e-Service for Complex Technical Products - a New Approach for Supporting Life-cycle Services

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Abstract   Service is an essential element of capital goods today. Sometimes it is even the most profitable business field for the manufacturer. This paper presents an investigation of the re-manufacturing industry in Germany and its competitiveness against new products. Requirements for making service more effective are adduced from this study, leading to the description of an internet-based life-cycle service system. This service system supports all phases of the life of a complex product from configuration to operation, repair and re-manufacturing.

1   INTRODUCTION

Companies producing capital goods have for a long time focused on technological leadership or low prices, but users increasingly ask for the benefit a product generates and not just the product itself. They demand not only more service but customized service. Service is widely seen as the central post-industrial product. According to Sihn, however, original manufacturers of equipment provide only 20% of the service of the capital goods they produce [1]. This is only a small fraction of the money they could earn through service. The delivery of service parts is an especially important business in this respect. In good years, the car manufacturer Volkswagen alone generates a profit of 2 billion Euros just by selling spare parts [2].

The potential for profit from service parts has been investigated by Cincom, a supplier of Enterprise Resource Planning systems (ERP) for life-cycles. Cincom estimates that the profit to be gained from products in this field can be much higher than the profit from selling the original products if the number of products sold annually does not exceed 2-6% of the total sold

to date. The profit which a capital good generates throughout a product's life-cycle can be considerably higher than the profit from selling the product itself [3].

In Eastern Europe, machines have been running for more than 50 years due to cheap labor costs and a lack of new machines, thus creating a large service market. Similar machines in the West have been replaced by new ones much earlier. If the processes of repair and re-manufacturing in countries with high salaries are also to compete better against new products, then ways have to be found to make the practice more efficient and to reduce the amount of work that does not add value.

2   USAGE: A POST-INDUSTRIAL PRODUCT

The usage or benefit of products is becoming more important for customers than the product itself. This is due to the fact that companies no longer regard the ability to use and maintain a machine as a core competence. An airline, for example, understands its mission as being to transport people and not to repair aircraft, which can be done more efficiently by other companies. This is leading to a sort of dematerialization, where customers buy the use of the product rather than the ownership of the product. Producers of photocopying machine are pioneers of this approach. They mainly lease machines to offices and then exchange them when they become too old for the customer. As a result, the office always has up-to-date and reliable copy machines. The manufacturer takes back the old machines and re-manufactures them as new. Producing new machines is getting to be the exception [5].
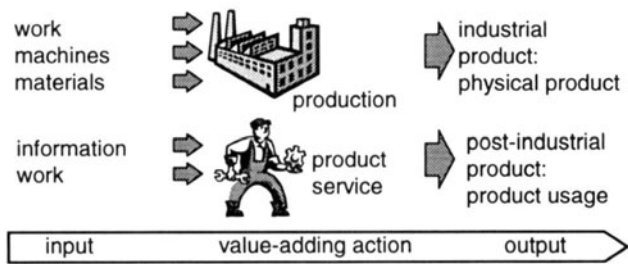

Figure 3: industrial and post-industrial products

Not only companies such as IBM, Hewlett Packard but also traditional industrial companies such as General Electric are also starting to focus on service. IBM already earns more money from service than from selling new computer systems [6]. General Electric Aircraft Engines already generates 57% of its income from the after-sales market. Selling service has a great

impact on the value-adding process, because the input factors, the process of creating value, and the output change. The traditional input factors of production (i.e. work, machines and materials) are gradually being substituted by information and skilled labor. The result of the service process is not a physical product (which already existed) but merely a benefit generated by the service (Figure 1). Another difference between the industrial and the post-industrial product is that the latter is often created on the customer's premises or in local workshops.

3 PRODUCING USAGE: RE-MANUFACTURING COMPANIES IN GERMANY

The re-manufacturing industry is the biggest sector to undertake service throughout the life of the product. A survey of 102 re-manufacturing companies was conducted in order to understand their problems. These companies do not usually produce new products, but restore old products to an as-new condition. They attract little notice despite being a large industrial sector. 73,000 re-manufacturing companies are registered in the USA alone. They employ 480,000 people, which is as much as the US steel industry employs in total [7].

Most of the companies in the study were engaged in the re-manufacturing of tool machines (27%), plastic processing machines (8%), office technology (9%), and construction machines (8%), but the survey also covered companies that re-manufacture car components, cranes, motors and aircraft. The authors can provide a detailed analysis on request.

Re-manufacturers usually sell re-manufactured products in as-new condition at a much lower price. 60% of them, for example, are able to offer the products at less than half the price. Only 10% of the companies charge more than two third of the price of a new counterpart. The re-manufacturers are also competitive against producers of new equipment in respect of delivery times. While the producers of new equipment have to build a product completely and produce or order all the components, re-manufacturers usually re-use most of the non-standardized components. Savings in production and ordering times mean that 60% of the re-manufacturers are able to deliver a complex overhauled product within the first month. Only 5% require more than three months.

Since these companies usually work closely with their customers and since they often carry out maintenance on the customer's site, one might expect the service to be supported by advanced information systems. In practice, however, most of what they offer on the internet, for example, consists of general product information and a presentation of the company. It

is very rare that spare parts can be ordered through the internet. In response to the survey's question about the importance of internet, many companies (35%) said that the internet would be an important additional medium. 15% felt the need to provide more content on the internet, but admitted to not having a strategy.

If the quality of the re-manufactured products is as-new and the price is lower, the shortcomings of these companies can be identified in the provision of information and the insufficient automation of processes by means of computerized systems. The information supplied both to the service employees and to the customer is mostly inadequate.

4   MAINTAINING USAGE: PRODUCT SERVICE THROUGHOUT A PRODUCT'S LIFE-CYCLE

The most common medium used in product service is the telephone. It connects service employees with customers all around the world and can be used for a direct exchange of information. This is often problematic, however.

If a customer cannot identify the required exchange part, for example, he either sends the part to the manufacturer, who then does the identification, or he describes the part verbally, which can be time-consuming and may cause mistakes. If complex information has to be exchanged or if sources such as drawings or pictures are needed, communication via email can be time-consuming. International service can also entail language problems.

Internet technology can provide information in the right context, i.e. customized to the product, to the user and to the particular phase of the life-cycle. Such a system can be easily kept up to date and can deliver information in various languages without having to change its structure. Throughout the life-cycle of capital goods, two major phases can be supported by internet-based product service.

During the period of use, services are needed to keep a product functioning and to pre-empt breakdowns. At the end of usage life, a recovery service can restore the product to an up-to-date technological state. Figure 2 depicts a typical product life with its remaining usage.

If and when parts have to be replaced, spare parts need to be ordered. This is usually done by selecting them from drawings or parts lists, which are often out of date or unavailable. For the identification and ordering of the required parts, electronic systems using interactive drawings can help, making this process faster and avoiding such mistakes as the ordering of the wrong part.
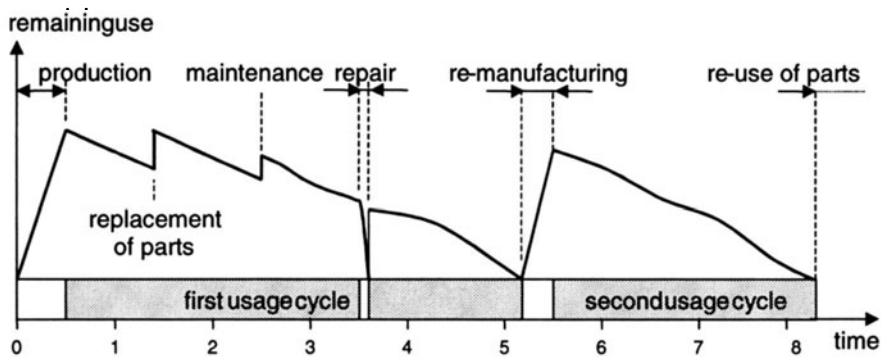
remaininguse

production   maintenance repair   re-manufacturing   re-use of parts

replacement
of parts

first usage cycle   second usage cycle

0   1   2   3   4   5   6   7   8   time

Figure 4: Services in the life-cycle of a product

During the period of usage of a product, the documentation, checklists and guidelines have to be available. Having this documentation electronically accessible helps keep it both up-to-date and in the right context and language.

For maintenance, specific information is required about the condition of a product, its history, the parts already replaced, modifications, and the current operating cycles of parts that wear out. This information is dynamic and cannot be generated in advance. It needs to be recorded during the period of usage. If it is available (e.g. if the manufacturer is the service provider), valuable information and assessment can be provided electronically. It is possible, for example, to generate a current list of parts which are due for replacement. In this case, the ordering could be triggered instantaneously. It is also valuable to provide an analysis of the running costs of a product within a particular time period, including all the parts, service and energy consumption.

If re-manufacturing is to be undertaken, information is required so as to be able to plan the process. Even before the product is disassembled it is often necessary to predict which parts will have to be exchanged and to order them. Assessments based on the age of specific parts and their typical failure rate improve these predictions. In searching for parts that could be salvaged from discarded products, product-specific electronic parts lists can help in finding suitable ones. In this connection, a part with a remaining life-expectancy similar to that of the overall product should be chosen.

5   SUPPORTING USAGE: INTERNET-BASED PRODUCT SERVICE

The Institute of Production Systems, in cooperation with EyeProm GmbH, has developed a web-based system which takes all these

considerations of product service into account. The aim of the system is to support all service needs during and at the end of a usage cycle. The Life-Cycle Service Solution (LSS) consists basically of functions that can be combined into modules which work as portals for user-groups with different information needs

The product structure and the documentation structure are defined in a relational database that has to be created for the LSS. This database contains individual items and their connections.

Items in the product structure (product groups, product types, products, components and parts) are linked together forming products. The items can be part of different product variants, by defining different connections. This enables a rapid definition of customer-specific variants.
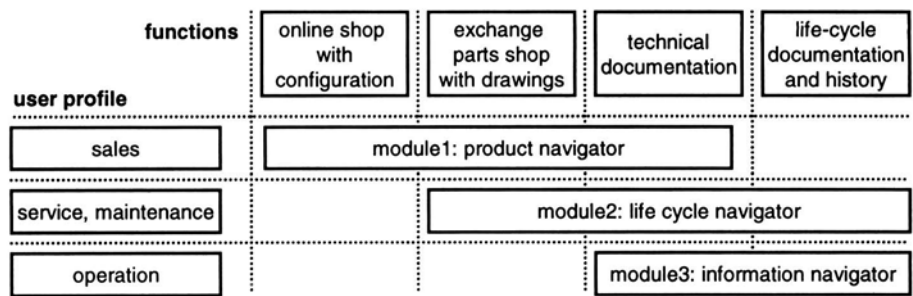

Figure 5: Structure of the life-cycle service system

Items in the documentation structure are also organized hierarchically. Information items can thus be combined to create complex manuals by flexibly linking these items together. This enables the automatic generation of customer-specific manuals by linking the general product information with variant-specific information modules (e.g. for extra accessories).

Other data sources for the information content are Product Data Management (PDM) systems for the manuals, pictures and drawings, and ERP systems for delivering commercial information about products and parts (e.g. availability and price). As the LSS can extract information from existing data sources, an application is possible without much additional data handling. This information is used by various service functions of the LSS (compare Figure 3):

• the online shop with configuration allows the definition of complex products individually for a customer. It is possible to check beforehand in the ERP system to see if the required components are available in the stock;

- the replacement parts shop allows parts to be identified from drawings and to be bought directly. As in the online shop, it is possible to generate an order using email, fax or ERP systems;
- the technical documentation contains general information about product types, such as operating manuals, drawings, diagrams, maintenance information and diagnosis advice;
- the life-cycle documentation records the history of serialized products with all modifications, part exchanges, repairs and specific configurations. Various assessments with regard to wearing parts, availability and costs can be performed on the system.

Figure 6: The three components of the service system

Different user groups have different requirements in respect of service and different rights for data access. Three user profiles are defined and form the basis for the modules which the users will see on entering the system (compare Figure 3):

- The sales employees need to be able to configure complete products, to order them, and to select and buy exchange parts. They also require general product information.
- The product service and the maintenance departments require information about the life and the service history of a product as well as the facility to order exchange parts.
- The operators only need access to the general and the product-specific documentation. They cannot make use of shop functions. The product

scope to which they have access can be limited to one product (Figure 5).

When the user logs into the system, a language adaptation is performed. The system then identifies those products for which he has rights and which user profile he has. He then gets access to the modules, which is configured for his specific requirements. Three basic modules can be dynamically generated: the product navigator, the life-cycle navigator and the information navigator. These modules combine different functions into integrated product-, user- and profile-specific service pages as depicted in Figure 6.

Security is an important feature of the LSS. Users need a password and a login (to load the user profile, language and product scope). A transaction number is then created for the rest of the session. Such an access can be generated customer-specifically and directly printed on the tag of the product or into the manual.

7 CONCLUSIONS

Information is a key element of today's complex technical products and the main resource for keeping them functioning. This paper has presented an approach for delivering information quickly and safely. Different functions are essential for product service systems. However, these functions need to be assigned user profiles and geared to product-, problem- and user-specific contexts. The result of this is a user interface, the so-called navigator. A user logging into the system receives the right information for the products serviced by him, and in the right language. Three different navigators have been implemented. Password-protected transponders make possible the physical combination of product information and the product itself.

8 REFERENCES

[1] Sihn, W. (1999). Deutsche Firmen brauchen mehr Innovationskultur, VDI Nachrichten, **34**, 2
[2] Wüst, C. (2000), Nirvana der Radkappen, Spiegel, **2**, 16
[3] Cincom: (1998), OEM Service Parts Management - Supporting on Out-of-Product Line, Brochure of Cincom, **8**, 2
[4] von Weizsäcker, E. U., Lovins, A.B., Lovins, L.H. (1997). Faktor 4 - Doppelter Wohlstand - halbierter Naturverbrauch, München, Kaur
[5] IEEE Expert (1996), Green engineering: AI pioneer cutting a trail, in: IEEE Expert Intelligent Systems, **6**, 4-6
[6] Stewart, T.A. Der Vierte Produktionsfaktor, Hanser Verlag, 1999
[7] Mühlemann, P. R. (1997), Up and down: Cycling auf jeden Fall: Technische Rundschau, **3**, 24-28