# Manufacturing Service Ecosystems

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## Towards a new model to support service innovation based on Extended Products

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**Abstract.** The trend for servitization is increasingly affecting manufacturing enterprises. Products are bundled with associated services to so called "Extended Products" (EP). However, the share of services becomes more and more important. This requires on the one hand an evolution of the EP concept towards greater interoperability of the physical product and on the other hand additional competencies in service innovation. Traditional manufacturing enterprises are not able to handle the related challenges by themselves. The paper presents a more open and service-oriented "EP 2.0" concept and introduces the Manufacturing Service Ecosystem as a model to support service innovation by facilitating collaboration.

**Keywords:** Servitization, Service Innovation, Extended Product, Manufacturing Service Ecosystem, MSEE Integrated Project

## 1 Introduction

A trend for servitization of products is affecting manufacturing enterprises. By looking for benefits, the customers force the manufacturer to give increasing attention to understand and solve their problems. The key success factor is the provision of additional value to the customer [1]. Thus, physical products are combined with associated services to so called "Extended Products" (EP) [2].

Take for instance a traditional manufacturing SME, which has evolved from the production of parts for machine tools, over the offering of standard drilling machines, towards customization of high precision machining centres. While in the past it has been sufficient to provide standard maintenance services like replacing expendables and spare parts, the customers now expect permanent availability of the machines. However, the complexity of the machining centres sometimes requires very difficult maintenance tasks. Although the distance between the manufacturer and the customer can be many thousand kilometres, immediate technical assistance is expected to minimize breakdown times. However, as a traditional manufacturer the SME has neither the competencies nor the resources to provide individual maintenance ser-

vices, which leads to high costs for preventive and corrective actions. The need is clearly to support the SME to innovate some kind of "smart maintenance service" and make their products interoperable accordingly (e.g. with sensors and remote control), which could produce additional revenues and profit.

Innovation of such Extended Products, from idea generation to realization and commercialization, requires on the one hand a better understanding of the customer requirements [3] and on the other hand additional competencies for the integrated design and provision of the product and services. Thus, the involvement of the customers as partners (e.g. to identify maintenance needs) and collaborative arrangements with other enterprises (e.g. local maintenance service providers) become more and more important [4]. Manufacturing enterprises do not only have to support service innovation and provide the required physical resources, organizational structures, as well as IT tools. Furthermore, they have to ensure the interoperability of their products to existing and newly developed services.

## 2 State of the art for service innovation in the context of Extended Products

### 2.1 The Extended Product concept and a step beyond to service innovation

The concept of an Extended Product (EP) describes a complex combination of tangible and intangible assets as a "utility package" to satisfy the customers' needs [2], [5]. In this concept, the core of the EP is the physical product and the services are aligned in circles around it. However, the share of services becomes more and more important even for the manufacturers of physical products. In some cases they are making more profit with the services than with the physical products [6]. In addition, development and production processes become more and more "open", this means that the manufacturers have to involve partners with specific competences and that they exchange information with the "outside world" like customers or even competitors. The concept of open innovation [7] is one example that represents this trend. Therefore, the initial concept of the EP has to be evolved in the direction of interoperability of the physical product with different services to avoid unnecessary restrictions.

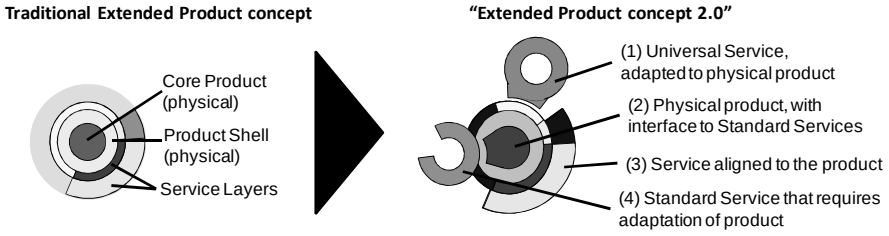


**Fig. 1.** Towards a more open and service-oriented Extended Product concept

According to **Fig. 1**, one of the main extensions in comparison to the initial EP concept is that in "EP 2.0" there are not just services that are developed specifically for

the physical product (3). Rather, the EP can make use of services that already exist independently from the particular physical product. However, some of these services need adaptations to work with the physical product (1). There are for example existing service centres that monitor data from sensors and take defined actions in case of alerts or if the received sensor data show critical values. If the machining centre mentioned above should be monitored by such a service provider, it is necessary to establish the data connection and to define threshold and corresponding actions.

Another category of services that extend the initial EP concept are available standard services that are applied without further adaptations (4). However, it may be necessary to prepare the physical product with interfaces according to the correct standards to make the service work (2). In the machining centre example, such a standard service could be express spare part logistics that enable the exchange of components and modules within 24 hours, 365 days per year. To apply the service, it could be necessary to align the size and weight of machine components to the standards of the specialized logistics provider that offers the service.

According to this widened view on the EP concept, there are different options for service innovation. Usually, it is assumed that service innovation leads to new services. E.g. Toivonen and Tuominen define service innovation as "a new service or such a renewal of an existing service which is put into practice and which provides benefit to the organization that has developed it" [8]. However, in the context of EP this does not cover all options of service innovation: Additional possibilities are new combinations of existing services with a certain physical product. Innovation also includes new adaptations of universal services or of the physical product to enable the application of standard services. This leads to certain challenges for manufacturing enterprises, if they are aiming at innovative EP:

- They need competencies in service development if they want to develop new services for their product or new products with related services.
- For new combinations of existing services with their products, they need to get to know potential service candidates. This means that they have to "look beyond their own backyard" into branches that are not yet related to their product.
- In both cases it could be necessary to have competencies in equipping the already existing product with standard interfaces to services. Therefore they need some "service thinking" that they can obtain from cooperation with services providers.

### 2.2 Existing approaches to support service innovation

In the past, approaches towards innovation in manufacturing enterprises have been focusing on the physical product, as their outcome has been rare in services [9]. Manufacturing and distribution as well as maintenance, repairs and recycling (in case such services are offered) were organized in linear deterministic Supply Chains. A new approach to support service innovation in manufacturing enterprises will have to overcome these rigid structures and address the challenges identified in the previous section. Two possible options to deal with this situation are described below: A top-

level perspective on the reconfiguration of Supply Chains and the approach to apply a Virtual organization Breeding Environment in the context of service innovation.

**Reconfiguration of the Supply Chain using the open universe of organizations.** The traditional way to initiate the innovation of a new Extended Product is the reconfiguration of the Supply Chain by selecting new partners from the "open universe" of organizations (suppliers, service providers etc.). This is usually done by first identifying the needs of the customer and then selecting the EP components from more or less standard parts and services available on the market (see **Fig. 2**).

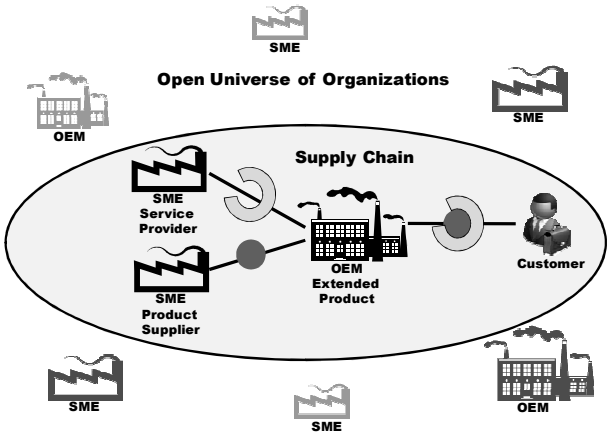


**Fig. 2.** Open Universe of Organizations

However, in this approach the innovation process (ideation, research, most of the development) is mainly conducted by the OEM. No guidelines or tools support this enterprise in service innovation. The interoperability of products and services is restrained by missing ICT support, thus mainly standard components are combined to a traditional EP. As there are also no "yellow pages" available to identify and acquire third party expertise and potential service candidates, reconfiguration of the Supply Chain is time consuming.

**Virtual organization Breeding Environment for service innovation.** A suggested approach to overcome the drawbacks of dealing with an open universe of organizations is the Virtual organization Breeding Environment (VBE) [10]. It provides common operating principles and infrastructures based on long term cooperation agreements. The involved organizations and supporting institutions are in that way prepared for ad-hoc short-term collaborations. According to the needs of the customer, partners with the required competencies are selected from the pool of the VBE and form a Virtual Organization (VO) to innovate the required EP (see **Fig. 3**)

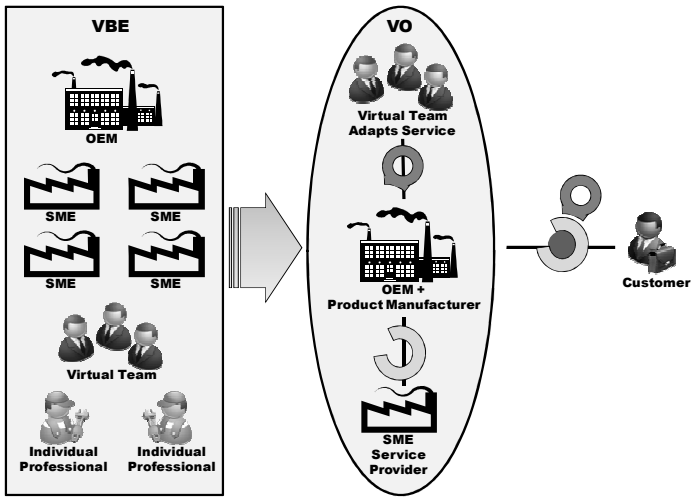


**Fig. 3.** Virtual organization Breeding Environment

While partner search and selection are supported by common rules and ICT platforms, this is not true for the innovation process itself. Although the reduced time required for the VO configuration allows for limited adaptations of services, the selection of components and competencies is still restricted to the partners of the VBE. Once configured, the VO cannot easily react to changing requirements by adding other standard services to the EP. Therefore, a new approach is required to fully support the full potential of the more open and service-oriented Extended Product 2.0 concept.

# 3 Manufacturing Service Ecosystems

## 3.1 Requirements towards a new model to support service innovation

As stated above, Extended Products need integrated development of physical product, services, and the manufacturing processes. Service requirements can have implications on the whole product life-cycle. Consequently, the product structure and additional components may have to be redesigned. Therefore, on the one hand a special development environment is needed to design and implement Extended Products. On the other hand, a set of models, methods, and tools to manage and align the product life-cycle with the service life-cycle is required. Besides, the governance of innovation processes needs "freedom" for new ideas and has to regard the common and complementary objectives of different stakeholders.

## 3.2 The Business Ecosystem concept

A promising concept to tackle the challenges identified for service innovation is the Business Ecosystem. Introduced originally by Moore [11], it compares the business

environment of an enterprise to a biological ecosystem. Members of the ecosystem are able to become new business partners or new customers by sharing knowledge, innovate and collaborate together. By interacting with each other, they can design new EP, communicate globally and develop new projects [12]. Members can involve big OEMs, SMEs, Universities, research centers, individual professionals and the customer etc. [13].

While the Business Ecosystem idea could provide a suitable basis for a new model for service innovation, the implications on product and manufacturing process design have still to be formalized. Appropriate techniques and guidelines are required to adapt the organizational structure and form a value network out of the ecosystem for a specific EP. Finally, the ecosystem members have to be provided with appropriate ICT tools to support the underlying transition [14]. These issues are addressed in the Manufacturing Service Ecosystem (MSE).

### 3.3 Manufacturing Service Ecosystems

The MSE is a non-hierarchical form of collaboration where various different organizations and individuals work together with common or complementary objectives on new value added combinations of manufactured products and product-related services. This includes the promotion, the development and the provision of new ideas, new products, new processes or new markets. Future Internet architectures and platforms enable the active participation of all stakeholders in all the phases of the product and service life cycle (see **Fig. 4**).

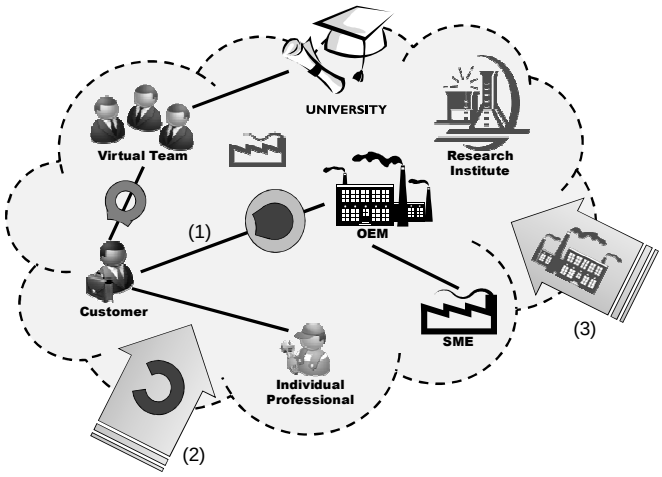


**Fig. 4.** The Manufacturing Service Ecosystem

The customer is part of the MSE, allowing for collaborative ideation and research in the ecosystem, based on the customer's requirements. The later steps of service innovation, like development, manufacturing and provision of the EP, are supported

through the formation of a Virtual Manufacturing Enterprise (VME) structure (1). The VME flexibly adapts to changing requirements and can incorporate new partners from the MSE. Should a required service (2) or competency (3) not be available in the MSE, its permeable border allows for extension of the ecosystem. In addition, the broad variety of the ecosystem support the "look beyond the own backyard". Thus, an EP 2.0 of interoperable products and services can be configured through the MSE members.

Service innovation within the MSE is enabled via ICT through a Service Oriented Architecture (SOA) and the Digital Business Ecosystem (DBE) concept. SOA supports the processes and workflows in a Business Ecosystem through dynamic, on-the-fly compositions of the available ICT services. DBE amends the Business Ecosystems with a pervasive Internet-based environment, showing an evolutionary and self-organizing behavior [15].

## 4 Conclusion

This paper has shown that the trend for more and more individualized products requires bundling of tangible and intangible assets to Extended Products. The provision of services becomes more and more important for manufacturing enterprises, causing a shift of the original EP concept towards more openness for service innovation. The analysis of existing approaches towards service innovation has revealed that simple reconfiguration of Supply Chains or the application of the VBE concept is not sufficient for the EP 2.0 concept.

The Business Ecosystem has been identified as an environment that provides the necessary "freedom" to service innovation processes. Enhanced by techniques and guidelines and supported with Future Internet architectures and platforms, it can form a Manufacturing Service Ecosystem as the new model to support service innovation for EP 2.0 in temporary collaborative VME initiatives. The MSE allows new value added combinations of manufactured products and product-related services.

While the basic concepts of EP 2.0 and the MSE have been defined and presented, the required models, tools and ICT support have still to be described in detail. Further elaboration of the EP 2.0 concept and the design of a service innovation framework for MSE will be addressed in subsequent works.

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