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SERVICE MODELING FOR SERVICE ENGINEERING

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Abstract: Intensification of service and knowledge contents within product life cycles is considered crucial for dematerialization, in particular, to design optimal product-service systems from the viewpoint of environmentally conscious design and manufacturing in advanced post industrial societies. In addition to the environmental limitations, we are facing social limitations which include limitations of markets to accept increasing numbers of mass-produced artifacts and such environmental and social limitations are restraining economic growth. To attack and remove these problems, we need to reconsider the current mass production paradigm and to make products have more added values largely from knowledge and service contents to compensate volume reduction under the concept of dematerialization. Namely, dematerialization of products needs to enrich service contents. However, service was mainly discussed within marketing and has been mostly neglected within traditional engineering. Therefore, we need new engineering methods to look at services, rather than just functions, called "Service Engineering." To establish service engineering, this paper proposes a modeling technique of service.

Key words: Service Engineering, Service Modeling, Service CAD, Artifactual Engineering

1. INTRODUCTION

Constraints and limitations imposed by natural resource availability, energy supplies, and the ability of the Mother Nature to accept industrially generated waste, have led to the obvious problem of making, using, and disposing of increasing numbers of artifacts. In addition to these environmental limitations, social limitations are also evident, as are limitations of markets to accept increasing numbers of mass-produced artifacts. Consequently, unless we develop revolutionary technologies, environmental and economic limitations will severely restrict economic growth. To fundamentally attack and remove these problems, we need to reconsider the current mass production paradigm and to pursue a new manufacturing paradigm. The new paradigm should reduce the production and consumption volume of artifacts to an adequate, manageable size and bring this volume into balance with natural and social constraints. This new idea is called the Post Mass Production Paradigm (PMPP) and it aims at qualitative satisfaction rather than quantitative sufficiency and decoupling economic growth from material and energy consumption [1-3]. To achieve PMPP, the current practices, methodologies, and tools to design artifacts should be revisited. Products should have more added values largely from knowledge and service contents, rather than just materialistic values, to compensate volume reduction under PMPP [2, 4].

This dematerialization of products requests to enrich service contents. To this end, we need engineering methods to look at services, rather than just materialistic values, called service engineering and to intensify service contents of product life cycles.

This paper focuses on a service modeling method which is needed in the first step of the Service Engineering. Firstly, we clarify why service should be discussed and argue that intensifying service contents is crucial not only for arriving at environmentally conscious design and manufacturing but also for creating more added values in future advanced societies. Secondly, we present essential concepts of service engineering that is required to intensify service contents. Furthermore, we discuss about subjectivity of service. In general, service is related not only to objective elements but also to the receivers' perception of service contents. In this context, we propose a service modeling method which can represent services with such subjective property of service by clarifying actual service cases.

2. SERVICE ENGINEERING

Service is generally perceived as an activity that changes the state of a service receiver [5]. This means that service cannot be stored as opposed to materials and it disappears instantly. Second, to conduct services, we need certain items, including service channel to deliver and amplify services and service contents to be delivered. Usually, artifacts play roles of service channels or service contents.

Figure 1 defines service within a framework of service provider, service receiver, service contents and service channel. A service receiver receives service contents from a service provider through a service channel in order to change own states. Service contents are material, energy, and/or information. The service channel in delivering service contents consumes material, energy, and information. These imply that service cannot be free from environmental impacts. Service sent by the service provider changes the state of the service receiver, which is the most important feature of service as activity.

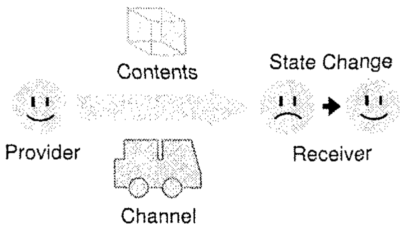


Figure 1. Definition of Service

In this definition, artifacts are devices to deliver, automate, or amplify services used as service channels. Artifacts have their own function, behaviors, and states. The generated total added value of a service is given by the function of the service channel and the quality of the service channel which may includes capacity (amplitude), efficiency, and channel quality (e.g., timeliness, frequency, punctuality, etc.). And service engineering aims at intensifying, improving, and automating this whole framework of service generation, delivery, and consumption. To increase total added value of a service, we can either improve function or quality. Traditionally, engineering design aimed at improving only function. However, this does not suffice in light of service engineering that should look at improving also total added value of a service. For instance, we need to address not only customization of products but also customization of service delivery.

3. SERVICE MODELING

In analogy with product development, service development could be facilitated with a variety of engineering tools and methodologies that can be called service development engineering. For instance, we may consider service modeling inspired by function modeling [6] and this will serve as a basis for establishing service engineering to design services. Namely, such service design assisted with a service modeling tool can help a service designer to design innovative services with more added values and less environmental impacts. According to the definition of service in Figure 1, we can outline some of its elements as follows.

First, service is an activity to change the state of the service receiver. This means that we also need to define activity. Our working definition of activity is that an activity is a series of actions or procedures performed by the involved participants (i.e., service provider and service receiver). Service has the following elements to be modeled. Having defined service elements, we might be able to develop a service modeling tool of which implementation is yet a research issue. It should be equipped with knowledge bases storing knowledge about activities, service environment, and service channel. We are currently planning to implement such a modeling tool.

As we mentioned above, service is defined as an act of a service provider, who is a supplier of service, to cause the service receiver's state change, which is the purpose of service. Service contents are defined as elements of service, which cause the receiver's state change directly in supply of service. A service channel is defined as a device that indirectly contributes to the receiver's state change by delivering, supplying, and amplifying. Service contents and channels are realization methods of service.

Given a purpose to achieve, to synthesize its realization method can stand in a contrast with conventional design of artifacts. Design of artifacts is a process to synthesize physical realization methods for given functions. This correspondence between service design and conventional artifact design suggests that methods to design artifacts (in particular, those for functional design) can be applied to service design.

The state of a service receiver can be represented by parameters. Therefore, these receiver state parameters (RSPs) can represent the receiver's state change that is the result of service. Representing the service receiver's demand with the RSP is the most crucial process in service design. A service content has also parameters. Those parameters that directly influence the service receiver's state change are called content parameters (CoPs). A service channel contributes indirectly to the service receiver's state change as well. A parameter of a service channel is called a channel parameter (ChP).

3.1 Subjectivity of Service

As discussed above, service design has a similarity with artifact design in that functions of artifacts corresponds to service purposes (i.e., the service receiver's state change), and physical mechanisms to service realization methods (such as service contents and service channels). However, even though given the same service as an action, the effect of the service could be different, depending on how the service receiver recognizes the service. Therefore, just like functions are subjective [6], service is also very much subjective and depends on the viewpoints of the service provider and of the service receiver. These two viewpoints must be considered in modeling service.

Because of this subjectivity, the division between the service contents and service channel could be sometimes unclear; *i.e.*, it depends on the viewpoints of the service provider and service receiver, or a service content can sometimes be recognized as a service channel..

3.2 A Model of Service

In building a model of service, it is essential to take into consideration the information about the viewpoints of the service provider and of the service receiver. For this purpose, we here propose a model of service with two assistant models that are called a view model and a scope model (see Figures 2).

A view model of a service represents the viewpoints of the service provider and should include service components and the relationships among them; namely, RSPs, service contents, and service channels in the functional context. Figure 2 illustrates a view model of cooling service containing relations between RSPs that describe the receiver's state changes, and CoPs and ChPs that trigger these state changes. Here, service contents are cooling function while the service channel could be a refrigerator. Functions of a service channel and a service content are represented with a set of function name (FN), function parameter (FP), and function influence (FI). FP is a main target parameter of the function and FI is a main influence of the function to the FP.

In general, functions in the view model are related to other function's FPs or RSPs. We define that a CoP is a FP that is directly related to RSP and a ChP is a FP that is indirectly related to RSP through other FPs. We consider that the essence of service design is to build such relationships among these service elements through functional structure containing RSP, CoP, ChP, and relations among these parameters. Because we also include artifacts in this functional expression of service, we can obtain images of artifacts as service channels or service contents.

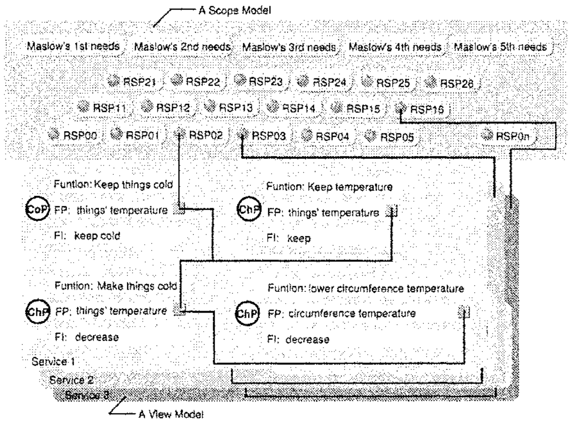
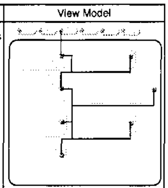
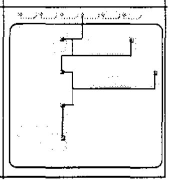


Figure 2. The View and the Scope Model of Cooling Service

Table 1. An Image of the Service Matrix

Service Name	ID No.	Entry Person	RSP	RSP Description	Needs Category	View Model
Manufactuiring / selling a refrigerator	001	xxxxxxxxxx	RSP02		Maslow's 1st Needs	
Manufactuiring / selling a refrigerator	002	xxxxxxxxxx	RSP03		Maslow's 1st Needs	

On the other hands, a scope model of a service represents the viewpoints of the service receiver. Because in reality services can form complicated structures with multiple service providers and service receivers, it is necessary to specify the scope of a service for which the service is intended. A scope model expresses a target area of the current service and represents relations between different services through relations between RSPs (see Figure 2).

In Figure 2, we used *Maslow's needs hierarchy* [7] to give rough classification for needs to represent the service receiver's viewpoints. This scope model represents the relationships among multiple RSPs.

By modeling service based on the above-mentioned definitions, we can arrange existing service cases with a matrix form in which the properties of services are used as keys and it is possible to use this matrix as a basic data for service design. Table 1 shows an image of this *service matrix* data. The cases of services in this service matrix can be organized with various kinds of key information combination (e.g., artifacts, changes of the receiver, functional structure as a realization method of a service, CoPs, ChPs, etc..) By arranging actual service cases in this way, we can generate service data that has high reusability. In addition it is possible to develop a new CAD system for service design by applying various design operations on the service cases represented in this data scheme.

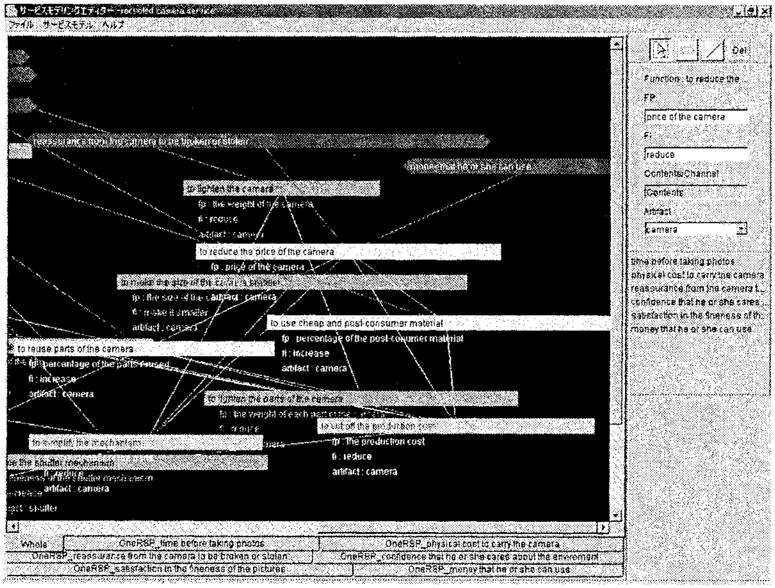


Figure 3. A Screen Shot of the Service Explorer

4. SERVICE EXPLORER

Based on above-mentioned definitions of our service model, we have developed a prototype system of computer aided service modeling tool, which is called Service Explorer. The current version of Service Explorer is developed using Borland JBuilder7 with Java SDK version 1.4.1 and XML version 1.0 on Microsoft Windows2000 environment. Figure 3 shows a screenshot of the prototype system. By using this service explorer, we can represent various services on a computer with the scope and the view model description. In Figure 3, a view model of 'disposable camera service' is expressed in the following manner. A hexangular node mean a RSP of the 'disposable camera service' and the other square nodes represent the functions with its FN, FP and FI in this service.

5. CONCLUSION

Motivated by the concepts of PMPP, this paper proposed a modeling technique of services that is essential to establish service engineering. First, we introduced fundamental concepts of service engineering which aims to intensify service contents (servicification) for creating more added values in future advanced societies and explained the definition of service in the proposed service engineering. Second, we explained the concepts of service modeling by identifying elements of service and then proposed a modeling technique of services introducing a view model and a scope model. A prototype system for service modeling is illustrated.

While many of these ideas are yet to be implemented, this paper is our first attempt to scientifically deal with service. In the future, a service designing tool should be developed on which service design engineering, service production engineering, and service development engineering will be established.

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