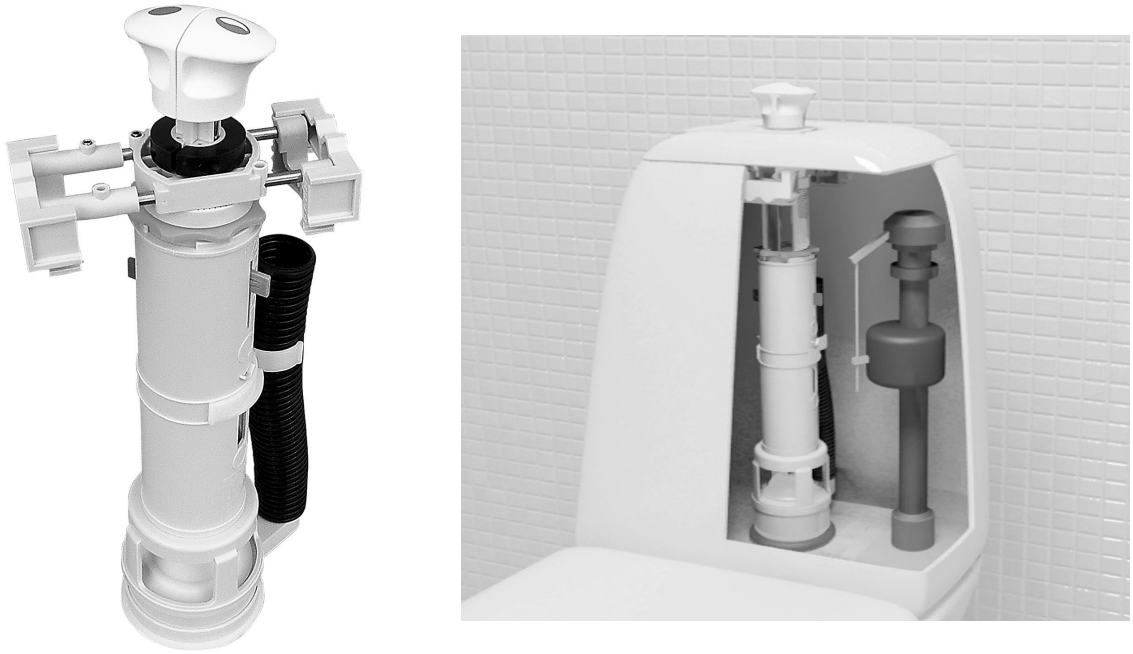
4.2 Product

The specific product used in this case, the DuoSpol (Figure 1), can be installed in a multitude of water-flushed toilets to reduce the amount of water used for flushing. Water-saving equipment has been developed by several other producers using the approach that a new toilet is installed with a device for large and small volume flushing. Such toilets are now very common among the large producers of water-flushed toilets on the Swedish market. This solution has the advantages of being easy to use, easy to clean and looking modern. However, the technology also has some drawbacks, such as the mechanical parts often breaking down, the water used for flushing becoming too sparse causing the user to flush several times instead of once, and sewage pipes becoming clogged, leading to stops. The latter is a consequence of a sewage system originally designed for larger water volumes. The DuoSpol was developed with the aims to be able to fit into most existing toilets on the market, reduce the risk of drainage stops, having a robust design yet still resulting in the use of less water. An effect of having implemented the DuoSpol has been measured, from one example, to be 18% reduction of water consumption at a house. This example is used for visualization in Figure 2.

4.3 Application of the framework

Applying the ES framework facilitates the comparison of the DuoSpol solution with a generalized previous-generation product as shown in Table 1. The following similarities and differences are revealed: The customers and their perceived values are identical for the two products. Two different types of customers can be identified, the traditional customer actually buying the installation (the real estate company) and the toilet user. The first customer has a special interest in cost-reduction

(spending less money on water), while the latter is mainly concerned with sanitation. Later, we will show other examples of the necessity to understand both types of customers.
A major difference can be found when it comes to the Systems and Components aspects. For the previous-generation product the customer needs to install a completely new toilet, including the porcelain and sometimes new pipes etc. DuoSpol allows the customer to use toilets already installed, and only upgrade the flushing equipment. This is made possible by making the device flexible in length and in width, as well as in volume of water used for flushing.



(a) The concerned product (b) The product embedded in the system

Figure 1. Exteriors of DuoSpol water saving equipment (Courtesy of NGL Teknik AB)

The possibility to use the DuoSpol in already existing toilets adds on to the environmental characteristics of the product. The environmental benefit becomes even bigger than reducing the amount of water needed to flush the toilets, since no new toilet or sewage pipes have to be installed. Additional information also tells us that the DuoSpol can lead to even less water consumption compared to previous-generation products. To realize this, it is necessary to understand the user. If the toilet is not clean after flushing, the user will flush once or twice more leading to more water used. This is often the case if the flushing device is not working properly or if the pipes are too narrow compared to the water volume used. The DuoSpol allows optimization of the amount of water used to finish the job properly. By doing this, the user will perhaps use more water per flush, but since the user flushes fewer times the total amount of water used will decrease. This can be difficult to explain to a customer, leading to that the company needing to prove to their customers that water saving actually occurs. To facilitate this, the company also offers a monitoring service to demonstrate the real case water saving occurring after the installations of their water saving equipment.
By the monitoring service, a customer has access to the data of water consumption on a web-based interface. Figure 2 is an example of measured volume of daily water consumption at a housing complex before, during, and after installation of DuoSpol. Each bar represents the average in each month. The installation of 370 houses in this complex began on December 2004 and finished on January 2006. The line graph before December 2004 and after January 2006 shows the average during the corresponding period.

Table 1. ES elements of the case product, DuoSpol Water saving equipment

Element	A previous-generation product	DuoSpol Water saving equipment (the concerned product)
Customer	Real estate companies Toilet users	Real estate companies Toilet users
Value	Sanitation Economic – cost reduction	Sanitation **More economic- cost reduction**
System (users activities)	New toilet Users flushing multiple times	Existing or new water-flushed toilet (multiple systems) **Users flushing once**
Function	Control flow of water in toilet	Control flow of water in toilet
Component	New toilet with flushing device	Flushing device **Length, width and volume adjuster**
Environmental characteristics	Less water consumption	**Even less water consumption** **More reuse of old toilets**
Service activity	N/A	**Monitoring service for the real estate companies**

N.B. Shaded cells mean no big differences are found between the two products. Bold letters mean added contents in the newer, concerned product.

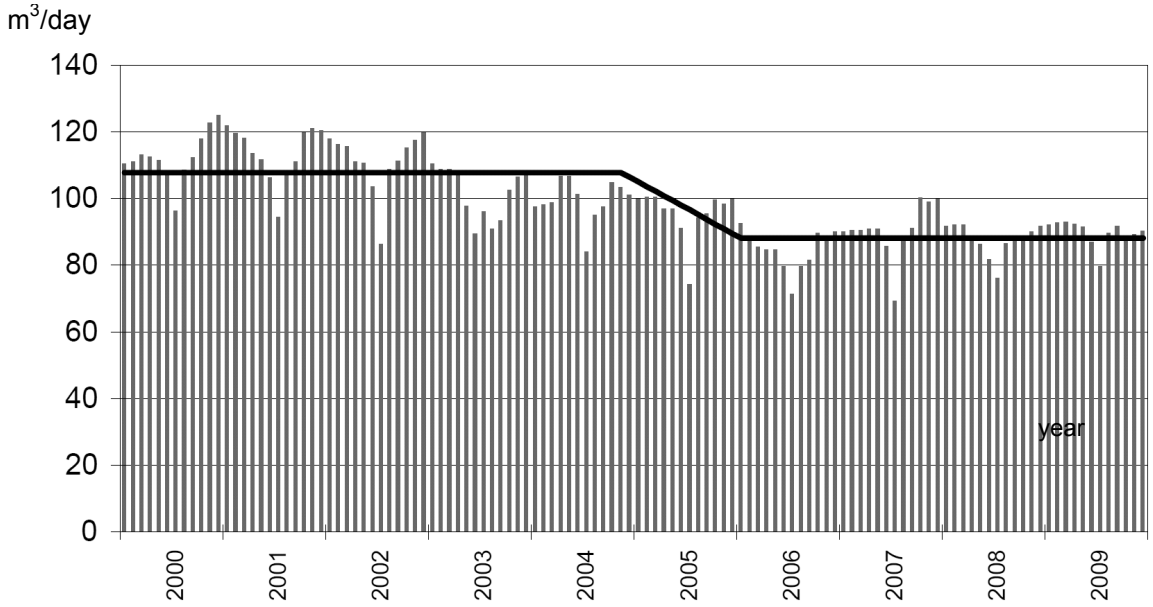


Figure 2. Communicated data on water consumption at a house before/during/after installation of DuoSpol (Courtesy of NGL Teknik AB)

4.4 Discussion of the results of the study

The DuoSpol case above tells us that the ES framework helps in understanding the ecodesigned product and its potential benefits for the customer (customer values). This is information that will be of significance for the future development of the product. In particular, differences in the System, Component and Environmental characteristics elements were obvious. Introducing service as an element to the framework added even more to the benefits of using the framework. The service element pin pointed the monitoring component, which is of great importance for the market success when persuasion of the customer is necessary.

The ES elements allow us to share the strategy of the product. In the DuoSpol case, the situation with the previous generation product was understood with the *system* element showing that users flush several times if the toilet is cleaned insufficiently. In addition, the idea shifting from less water to enough water is understood thanks to the *component*, adjuster. It was also found to be important to discriminate between different types of *customers*, i.e. "true customer" (price payer) and user, because the *service* was designed for the real estate companies, not for toilet users, who are not normally so conscious about the volume of water consumed.

5. Discussion

5.1 Design perspective

The discussion about the ecodesigned product in Section 4 revealed that the six elements in the extended ES (customer, value, system, function/component, environmental characteristics, and service activity) are powerful in explaining the intention of Ecodesign. Describing the six elements for the concerned product, and identifying the relations between some of those elements, helped to understand the intention. Especially in this case, the *system* element was a key in connecting the environmental characteristics and the component. The ES' capability to effectively explain design solution implies its ability to support designers with designing an environmentally friendly solution during the design process.

A part of the design process of the case product is regarded as customisation, since a part of the product is for adjusting the size of the product in order for the product to be fit into different types of toilets. Due to the focus of the paper, no such discussion on customization was made in Section 4. However, this is also a piece of evidence showing that the framework is compatible with customisation. Those who are interested in this are suggested to read [Sakao and Fargnoli, 2010].

Implementing an operation using the ES framework is left for future research. Actually, other interesting types of operations other than customization are foreseen as well. For instance, in order to decrease environmental impacts, investigating the current system (i.e. not limiting the scope to the product) and attempting to create new components is a promising piece of partial design procedure.

Furthermore, considering persuasion of customers can influence the product-design process to. In the case presented in Section 4, such influence was not obvious through the in-depth dialogue with the product developers. However, this can be of interest in the design research. Namely, it may be interesting to ask what should be done in design in order to decrease the efforts to make the product accepted by customers.

5.2 Management perspective

Tackling how to address services or how to communicate to customers immediately makes us recognize the need to go up from the conventional narrow arena for designers to the world of design management. We have to address managerial issues. This is a big challenge for manufacturing companies but, at the same time, an opportunity for them. Actually, in the case described in Section 4, the newly added element, service activity, was found to be an important element for the company, NGL, especially from their business perspective, i.e. how to sell this product. This framework helps companies to explore new business opportunities. In the NGL case, even a possibility to expand their business to e.g. "water management service" with "profit sharing" could be examined. Note that this is exactly a type of service provided by ESCO (energy service company) in the energy sector.

The issue of the paper may be more relevant to products with new technologies, where it is more likely that customers encounter unfamiliar technologies and need instruction. Before purchasing products, there emerges the need of persuading customers. This situation may be interpreted as this issue becomes more important when products are more innovative. Considering both new technologies and innovation are of high interest in Ecodesign, the issue of the paper is important in Ecodesign.

6. Conclusion

As a proverb says, “seeing is believing”. Customers or users want to be sure about the benefits of a product, and persuasion is needed by providers in some cases. This is especially true in the case of ecodesigned products. The paper proposed a new framework used for Ecodesign Strategy including one element, service activity. Communication, a type of service activity, is focused on in the paper. The case study with a product successful on the Swedish marketplace showed the effectiveness of the new framework. Future research topics in the engineering design field include developing a general set of operations using the framework, as previously mentioned in Section 5.1.

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