Product support strategy: conventional versus functional products

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Abstract

Purpose – Most advanced durable industrial products need some kind of support to compensate for weaknesses in design or in product exploitation. Aims to examine different scenarios for product support and discusses approaches for development of product support strategy for conventional and functional products.

Design/methodology/approach – The paper is based on a case study of a manufacturer of advanced durable industrial production systems.

Findings – Traditionally, the customer buys, operates, and maintains equipment used in production systems. Alternatively, the customer can buy the performance, instead of the physical product. In such cases, the manufacturer is responsible for operating, maintaining, and supporting the product in addition to designing and making it. Thus, the long-term profit for both user and manufacturer will depend on the product's designed-in life cycle costs, RAMS (reliability, availability, maintainability and supportability) characteristics, as well as on the effectiveness and efficiency of the product exploitation and support processes. In general, product support is a source of income for the manufacturer. In a functional product scenario, the need for product support is a liability and a cost driver for the manufacturer. Hence, delivery of performance requires a fundamentally different approach for product support strategy.

Originality/value – An examination of different scenarios and different approaches for manufacturers' product support strategies.

Keywords Life cycle costs, Service delivery, Manufacturing industries, Business support services

Paper type Conceptual paper

Practical implications

Improved product support has the potential to improve the performance of a product by reducing or preventing losses related to the non-performance of product.

The paper examines approaches for the development of product support strategy for conventional and a functional product. It is emphasized that product support is a source of income for the manufacturer in the conventional product scenario, whilst it is a cost and a liability in the delivery of performance scenario. This new paradigm dealing with product support strategy for functional products will motivate the

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supplier of such products to review and analyze the product support strategy being practiced to support the conventional product before applying it to functional product.

Introduction and background

When a manufacturer delivers an advanced industrial product, the customer receives more than just a physical product/machine. Increasingly, traditional manufacturers find that both they and their customers depend on the services attached to the products. The services create an additional long-term income and performance feedback for the manufacturer and improved utilization and maintenance performance for the customer. Levitt's (1972) contention "everybody is in the service business", seems to be coming true.

Industrial customers demand increasingly better performance with respect to capability, capacity, quality, reliability, regularity, costs, as well as profits generated over time from their production systems. Even though many advanced[1] products/systems are steadily becoming more reliable (thus requiring less corrective maintenance), and easier to maintain (thus resulting in reduced down time), they may need more advanced support services than before due to increasing complexity and integration of hardware, software, sensors, controls, information technology, etc. Often these services can only be provided by the manufacturer. Consequently, the customer and manufacturer may have a business-to-business relationship lasting throughout the product's service life. The relationship is based on the product's weaknesses, the manufacturer's and customer's capabilities and expertise, operation and maintenance strategies, infrastructure, etc. The relationship is as much based on intangible knowledge and expertise as on tangible physical components (such as spare parts, repair tools, documentation, etc.). Therefore, it can be characterized as a service process, where the service delivery strategy is dependent on a negotiated agreement (Kumar *et al.*, 2004; Kumar and Kumar, 2004).

In the following, the concept of delivery of performance as an alternative to a conventional product is examined. However, for many companies the delivery and support for conventional products is still the only alternative. Therefore, firstly the product support strategy for a conventional product is discussed. Thereafter, the improvement opportunities of conventional product performance based on a case study is discussed. At the end, the implications of delivering performance on the background of conventional products are presented.

Definition of functional product: delivery of performance

As an alternative to selling and supporting a conventional product, the manufacturer can deliver the product performance. In this scenario, the plant owner outsources the whole function to the manufacturer and/or supplier. In other words, the customers do not buy the industrial products/systems/machine, but instead buy performance such as drilled meter per shift, volume per hour, etc. The manufacturer is responsible for the product performance based either on a pre-designed existing product or on a new product. The focus thus is on the delivery of performance, rather than on the physical product and support services. In brief, product support strategies will be different for functional products when compared to conventional product.

There exists a large volume of literature discussing product support strategy for conventional products. However, we have not found literature that explicitly focuses on development of product support strategies for situations where the business process owner buys the performance of the products/systems rather than the physical product itself. In an increasingly competitive global market, where the industry is looking for ways to reduce operation and maintenance costs and to increase performance of their production lines, the purchase of a functional product is becoming an interesting alternative.

Product support strategy for "conventional products"

Most published literature on product support focuses on support from a traditional perspective where the customer buys and exploits the product and the manufacturer makes and supports it (Blanchard, 1998; Dhillon, 1999; Fabrycky and Blanchard, 1991; Patton and Bleuel, 2000). In a conventional scenario, the product owner normally performs operations and maintenance processes. Expert assistance as well as original spare/warranty parts may be required from the manufacturer and/or third party. The manufacturer interacts with the customer's maintenance function to supply what in the literature is commonly called after-sales service, product support or just support. Advanced and repeated training may be needed to ensure effective and efficient operation and maintenance. Furthermore, many of the systems need to be modified and upgraded during its service life. In the end of the product's service life the customer may need assistance from the manufacturer to dispose of/recycle the product. Since advanced systems are seldom off-the-shelf products, most often the customer and manufacturer have to cooperate early in the design phase to specify the products. In design, one wants to optimize values with respect to lowest cost related to function, economics, and HSE (health, safety, environmental) as shown in Figure 1. In the conventional product scenario the customer has to pay for the product, unavoidable services to compensate for product weaknesses, and possible supplementary services to assist optimal product exploitation. Product operations and maintenance is an expense as well.

The objective of services accompanying physical products is to "ensure that the product delivers the promised level of performance" (Patton and Bleuel, 2000). One of the important characteristics of a service as compared to a physical product is that services are processes, not things. The product of a service is the process of providing the service. Relationship success and satisfaction therefore is also dependent on the quality of the process. The monetary worth of service products is dependent on the

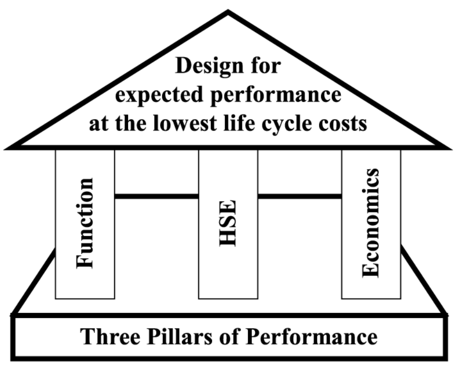


Figure 1. Design for expected performance at lowest costs

"functional worth" to the customer (Michaels, 1996). Functional worth can be defined as the cost of the least expensive way to perform the intended function of a product. Functional worth may vary over time, but generally it is a function of what the product does (functionality, or a product's form, fit and function relative to intended use), its availability when needed, and its costs. Since processes, and hence services, are more difficult to copy than a physical product's characteristics, services can be used to differentiate products providing the same function, in a situation where product price and quality are equal (Grönroos, 2000). The supplier therefore needs an intimate knowledge of the customer's operations and how the product and attached services will fulfill this purpose.

In this paper, a difference is made between services supporting the product (often called product support, after sales service), and services supporting the client actions related to the product (customer support) (Markeset and Kumar, 2003a; Mathieu, 2001). Product support is governed by the product's functional weaknesses. It therefore includes support services such as maintenance, repairs, spare parts, expert advice, and so on. Customer support, we believe, is governed by both manufacturer's and customer's knowledge, expertise, and preferences. In addition, the manufacturer's capabilities, willingness to provide necessary support, geographical location, business strategies, and so on, influence this kind of support. The purpose of customer support, is to assist the customer to maximize all processes (including operations and maintenance), actions and strategies related to the product in order to optimize the product's profit making potential. Figure 2 shows the conventional relationship between a product's designed-in characteristics, its type of application/exploitation (including use environment), product support, and customer support. Also shown are some of the factors that influence performance of each. The continuous lines indicate primary influencing characteristics, whereas broken lines indicate secondary influences. RAMS and functional product characteristics create the basis for exploitation, as well as support services needed. However, to optimize product performance, these characteristics must be considered in the early design phases based on customer's requirements (Markeset and Kumar, 2003a; Blanchard, 1998; Dhillon, 1999; Østerås, 1998). This is often not done before late in the design process. Hence, technology and services to support the product is partially pushed onto the customer, instead of being pulled by the customer based on real needs, wants, and preferences.

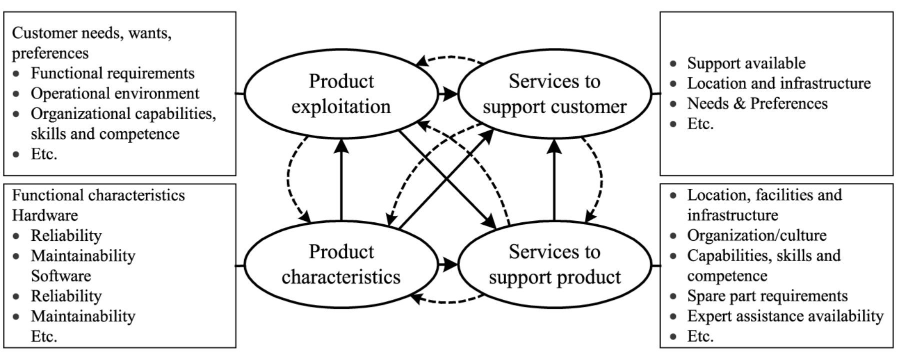


Figure 2.
The conventional view of influences between product characteristics, product exploitation, services to support the product, and services to support the customer

Based on a case study of a manufacturer of advanced products, we will discuss how maintenance and services influence LCC and LCP (life cycle profit) for both manufacturer and customer. In the case study, we first map services offered to the customer. We will thereafter discuss how the company in a traditional approach has the potential to create services as separate products, based on expertise and a strong worldwide service network. Moreover, we will introduce the concept of "Integrated System Performance", based on the concept shown in Figure 2, as a way of achieving goals and additional value creation, and to create a lasting win-win situation for both parties.

Product support strategy for a conventional product: a case study

The case study reported in this paper is part of a larger study of a manufacturer of advanced customized industrial products/systems (Markeset and Kumar, 2003a, b, c). Information was collected through interviews, surveys, conversations, and through participation in meetings, and can be categorized as participatory action research. The manufacturer is a subsidiary of a large multinational firm with Regional Offices (ROs) worldwide. Since the firm offers (and partly manufacture) a wide range of products, mostly related to production line automation, the ROs have to supply a wide range of services. They function as technical support centers offering services such as onsite (field service), telephone, and online support. For online support, the customers get access to online "problem solution banks" containing documented technical information and knowledge. Customers can download documentation, user manuals, video instructions, etc. They can also participate in technical forums and sign up for auto notification of technical updates and product releases. Some of the online support is free, whilst some is offered as "premium" services. The ROs are the first contact point for the customers, whether it is in product inquiry or a support (service) inquiry. If the ROs are not able to assist the customers, the manufacturer is contacted.

It was found that the company and the ROs offer services for all life cycle phases (needs analysis, concept and design, design and delivery, etc.). Many of the services are directed at improving the use of the products (advanced training, upgrading and modifications, access to problem resolution and technical information databanks, etc.), rather than just supporting the product (spare parts, warranty parts, failure diagnostics, etc.).

The various ROs also offer services such as: consulting services, design and delivery services, environmental services, financial services, maintenance services, migration services, optimization services, outsourcing services. It was observed that many of the services offered are not directly related to the products offered, but rather to the expertise/knowledge available in the firm (e.g. financial services, productivity analysis, process analysis, etc.). However, it was further observed that the manufacturer on the other hand, mainly delivered services that supported the product, and that the service department was not very well integrated with the design and manufacturing environment/disciplines. Information flow from the product users and service engineers back to the design environment was not well developed (Markeset and Kumar, 2003c). The company clearly has the potential to create services as separate products based on expertise and a strong network. Such service products can for example be support for competitors' products, support on similar products, services directed at enhanced product use, productivity analysis, process analysis, financial services, etc.

Additional value creation based on "conventional product" performance

As described in Figure 2, the system life cycle performance for a conventional product is dependent on the performance of the delivered product's characteristics, product support, as well as customer support. Figure 3 shows that the total integrated performance of a conventional product is dependent on product characteristics, characteristics of the customer (product exploitation), and characteristics of the compensating services. The system's designed-in characteristics, exploitation environment characteristics, and user characteristics decide how the product performs with respect to capability, capacity and quality. Even with excellent maintenance and operational strategies, the performance of the system cannot become better than "built-in by design" without redesigning or modifying the product. Judgment of capability, capacity, and quality performance can be used to assess the kinds of services needed for the individual customer. Product characteristics together with characteristics of the services intended to support the product, decide the maximum possible performance of the physical function. The performance of the function can be used to assess its exploitation performance (compare actual to possible performance) and the need for supplementary services to support the customer in exploiting the product function. Note that the kind of and amount of services needed may vary widely among the customers. The total service performance is a function of the performance of all the services delivered.

In a conventional product scenario, it may be difficult to see how a win-win situation between manufacturer/supplier and customer can easily be achieved. There are many areas for possible conflicts – especially with respect to sharing of generated profit and costs, as well as with respect to performance measurement and evaluation. The manufacturer can make money in selling the product as well as in offering services. In the worst case, the manufacturer can sell the product with a loss only to earn money on offering unavoidable after sales services.

Actually many manufacturers have problems in seeing incentives as to what there is to gain from making the product more reliable and easier to maintain, as long as they are not worse than competitors' products. The predominant belief is that it will cost more and take more time to design a product for high reliability and low maintenance costs (Markeset and Kumar, 2001; van Baaren and Smit, 1998, 2000). The benefits of

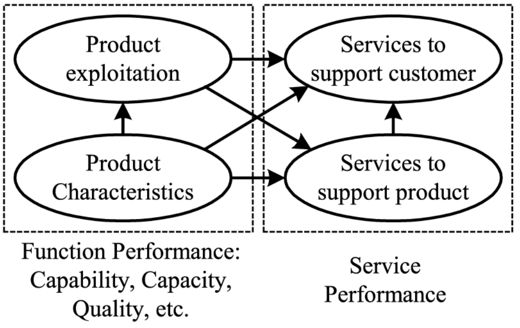
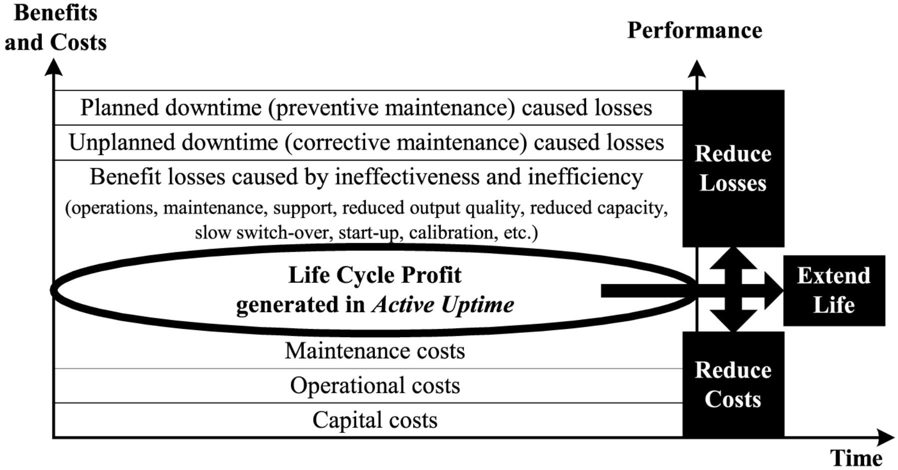


Figure 3.
Conventional product performance

designing the product for reduced LCC through improved RAMS and functional characteristics, are reduced operational and maintenance costs and extended service life. LCC and LCP analyses are performed with respect to cost and the amount of profit the product will generate for the owner (Blanchard, 1998; Dhillon, 1999; Fabrycky and Blanchard, 1991). However, the same analysis can be performed with the product manufacturer in mind. To create a win-win situation for manufacturer and customer the focus has to be on how to optimize the value chain for maximum competitive impact, and on how to create additional value for the end-customer. To do this, cost drivers and performance killers associated with production equipment, work processes, and organization, need to be mapped and controlled. However, for a product owner there are opportunities for improving the product performance in collaboration with the manufacturer for mutual benefit.

Improvement opportunities: conventional product performance

Unplanned stoppages are generally the most common cause for low performance (Jonsson, 1999). Ericsson (1997) reports from TEN field studies that industrial machines were functioning satisfactorily only 59 percent of planned production time. The remaining time was spent on maintenance, machine setting up, and on materials. Plant owners want to maximize the LCP generated by the production facilities (Ahlmann, 1984). In Figure 4, life cycle benefits and costs are shown in a time perspective. LCP can be improved by reducing the costs, by improving ownership effectiveness and efficiency related to operations and maintenance, and by improving support. However, one needs to keep in mind that minimizing the costs does not necessarily result in maximized profit. Production equipment operation, maintenance, and support planning need to be based on market dynamics. Opportunities for profit may be lost because of unavailability caused by badly planned preventive maintenance, unplanned corrective maintenance, as well as ineffectiveness in operations and maintenance strategy.



Source: Adapted from Ahlmann (1984)

Figure 4. Enhancement of a product's life cycle benefits

Mapping of performance "cost drivers" and "performance killers". The goal of mapping cost drivers and performance killers is to reduce unnecessary losses in technology and processes and to take advantage of opportunities for profit in a dynamic market by optimizing maintenance and plant availability. Examples of cost drivers are unplanned maintenance, process bottlenecks, equipment with high energy requirements, potential liability issues, operational and/or maintenance costs, training costs, facility costs, disposal costs, etc. Performance killers are factors/issues that reduce performance without being strong enough to stop the process. Examples of performance killers includes equipment that is critical with respect to uptime/health/safety/environment, bottlenecks in capacity/administration/inventory, incompetence, lack of proper tools and facilities, faulty procedures/checklists, inadequate information and communication flow and system, etc. Performance is furthermore, heavily influenced by personnel motivation and attitudes.

Alignment of service delivery strategies and service reception strategies for enhanced performance. Since industrial product owners will need various kinds of services and support for the various products in use in their product lines throughout their service life, they have to have in place an overview and control of services to be received and a strategy for how to receive them. Each owner therefore needs to develop a service reception strategy. This reception strategy has to be closely linked to the operations and maintenance strategy employed in the company. The reception strategy will further be dependent on the type of equipment, competence, criticality, etc. It therefore has to be closely linked towards the various service delivery strategies of the manufacturers providing the support as shown in Figure 5. If the manufacturer's service delivery strategy is not closely aligned with the product owner's service reception strategy, there are inevitably going to be gaps between them. These performance gaps will lead to dissatisfaction for all parties involved. The consequence could be a less than optimal relationship between the parties involved and a reduced possibility for creating a win-win situation.

Furthermore, since the manufacturer's customers have various support needs, the manufacturer needs to have a general strategy in place directed at all the customers, and a special strategy that fits the needs, demands, and requirements of individual customers. The product owner needs to have a general and specific strategy in place

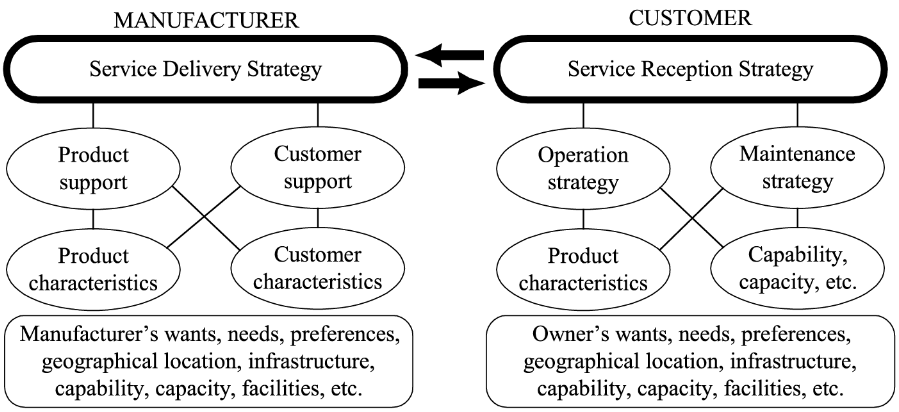


Figure 5.
Some factors influencing service delivery strategy and service reception strategy

depending on the kind of products the strategy encompasses. Some products are more critical and complex and therefore need more maintenance and support. For such products, a specific strategy has to be developed.

Outsourcing of functions. Often the companies neither have nor want to have the competence and resources necessary to perform maintenance on advanced systems. They therefore often resort to outsourcing maintenance to manufacturers, to specialist intermediaries, or to a combination of both. Lately, increased focus on core activities has as well resulted in more outsourcing of non-central functions. In the Shreeveport study (Gay and Essinger, 2000) the most common motivating factors for outsourcing were found to be service cost reduction, headcount reduction, focus on core business, competitive strategy, access to expertise, improved service delivery, and improved quality. However, outsourcing is not without risk – it may result in loss of control, competence, operational flexibility, etc. but, on the other side, it can be a way to mitigate business risk and enhance business performance as well. Outsourcing is often a matter of trust and cooperation between the parties involved. See Bragg (1998) and Kakabadse and Kakabadse (2002) for further discussion.

Moreover, due to the fast development in technology and increasing focus on core activities, in the recent past a new trend is noticed where customers are not willing to invest capital in buying advanced complex industrial systems. They are showing preference for purchasing the function, or to be exact, the performance from the product function, such as tons per hour, meters per shift, etc.

"Delivery of performance" scenario

In the conventional product scenario the plant owner purchases the product, operates and maintains it, as well as disposes of it. Since the customer is primarily interested in obtaining the benefits of the function (i.e. the customer is interested in the hole the drill makes, not the drill, to use Levitt's (1969) well known metaphor), a scenario can be described where the plant owner chooses to outsource the total function to, for example, the manufacturer of the product/machine. This is an advanced form of outsourcing, which is becoming increasingly attractive to companies as they attempt to focus on core activities. In this scenario, the manufacturer is responsible for the continuous performance of the function. Thus, services to support the product or to support the customer have to be an integrated part of the function to be delivered. Actually, the process of continuously delivering the function according to some agreed upon performance criteria is the service. However, this service will depend heavily on the performance of the physical product function. If performance is too low, the manufacturer needs to do what is necessary to improve it and to deliver the agreed upon performance level. In this scenario, the manufacturer will not profit from after sales support services. Rather product support will become a cost and a liability for the manufacturer.

In the following, two sub-scenarios of performance delivery will be considered. In the first case, the manufacturer bases the delivery of continuous functional performance on a new design, whilst in the second case a pre-designed product is the basis for the functional performance.

Delivery of performance based on a new product

If a manufacturer is to be responsible for delivering "total functional performance" instead of just delivering and supporting a physical product performing a function, the physical function needs to be designed for maximum performance effectiveness and efficiency at minimum LCC and maximum LCP. This means that the operational and maintenance costs needs to be as low as possible. Product weaknesses causing the need for services to support product (Figure 2) must be designed out, if possible. If not, the product needs to be designed for cost-effective reliability, and thereafter for easy maintenance and support at lowest cost. Services and maintenance, directed at enhancing product exploitation, need to be attempted and minimized by incorporating them into the training of operation and maintenance personnel, or designed out through improved product RAMS and usability characteristics, improved documentation, and so on, as shown in Figure 6. The less required of the "conventional product services", or the more that can be designed into the product or incorporated in operators and maintainers training and experience, the better the performance will be. The manufacturer will not make any profit in speculating in maintenance and support.

In this scenario, the manufacturer would like to optimize all RAMS and functional characteristics, as well as product support. The manufacturer would benefit from designing the product for lowest possible capital, maintenance, and operational costs, and to do it in less time as shown in Figure 7. After all, as a supplier of a function, the

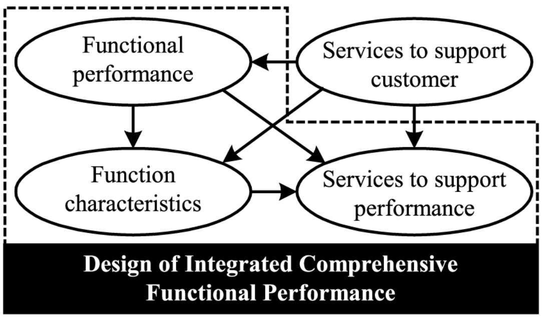


Figure 6.
Product designed for integrated comprehensive functional performance at lowest life cycle costs

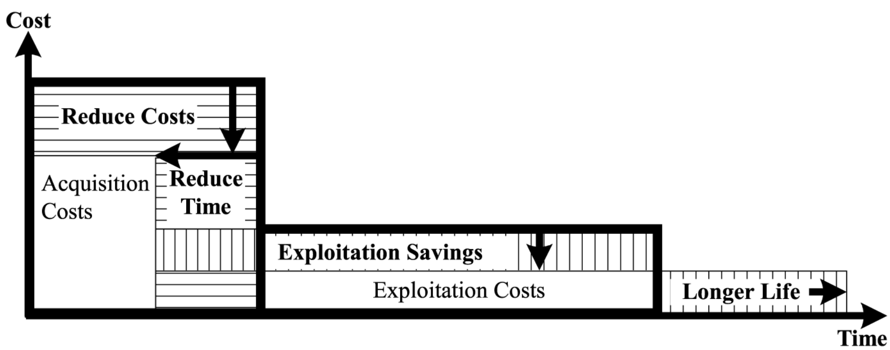


Figure 7.
Functional product – effect of design for performance

manufacturer would benefit from reduced operational costs and extended life. In addition, if, for example, the delivery of the performance were tied up to performance bonuses and/or penalties, it would pay to reduce losses in the operation phase and to make the performance as effective and efficient as possible. If the manufacturer and customer both focus on creating the best possible value for the end-customer, in the end, they would both benefit from best possible performance by having production line equipment that had high uptime and produced best possible quality output. Thus, the product support strategy can be designed on exploitation performance premises. Actually, in this scenario, there is much less a conflict compared to the delivery of a conventional product scenario.

Delivery of performance based on an existing product

In the second case, the manufacturer delivers performance based on an existing designed product. This case is similar to case one, except now the manufacturer has less possibility to influence performance through product design. Since many products are developed through an evolutionary improvement process based on improved knowledge and experiences, technological development, as well as market inputs, they have reached a technological level at which it is neither possible nor cost efficient to improve the functional and/or RAMS characteristics further. Moreover, since the manufacturer owns the physical function, and hence has to live with the weaknesses, there will be no profit from "conventional services" to support the product or customer. In other words, improved profit must come from improved operational, maintenance, and product support strategies. Reliability is influenced by how the product is used, by the use environment, load, and so on. Availability also can be influenced by improving the preventive maintenance strategy and product support strategy. Consequentially, training of operation, maintenance, and support personnel will be important to ensure effective and efficient function performance.

Additional value creation: functional product versus conventional product

To generate maximum profit, industrial customers are interested in products that will produce quality output at minimum costs at the rate and time the market wants. In the conventional product scenario, the manufacturer potentially can profit from selling the product, from selling services to support the product, as well as from selling services to support the customer. Hence, to generate maximum profit through reduced costs, the manufacturer will have to focus on optimizing the performance of each of the related processes. The customer will have to optimize the performance of the operation and maintenance processes, as well as reduce costs related to external services, which for the manufacturer is a profit.

In the case of functional products (delivery of performance), the manufacturer will have to focus on optimizing the same processes that the customer is interested in optimizing. The manufacturer would be responsible for total costs, and the total, comprehensive, and integrated performance. It is also an opportunity to gain knowledge about the operational and maintenance performance of the system under varying conditions. In product design and development, there exists a window of opportunity during the early life cycle phases to reduce life cycle costs, where the "risk avoidance opportunity" is greater than the costs of risk avoidance (Michaels, 1996). By taking advantage of the information and knowledge now readily available, both products and processes can be improved. The knowledge can be helpful for developing new products as well. Furthermore, the knowledge would be valuable for developing and/or improving services for customers who choose to purchase the product in the conventional way.

In the conventional product scenario, the customer's internal interface is between the production process and maintenance process. The manufacturer interacts with the customer's maintenance organization to supply spare parts and expert assistance. In the functional product scenario, the customer receives a performance as a product. The interface and coordination is now between the manufacturer and the production process owner (customer's production department), and in some cases, maybe between the manufacturer and the customer's marketing department. If performance of the function is too low, or costs too much, it would be in the manufacturer's interest to do what is necessary to deliver the agreed upon performance and cost level. This leaves maintenance and support in a new perspective where design for high performance at the lowest cost becomes the sole goal.

Furthermore, if a supplier/manufacturer offers functional products to several customers, conflicts may arise where priority of resources (expertise, spare parts, etc.) may be critical. One of the challenges will be to be able to meet multiple needs for several customers and to make the best necessary trade-offs to satisfy all the customers simultaneously. Moreover, if a business owner purchases functional products from several manufacturers, problem may arise with respect to coordination and cooperation, as well as effectiveness and efficiency.

Table I summarizes some of the basic differences between a conventional product and a performance delivery scenario.

Concluding remarks

In this paper, the focus has been on product support strategies for enhancing the performance of industrial products. Industrial customers are interested in the total integrated long-term value offered, not only the product performance. Increasingly, this integrated value includes the performance of services in addition to the performance of the products. A conventional product scenario is studied and compared to a scenario where the customer only buys the performance.

In the conventional product scenario the performance of the product can be enhanced by improving the service delivery strategies for supporting the product as well as supporting the client in using the product. In this scenario, the manufacturer potentially can benefit from delivering the product as well as the supporting services. Therefore, few incentives exist to improve the product more than necessary from a competitive perspective. Furthermore, the customer needs to have in place a service reception strategy especially fit for the product. To achieve customer satisfaction, this strategy has to be aligned with the manufacturer's service delivery strategy.

In the case of functional product, the customer buys the performance, not the product and the related services. The manufacturer actually provides a service. In this perspective, there is little to gain for the manufacturer from traditional product support. Actually, the need for product support becomes a cost driver and a liability for the manufacturer. Thus, if possible, product performance should be improved through improving the RAMS and other characteristics. Furthermore, operation, maintenance and product support strategies need to be developed with cost reduction, effectiveness,

Product support strategy specifics	Conventional product	Functional product
Ownership of physical product	Customer	Manufacturer
Support	Support generates revenue for manufacturer but is a cost for customer	Support is a cost driver and liability for manufacturer
Functional and RAMS characteristics	Manufacturer focuses on selling a competitive function in the form of a physical product Manufacturer profits from support and therefore may be reluctant to optimize RAMS characteristics	Best possible product RAMS characteristics results in lowest operational and maintenance costs
Interface in exploitation phase	Service delivery department and maintenance department	Manufacturer and customer's process owner
Process optimization with respect to effectiveness and efficiency	Manufacturer and customer will focus on optimizing own processes with respect to cost and profit generation Customer will focus on balancing operational, maintenance, support costs and product performance	Manufacturer and customer are interested in optimizing the performance of the function and all related processes to generate maximum profit at lowest cost
Profit generation	Manufacturer profits from sale of physical product, and any support services delivered. Customer profits from the output generated by the product	Both parties profit from the output generated by the product performance
Price	Customer wants highest function performance for lowest cost Manufacturer wants maximum profit from product and supporting services at lowest cost	Both parties are interested in the performance of the product The product and all related processes must generate maximum profit at the lowest life cycle costs
Negotiation of services	Focus on trade-offs between product price, performance and costs Operations and maintenance processes are controlled by the customer	Focus on performance at the lowest costs Operational, maintenance, and support costs are all in the hands of the manufacturer/supplier

Table I. Comparison of conventional and functional products from a manufacturer's perspective

and efficiency in mind. Consequently, for functional products the product strategy will be fundamentally different when compared to conventional products.

Note

1. In this paper, the notion "advanced products/systems" refers to industrial durable products where mechanical, electrical, electronics, components and sub-systems, cables, etc. are integrated into complex systems and (often) controlled by the use of sensors, electronics, and software. Several "advanced systems" can be engineered and programmed to perform a holistic function together. See Stevens *et al.* (1998) for details.

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