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Innovative Service-Based Business Concepts for the Machine Tool Building Industry

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Abstract
During the last decade, machine tool building companies have been forced to put innovative offers on the market. Due to the technical features of their products and the prevailing organizational structures in this sector, especially product-service systems are a promising way of creating a unique selling point. In this paper, potential new business concepts for machine tool builders will be presented which aim at fulfilling basic customer needs like the increase in quality, flexibility, productivity and the reduction of lead times, costs and risks. For the implementation of these product-service systems, practical examples are given.

Keywords:
Machine Tool Building Companies, Service-Based Business Concepts, Product-Service Systems

1 INTRODUCTION

During the last decade, machine tool building companies have been facing a turbulent economic environment. Especially challenges arising from the growing competitiveness of Asian business rivals [1] force machine tool builders to launch innovative offers on the market with the purpose of strengthening customer relationships and generating long-term customer loyalty. Due to the technical features of the products and the organizational structures in this sector, especially product-service systems (PSS, IPS^2) are a promising way of creating a unique selling point.

A range of generic business concepts based on product-service systems has been developed for these conditions, comprising high quality goods and product-related services. In this paper, six potential new business concepts for machine tool builders are presented which aim at fulfilling basic customer needs. Furthermore, it will be shown how based on promising value propositions win-win situations can be generated by new concepts of configuring the sharing of tasks between suppliers and customers and the performance of high class service delivery. For the implementation of the depicted product-service systems, practical examples from machine tool building companies from the European industry are given.

The objective of this paper is to give a comprehensive overview about potential service-based business concepts for machine tool building companies. The basis for offering business concepts in the machine tool building industry are product-service systems adapted to the customers' requirements [2].

Product-service systems are a widely accepted concept, in the field of research as well as in practice. They can be defined as a mixture of "tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs" [3] and are regarded as a powerful source of innovation in the sector of machine tool building companies [4, 5, 6]. This mature sector is of high importance for Europe and the European machine tool production and accounted for more than 19,000 million euros turnover in 2006 [7]. Europe continues to be world leader in the machine tool industry, but after the collapse of the economical-political barriers and the globalization process triggered by the diffusion of new technologies, in the last decades new competitors from emerging economies have started approaching the market offering cheaper machines. As the automotive industry, in which a fundamental competition driver is cost, is the major customer of machine tool builders, European companies have lost significant market shares. Europe's difficulties in this sector are clearly outlined by the constantly increasing gap between European production of machine tools and global production figures. Furthermore, although exports to developing countries are increasing, the ones to mature economies are on the decrease. Low cost producers from emerging markets are gaining more and more market shares [7].

Whilst for countering the market entry moment of emerging competitors, European companies could rely on superior quality as well as technology of their products, the technological and managerial gaps separating them from e.g. Asian companies have been reduced and no longer constitute a real protection for the future of this industry in Europe. The development of innovative product-service strategies will thus be a strategic response to the global market challenges.

Especially in the manufacturing sector, companies increasingly have to adapt their business concept to the newly arising challenges depicted above and hence increase the service content of their offers. Product-service systems in the machine tool building sector have several advantages for machine tool builders and their customers. While manufacturers can stand out from the competition, particularly against their low cost rivals in business, they can achieve customer loyalty by developing solutions in a customer-oriented way and hence create a greater value for their customers [2]. By means of the new business concept customers can benefit from customized solutions, increase quality, flexibility and productivity and reduce risks, costs and lead times at the same time.

A widely used categorization scheme [8, 9, 10] for product-service systems was compiled by Tukker [11]. In

this approach, they are divided into three subcategories sorted by decreasing product content and increasing service content (figure 1):

- *Product-oriented services* are strongly connected with the product. The property rights of the physical assets are transferred to the customer while the machine tool builder adds extra value to the offer by arranging services around this product. Especially technical services have a strong product relationship [12], yet the interdependencies between the product and the related service are generally weak [8].
- In *use-oriented product-service systems*, the property rights of the physical product remain at the manufacturing company which sells the use of this equipment via concepts like pooling, leasing or sharing, making the physical product available for the production of one or several users.
- *Result-oriented product-service systems* are an approach focusing on the result of production or services whilst disregarding the underlying product. As in use-oriented product-service systems, the property rights of the product the concept is based on are retained by the manufacturing company. The provider of the result can freely decide on how the result is produced.

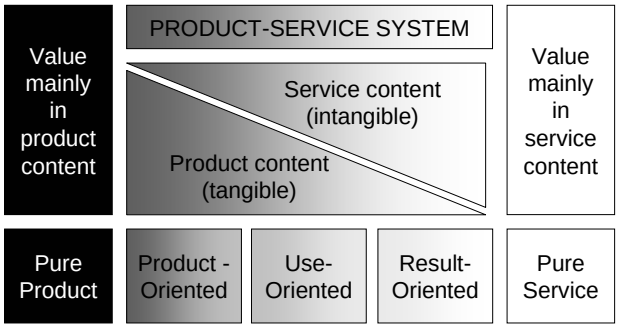

Figure 1: Main categories of product-service systems [11].

2 SERVICE-BASED BUSINESS CONCEPTS FOR MACHINE TOOL BUILDING COMPANIES

As shown in figure 2, a business concept defines

- the value generated for customers and other actors in a business transaction ("value proposition"),
- the actors who are involved in the business transaction as well as their roles and their contribution to creation of value („value chain configuration") and
- the payment model of the business transaction ("revenue model").

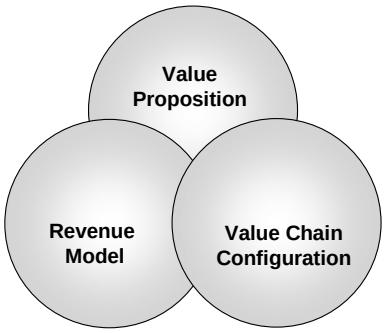

Figure 2: Elements of Business Concepts [13].

In the machine tool building industry, product-service systems can serve as a basis for new business concepts. Combining machine tools with services can generate value for the customer and for the manufacturer as well. Customized product-oriented, use-oriented or result-oriented product-service systems pose as the value proposition offered by machine tool builders to their customers.

The cooperation process between the machine tool builder and the customer companies in new business concepts based on product-service systems affects the value chain and thus describes the novel share of work. These cooperation scenarios have several dimensions which vary depending on the characteristics of the sharing of tasks in the business concepts. In order to explicitly consider these dimensions with their corresponding characteristics while designing a product-service system, the morphological box in figure 3 on the basis of Lay et al. [14] is proposed. The comprised dimensions are ownership of the product during the use phase and ownership after the use phase, location of the technical equipment, operation personnel and maintenance personnel as well as the number of customers served with the business concept. The revenue model is also included in the dimension payment mode.

Characteristic features	*Options*			
Operating personnel	MTB	Operating Joint Venture	Third party	Customer
Maintenance personnel	MTB	Operating Joint Venture	Third party	Customer
Location	MTB	Third party	"Fence to Fence" to the customer	Customer
Payment modus	Pay per Part	Pay per use	Pay for availability	Fixed rate	Pay for equipment
Owner-ship – **During phase of use**	MTB	MTB	MTB	MTB / Leasing bank	Customer
Owner-ship – **After phase of use**				MTB / Leasing bank / Customer	
Single/multi customer operation	In parallel operation for multi customer			Operation for a single customer	

Figure 3: Morphological box on product-service systems for machine tool building companies (MTB).

In the machine tool building industry, several kinds of key players involved in the supply chain of a new business concept can be thought of. First of all, the machine tool building company is an actor, offering product and/or services to the customer which is the second actor. A third stakeholder in a new business concept based on product-service systems can be a leasing bank supporting the machine tool builder or customer in the financial matters of the transaction. Beyond these, a potential scenario in the machine tool building industry is the foundation of a joint venture formed between two or more actors. Furthermore, a third party can as well be involved in the business concept. As an example, a temporary employment agency can provide staff to operate or maintain machinery and equipment.

The traditional business concept can be found on the right side of the morphological box. Here, the manufacturing company sells the machinery to its customer. The equipment is operated on the customer's site. The customer pays for the equipment, and is responsible for manufacturing operations as well as for maintaining the machine. The amount of products manufactured meets only the needs of one customer, who is the owner of the machinery.

The concept of outsourcing of entire business processes to equipment suppliers is represented by the characteristics depicted on the far left side of the morphological box. In this case, the equipment producer retains ownership of the equipment, employs operating and maintenance personnel, implements the equipment in its production plant, produces parts on this equipment for multi customers and is paid per part.

Suitable customer-oriented business concepts based on the combination of products and services can be designed evaluating the technological particularities of machine tools, together with the manufacturer's and the customer's organizational structure requirements, like the need for reduction of costs, risks and lead times or increase in flexibility, quality and productivity. Based on the results of large scale surveys and on the findings of case studies [15], several value propositions in the machine tool sector were categorized and described in terms of machines and related services. In this paper, the six most significant of these value propositions are presented below, structured according to the categories of product-service systems cited above and described with regard to the characteristic features introduced in the morphological box.

2.1 Product-oriented Product-Service Systems for Machine Tool Builders

Availability guarantee

The availability of the production system is a crucial task for an industrial company because it may have impact on the total lead time, the production volume to be realized and the costs related to production loss and the eventual recourse to outsourcing. In situations in which the customer company is not able to reach adequate performance and achieve the needed equipment availability, the machine tool builder can solve this problem by offering an availability guarantee with lower costs and time-saving effects. Leveraging its specialization in maintenance activities, the supplier is able to guarantee higher availabilities on better conditions compared to those of the customer. In this case, the planning of preventive maintenance as well as the entire maintenance strategy can be performed more efficiently, leading to a lower repair frequency (MTBF) and costs. The know-how and specialization in maintenance enables the respective staff to develop competences and skills to allow lower repair time (MTTR) and a more efficient consume of the materials needed for the maintenance, both factors leading to costs savings. The end user is charged for the availability of the production system. The higher the guaranteed availability, the higher the costs for the customer will be. For this value proposition, a cooperation scenario in which the property rights of the machinery are transferred to the customer can be appropriate. The machine tool builder maintains the production system and is paid based on the availability it is able to guarantee to the customer. This concept can therefore be counted among the category of *product-oriented* product-service systems.

Solving customer qualification deficits

Companies acting in industrial sectors with up-to-date technologies and rapid technological change may hesitate to invest in new production systems. One reason might be the lack of sufficiently qualified personnel. If the customer's workforce does not have the required skills to operate and maintain modern machinery, this can result in the management's decision to forgo capital-intensive investments and to continue working with an out-dated machine. This attitude can be observed particularly in developing and emerging countries. This is where new service-based business concepts can be applied. A machine tool builder can sell its advanced production system in combination with the offer to solve the customer's qualification deficit either with a training solution or a production service solution. In the first case, a professional training for the customer's workforce is conducted by skilled personnel of the machine tool building company before the implementation and during the operation of the new production system, especially in the ramp-up phase. This business concept is based on a *product-oriented* product-service system.

The alternative solution, a temporary production service offer can take place at the customer's plant on a short- to mid-term level, as mentioned above during the equipment ramp-up and in the initial production phase by providing the customer's facilities with qualified personnel that runs the machines. This can be categorized as well as a *product-oriented* product-service system. Alternatively, a production service in terms of outsourcing entire processes can be offered which is described below.

Reconfigurable production systems

The concept of reconfiguration can be described as the technical customization of the equipment to technological change and varying customer requirements. Especially fields in which machinery is in use for long periods of time but is needed to manufacture many different product variants and consequently has a high retooling frequency have to be mentioned in this context. Furthermore, unpredictable market demands and requests force the industrial companies to be as flexible as possible in order to respond to them at the right time and with low costs. Customers often do not want to invest in the latest equipment since they fear the high investment costs. A manufacturing company can offer a modernization concept to customers based on reconfiguration and refurbishment of modules or entire production systems. Thereby, the machine tool builder offers to modify rapidly and economically in terms of targeted production volume and mix. Offering such a service for a production system allows the companies to be flexible, to reduce costs and time needed to respond to the market and to reduce the technological and operative risks related to the use of static machines. This cooperation scenario is characterized by the ownership of the end user and a production system addressed to increase its performance and efficiency level which can be very low in out-dated machinery. The business concept is based on a product-oriented product-service system.

Lean machine business concepts

Many up-to-date production systems offer a multitude of features customers can use for the production of advanced products and a multiplicity of product variants. Yet, there are cases in which customers do not need these advanced machines with many functions and with a high performance. For the manufacturing of basic products or components, especially in low-tech industries, simple machines with a restricted number of functionalities are sufficient. In this case, the use of overdimensioned and oversized machinery may result in high production costs, since the investment and maintenance costs for a production system with a bulk of special features are higher than those for a basic model. The outcomes of this are high production costs per unit. Customers aiming at purchasing a new production system could be offered an alternative to high-end solutions, i.e. the "lean machine" concept with only those functions needed and consequently with stripped-down equipment. This cooperation scenario is characterized by the ownership of the end user and therefore the basis of this business concept is a *product-oriented* product-service system.

2.2 Use-oriented Product-Service Systems for Machine Tool Builders

Concepts for levelling irregular and temporary customer capacity requirements

In cyclical industries, but also in make-to-order production and in manufacturing of prototypes, sample parts and trial parts or in cases of high market risks and uncertainties, the capacity utilization of the machinery is low on the average. However, these types of production are often also characterized by significant capacity variances. In this situation, customers have two possibilities: they can either provide capacities that cover capacity peaks and therefore may have unexploited capacities during the production time which results in high costs per unit. The alternative is to dimension the production system for smaller capacity requirements. In this case they may risk delays in the production process. In the worst case orders might have to be rejected. This is where the value proposition of levelling capacity requirements applies. A machine tool builder can provide the customers with a mobile production system in times of capacity peaks. In this case, the customers can either pay a fixed rate depending on the time the machine is needed or the payment is based on the number of operations carried out on the mobile machinery. This product-service system can be regarded as a use-oriented one.

2.3 Result-oriented Product-Service Systems for Machine Tool Builders

Concepts for levelling irregular and temporary customer capacity requirements

As an alternative for levelling customer capacity requirements, the machine tool builder can also run a machine similar to the customer's one and produce parts simultaneously for him. The customer situations described above vary between temporarily restricted time spans, e.g. in the ramp-up phase of a product variant and can last up to the entire life span of a production machine in seasonal customer industries. If producers of machine tools succeed in increasing capacity utilization by means of offering service-based business concepts so that their customers merely have to invest in machinery and equipment to satisfy the average demand whereas demand peaks are covered by the manufacturer's facilities, then economic advantages can be achieved for both parties. The parts produced by the machine tool builder are sold to the customer on a pay-per-unit basis. The manufacturer might be able to bundle orders from several customers and benefits from economies-of-scale effects.

For this value proposition, a cooperation scenario in which the machine tool builder owns, operates, maintains the production system can be proposed. The customer pays based on the realized production. The location of the operation is not fixed in this cooperation scenario and therefore all options are open. In case of an unstable and short-term production, the manufacturer can operate simultaneously for more than one customer in such a cooperation scenario. Therefore, this product-service system can be regarded as a result-oriented one.

Production service

Due to their specific knowledge of the machinery, in certain cases machine tool suppliers can produce higher quality with lower costs in less time than the end users producing autonomously at their own plants and hence turn into a part supplier. The reason for this might lie in the fact that with time the machine tool builders are able to acquire those competences and skills that enable them to obtain higher performances in a particular type of production, not least owing to economies of scale and learning curve effects. In these cases, the suppliers can guarantee the equipment availability for long periods to their customers, running the production system and producing for them whilst being responsible for the manufacturing staff as well as for maintenance and location of the production system. On the other side, the end user can externalize the production to the supplier, purchasing the end products directly from the supplier, paying per unit. In this way, risks can be reduced and the customer's flexibility increases. In unpredictable production situations, the machine tool builders can operate simultaneously for more than one customer using such a cooperation scenario, realizing the economies of scale mentioned above. Offering a production service ranks among the *result-oriented* product-service systems.

All product-service systems depicted above can be found in Tukker's categorization scheme in figure 4.

Product-Oriented	Use-Oriented	Result-Oriented
• Availability guarantee • Solving customer qualification deficits • Reconfigurable production systems • Lean machine business concepts	• Levelling irregular and temporary customer capacity requirements	• Levelling irregular and temporary customer capacity requirements • Production Service

Figure 4: Product-service systems for machine tool building companies.

3 PRACTICAL EXAMPLES FROM THE MACHINE TOOL BUILDING INDUSTRY

In the following paragraphs, examples for potential business concepts based on the three types of product-service systems will be depicted.

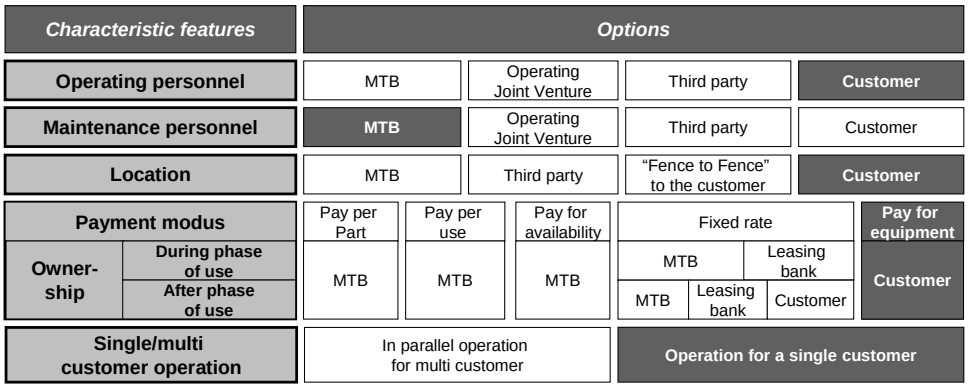

Figure 5: Morphological box for product-oriented product-service system case study.

3.1 Practical examples for product-oriented product-service systems for machine tool builders: Solving Customer Qualification Deficits

The case study company is a large company operating worldwide as one of the international market leaders in designing, producing, maintaining and supplying equipment and components for the railway industry. It consists of three divisions which up to now independently offer training to their customers. A basic training is offered to solve their customers' qualification deficits during the installation of a machine or in the end of this phase, in the beginning of the testing and ramp-up phase. It mainly consists of a verbal explanation of the instruction book and the programming of the machinery. This training takes place at the customer's facilities and is conducted by a technician of the case study company. The price for the training is included in the price of the machine.

Additionally, for machines with new technologies or for special parts that are supposed to be produced, special training courses are offered as well. They are conducted according to the customer's requirements at the customer facilities or at the manufacturer's facilities. The price for the training is negotiated in every additional training case.

For the future, alternative ways of giving training to the customers are assessed as the case study company plans to outsource the training activities to a subsidiary company which will conduct training for the three divisions of the company, bundling resources and realising economies of scale. However, in case of a change of the supply of training, in the case study company, its divisions and in the subsidiary company a multitude of processes needs to be modified. Furthermore, a decision has to be made on the hierarchical integration of the subsidiary into the corporate group. Hence, guidelines and supportive tools are needed to assist the company in the transition process.

The morphological box with the characteristic features of the training business concept of this case study company can be found in figure 5.

3.2 Practical example for use-oriented product service systems for machine tool builders: Levelling irregular or temporary customer capacity requirements

The case study company is a small enterprise specialized in electrical discharge machines, like sinking machines, wire electrical discharge machines and filtration units. The main customers are companies producing parts for electronic and mechanical applications as well as for filtration and process technologies. Furthermore, the customer companies which are served by the case study company range from very small enterprises with less than ten employees to multinational corporate groups.

In addition to the traditional sale concept the company offers their machines in a new business concept to increase its market share. Customers are expected to benefit from this offer as they can use the electrical discharge machines without having to buy them since the property rights of the machines either stay with the producing company or are transferred to a third party, in this case a leasing bank. If a customer is interested in renting the machinery instead of buying it, a leasing bank is contacted. After verifying the reliability of the customer, the bank buys the equipment from the manufacturer and leases it to the customer. The machine tool builder is paid for the equipment by the bank while the customer pays monthly or quarterly fees to the leasing bank.

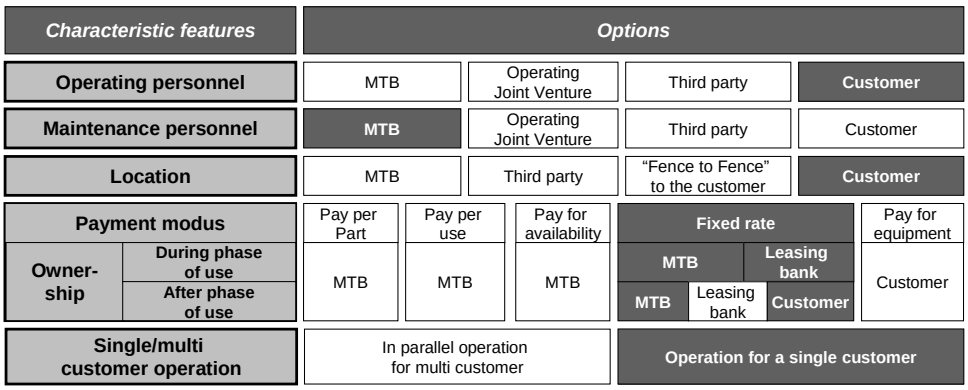

Figure 6: Morphological box for use-oriented product-service system case study.

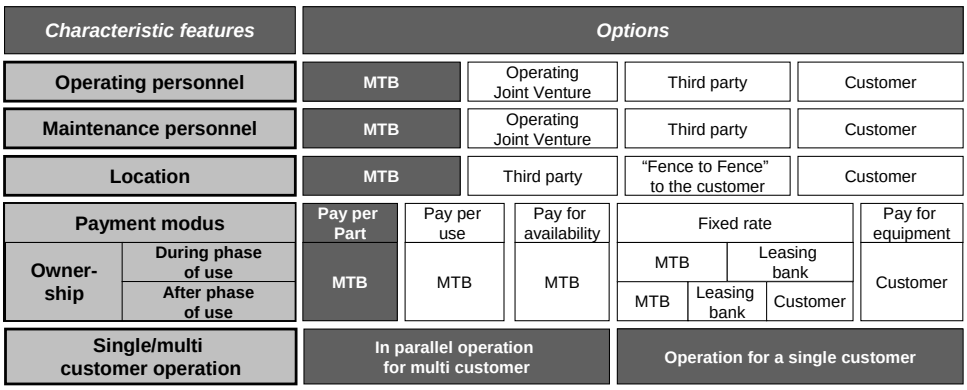

Figure 7: Morphological box for result-oriented product-service system case study.

When the contract expires, the customer company has to decide whether the equipment will be bought from the bank for the residual value or not. If not, the machine tool builder has the chance to buy the equipment back from the bank, to refurbish it and to put it onto the second hand machinery market.

In this renting concept, the operating personnel are provided by the customer like in the traditional business concept, but the maintenance is carried out by the manufacturing company. The machine is operated in the facilities of the customer company for only a single customer.

Like in the product-oriented product-service system case study, a need for tools and guidelines can be derived. The machine tool building company needs hints on how to deal with financial matters. Furthermore, like in the case described above, when a third party, in this case the leasing bank, is involved additionally besides the customer, processes change. For this transition guidelines are needed as well to make the changes visible and to support the manufacturing companies.

The morphological box with the characteristic features of the renting business concept of this case study company can be found in figure 6.

3.3 Practical example for result-oriented product-service systems for machine tool builders: Production Service

The result-oriented business concept case study company is a SME producing milling and grinding production systems for precision mechanical components for the aerospace industry. As these products are large, complex systems and have an advanced technology level, they are sold at high prices. To also serve customers which cannot afford this equipment, the company offers a production service as a new business concept to its customers. This leads to a win-win situation as the customer can access an advanced technology for which the machine tool building company owns specific know-how.

Parts are produced at the facilities of the customer on refurbished equipment. The company's personnel are responsible for operation as well as for maintenance of the machinery. The company is paid according to the results of the production, the number of parts produced. In order to reduce the machine tool builder's risk, the customers have to sign contracts with minimum purchase agreements. After a predefined period of pay-per-part production, in which customers can acquire experience of the process and test the market potential, customers have the option to buy the machines, to renew the pay-per-part contract or to re-negotiate it.

In this case study, it became clear that machine tool building companies which plan to implement a product-service system like the one described above need assistance in evaluating the profitability of the production service, considering the costs and revenues during the entire life cycle of the business concept.

The morphological box with the characteristic features of the production service business concept of this case study company can be found in figure 7.

4 CONCLUSIONS

Product-service systems are widely spread in the machine tool building industry. Although ways of offering use-oriented and result-oriented combinations of products and services to stand out from competition have been investigated in literature, product-oriented product-service systems, especially in the form of product-related services, still prevail in practice. The reasons for this can be seen in the increasing complexity of use and result-oriented concepts requiring the integration of products and services already in the early stages of development [8] and hence in the lack of appropriate instruments for machine tool building companies supporting them in the transition process from offering the traditional business concept of selling the products with obligatory services to the creation of new relationships between manufacturers and their customers. From the analysis of the case studies, it became clear that tools and guidelines to support machine tool builders in this process are needed, especially with regard to the selection of the appropriate business concept as well as concerning financial issues, technological features of the products and organizational questions.

5 ACKNOWLEDGEMENTS

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