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The Servitization of the Aerospace Industry and the Affects on Product Development

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Abstract

The aerospace industry is facing a servitization as the service integration is increasing in the product development and product-service systems (PSS) offers become more and more common. This change implies new challenges for the development teams as well as for the whole organization and its network. This research has studied this servitization at GKN Aerospace Engine Systems. The research has focused on the collaborative issues and the findings show examples of methods and activities that support the organization and its teams in the servitization of the product development.

1 Introduction

The long life cycles and product complexity of aircraft engines imply that every engine is an opportunity to supply a stream of spare parts and maintenance services. And since availability of the engine is increasingly valued, rather than the ownership of it, offers such as TotalCare by Rolls Royce has arisen [1]. In these "power by the hour" offers, the functionality of the engine is sold, but the ownership remains with the OEM (Original Equipment Manufacturer). This business model provides a steadier revenue stream for the OEM during the life cycle of the engine.

The safety issue is also of large concern in an industry that risks several lives at engine failure. This implies the regular schedule of maintenance and overhaul, which are services of large cost to the engine owner. It has also lead to large investments in monitoring systems to predict the need for services and exchange of spare parts prior to failure [2].

These are some examples of the "servitisation" of the aerospace industry and the increase of complex Product-Service Systems (PSS) [3] [4]. With this emerges the need for the companies in the industry to build the capability to develop PSS in a systematic way similar to the "traditional" product development.

However, a product development that includes the development of services, software and business models demands a higher complexity of team composition, ways of working, processes, methods and tools for an integrated connection between business development, service development, software development and product development.

The presence and co-creation with users and end customers is critical in service development. This is one of the known difficulties to manage

in complex product development processes where the focus is on requirements establishment and verification. To involve the end customer directly in development is hindered by the de-composition of requirements.

This study point to challenges in PSS development and suggest changes in order to integrate a PSS mindset in the development processes and support practitioners and organizations in their transitions to integrated PSS development and increased customer value.

2 Theoretical Framework

Product development has by Kennedy, Harmon & Minnock (2008) [5] been divided into two value streams; a product value stream and a knowledge value stream (Figure 1). The product value stream consists of the flow of tasks, people and equipment needed for creating the product. Whereas the knowledge value stream represents the capture and reuse of knowledge within the organization regarding for example markets, customers, technologies, products and manufacturing.

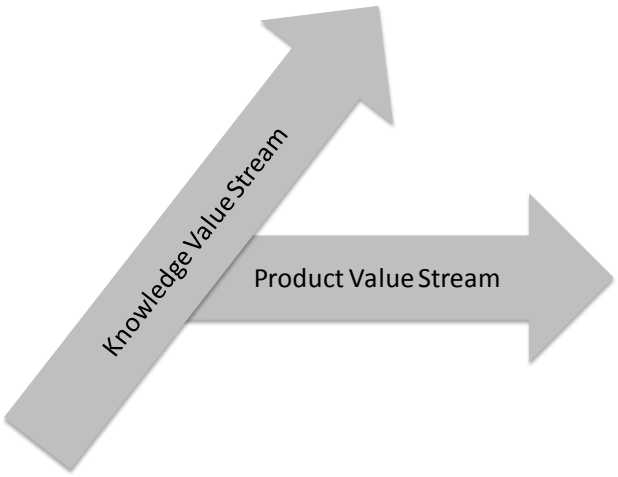

Fig. 1 The value stream in product development (after [Kennedy et al, 2008]).

The servitization of the industry is not something that is happening to the aerospace industry alone. This phenomenon can be noted in all kind of manufacturing companies and industries. One example is IBM that has transitioned from a hardware manufacturing company to a global service provider and software company [6] or Volvo Group that has increased their focus on 'Soft Products' meaning products and services that enhances the satisfaction of customer beyond the core/hard product [7].

There are three main factors that drive companies to PSS development according to Baines et al (2007) [3]; financial (for a higher profit margin or more stable income), strategic (to gain competitive advantage) and marketing (to use services to sell more product).

Literature on the topic has also claimed that there are ecological and sustainable aspects since services can extend the product's life cycle [8], manufacturers become more responsible for upgrades and material recycling [9], it contributes to a more conscious product usage and increases resource productivity [10].

The different characteristics of products and services challenge the development of PSS. There are three main differences between products and services: (1) Products are first produced and then used, whereas services are produced and used at the same time [11]. This also has its affects on the lead time, product design is longer compared to service design, and products are therefore harder to adjust to a changing environment compared to services [12]. (2) Products and services are conducted by different areas of expertise [12] and the ownership of a product is transferred to the customer when the product is sold; whereas the ownership of a service is not generally transferred [11]. (3) Products have hard technical variables (material, dimensions etc.) whereas services soft variables (time, place etc.) [12].

These differences imply barriers for the development of integrated product-service systems.

3 Methodology

The purpose with this research has been to advance our knowledge and support methodology of PSS innovation capability in the aerospace industry. Therefore a qualitative approach was chosen since it is appropriate for

obtaining insights into the experiences of individuals and groups. To enable an in depth understanding of the conditions regarding organization, culture, processes and challenges, it was conducted as a single case study.

3.1 The case company

The case company GKN Aerospace Engine Systems (previously known as Volvo Aero). The company has three main businesses; First, the largest, the commercial market, where the company develops components to aircraft engines in partnership with the engine Original Equipment Manufacturer (OEM). The second market is the military, where the company develops the engines to the military aircrafts, such as the Swedish Gripen fighter. Thirdly, the company develops components and subsystems to European space rockets.

In addition to product developments, the company provides services such as maintenance and product support.

This research has focused on the military and commercial business side. The military business side has integrated more service offers to their military engines compared to the commercial business side (Figure 2). This has to do with the fact that on the military side, the company is engine OEM, on the commercial side the OEM is their partner.

3.2 Data collection

Data has been collected through three years of observations at the case company as well as 35 semi-structured interview sessions with stakeholders of business, product, service and PSS development that are distributed across several functions and hierarchy levels at the company. Workshops have also been held to test creative methods for PSS development teams.

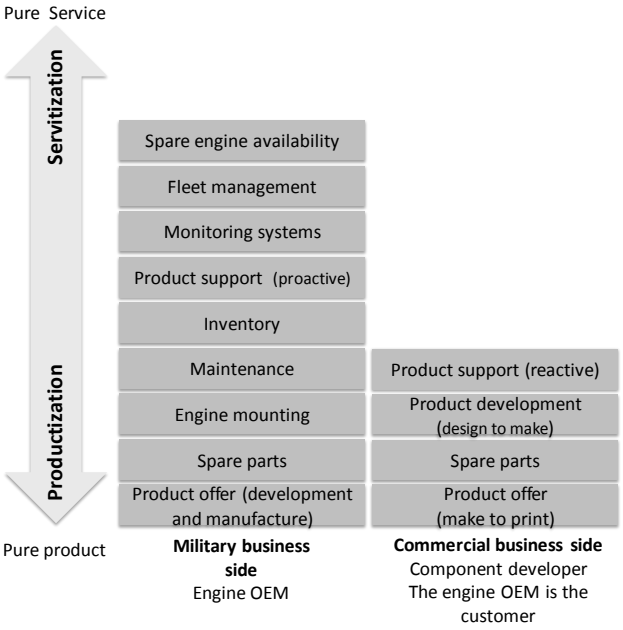

Fig. 2 Service integration in product development at case company.

4 Findings

4.1 The PSS challenge

When talking about 'products' it is not always a clear definition. Sometimes the word includes more than hardware and is rather a definition of PSS:

> *"Product, it actually means more than just hardware, for what we sell, and have done for many years, that is our product expertise, our process technology in production, and our understanding of how the product works on engine level. /../ But I think 90% think of the hardware. And that is a problem in itself".*

The definition of product as hardware only, limits the value creation. It has its history from the traditional business models of selling engines rather than "power by the hour" and the increased value of availability that is recently happening in the aerospace industry.

> *"Adapt to trends, that's perhaps the only way to survive, to keep up with the trends and bring more value. And the*

value may exist on other levels than pure hardware".

The value is considered to be in the product and its functionality. In the aerospace industry there is for example a focus on making the product as light as possible to reduce thrust which leads to a reduction of the fuel consumption.

"Our task is to deliver something that the customer wants. And they want it [the product] to be lighter and cheaper. That's what they want. Then there may be other things, those sorts of things that they do not know that they want".

The product development projects are initiated by the customer in the engine programs and requirements are received from the OEM.

"We shall comply with the requirements. Customers have expressed their expectation. So, the process is not about surprising the customers".

However the same respondent later explained:

"To only do what the customer says is perhaps not sufficient".

4.2 PSS strategies and business models

In a product-focused organization there are ideologies that influence the decisions and strategies in the organization, for example:

"We shall operate in the aerospace industry" or *"We shall not develop software".*

Although, software can be a link between product and services and can therefore be important for the development of PSS offers. A strategy that encourages focus on value propositions or product-service systems strengthens the PSS teams. One project manager of a PSS team described the introduction of a "Soft product" strategy (soft products being products and services that enhance the satisfaction of the customer beyond the core product):

"we got quite a boost, people talked about it quite high up in the company. And it was relatively easy to obtain resources"

This indicates that strategies can change product-focused ideologies in the organization, which is a step forward to find ways to support the PSS transition in the organization.

The development of PSS provides new opportunities to explore new markets. For the case company it has been considered important to provide services that are close to their own core business, but in the periphery of the customers' business. To create long-term value for their customers, the company puts great effort in their relationship with their various customers.

However, it is important to note that the integration of service to their product offer can lead to a position of being competitor to their customers/partners since their customers of their products is the engine OEM, while the customer of certain services are the airlines.

A previous study has analyzed a well known business development tool, The Business Model Canvas [13], from a PSS perspective [14]. The tool is commonly used to design business models. This study concluded that the tool is appropriate for PSS development since is focuses on Value Proposition, however for PSS development it would need a larger focus on a change perspective to widen the business scope, as well as including attention on risks since the transition towards PSS development involves business risks.

4.3 Organizational structures and networks for PSS development

Even though the company is focused on developing and manufacturing of product, they also provide services such as maintenance and overhauls. However the service organization is separate from the product development

organization with weak ties between them. One reason is that the services that are provided are often connected to other products/engines then the products that the company is developing.

These weak ties between divisions mean that the two divisions do not directly affect each other in the organization. Although, more close connected to the product development organization is the department of Life Cycle Data Management, which deals with Customer Support and Maintenance Development. This department has increased the strength of the tie between product and service development which is important for the support of the servitization. The department has for example developed software for monitoring systems of users' behavior to maximize product use. Software development falls in the middle of service and product development and is coupled to both.

In PSS development project it has been evident that people with double competences or experience from both product development and software/service development have gotten key roles. They have been important for the communication between different areas of expertise and therefore strengthen the ties between divisions and departments.

The challenges that rise in the process of PSS innovation need to be met with both internal and external routines within the process, such as establishing an innovative PSS culture and have continuous customer interaction. This study has indicated the importance of interaction, collaboration and communication between disciplines internally within the organization as well as externally with customer, in a higher degree compared to product development.

Building PSS innovation capability involves the development of new PSS competence. This research has shown that this can happen through job-rotation, bringing in external recourses and emerge competences.

4.4 Workshops for PSS teams

When the solutions to the problem not only involve the design of a product but also could include the design of services, this opens up the design space for new innovative solutions. The differences of products and services characterize and challenges PSS innovation. However, these challenges can be handled using certain workshops methods with the cross-functional design team which has been shown in previous findings [15].

The differences between product and service development implies challenges for the PSS design team, which can be handle by appropriate workshop methodology. For example:

1. The time perspective is different. This implies that the PSS design team need to visualize the time perspective of history and foresight of the problem and the whole life cycle of the product.
2. The ownership of products and services is different. This implies the importance of having a cross-functional team that includes product, service and business expertise and the importance of having a contact and collaboration with the customer as well as the user of the products and services in order to ensure value creation.
3. The design of products and services are different. Products have hard technical variables of a product, such as material, dimensions etc., whereas services soft variables of services, such as a time and place etc. Therefore there is a need to visualize not only the product but also the services with prototypes for example, in order to unify the cross-functional team and support communication about value creation. *"With the prototype, we could show the value and use it as a tool for communication"* described one interviewee regarding the importance of prototyping.

5 Discussion and conclusion

This research has shown how the servitization of the aerospace industry is evident not only for OEM but also for 1st tier suppliers as the case company.

As the offers no longer consist of products (hardware) only but also of various value adding services, this changes the view of the value

stream within the organization. The value stream of services runs in parallel with the value stream of products.

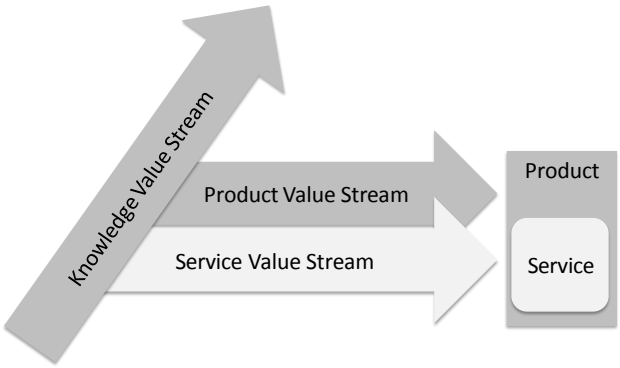

Fig. 1 The value stream in of product-service system development.

This research has exemplified the importance of strategies that is communicated through the organization. This can support the team as they handle the new challenges of servitization and get the right mindset for value creation that is not limited to products.

This research has shown an increased need for collaboration and a larger degree of complexity in the collaborative network as the aerospace industry is servitized. The collaboration involves more stakeholders, which including the customer and user who need to collaborate for a longer period of time, through the whole life cycle of the PSS. To handle the challenges of servitization it is importance to have a larger degree of cross-functionality in the teams compared to product development. Hence, includes product, service and business expertise within the team.

Individuals with double competences or experience from more than one area deserve special attention, because they can play an important role in the communication between different areas of expertise that are new to this collaboration.

Further, this research has shown that the teams need to focus more on the time perspective of products and services, discuss the ownership and value creation of products and services through the lifecycle and preferable visualize this for better communication.

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