Modeling Service Life Cycles within Product Life Cycles

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Abstract: The delivery of product-related services is already a necessary commodity for most goods-producing enterprises [1]. These product-related services are regarded as necessary attachment to successful production of goods. Product and service management include different methods and tools that cover the whole lifecycle [2]. Information systems such as Product-Lifecycle Management/Product-Data-Management (PLM/PDM) systems help to support and implement these methods with the aim to raise efficiency and quality at affordable costs. However, there is a gap in modeling product-related services, with the aim to support the development and management of services. These services increasingly become a vital part for many companies, yet are often neglected. The objective of our paper is to reduce problems with product-related services focusing on the modeling of services and their lifecycles in companionship with the lifecycle of the products they support. It can help to solve problems such as fitting cost estimation, matters of quality control and communication in-house or with the customer. Therefore, modeling approaches of service engineering need to find their implementation in PLM/PDM systems, in the way, that the interrelationships between product and service (e.g. a maintenance service for a certain sold machine) can be accounted for. Our work derives from case study work realized in the field of engineering. Therefore, as result, we are able to show exemplarily how this model can be integrated in an existing PLM system [3].

Keywords: product-related services, service modeling, Service-Lifecycle Management

1 Introduction, Purpose and Scope

To avoid stagnation in the goods-producing industrial sector, which is in many cases characterized through lower pricing margins and a high competitive pressure, successful producers of industrial goods have to look for new ways to sell. They often find a solution in offering hybrid solutions as an integrated bundle of services and material goods [4][5].

In order to provide hybrid solutions, producers of industrial goods have to focus to a greater extend on enhancing their product portfolio with services and bundle them in an appropriate matter to differentiate from competitors, raise customer satisfaction and achieve monetary advantages [5] [6].

Services, which supplement a tangible good, will affect different product lifecycle stages or the whole lifecycle of the material good / product. For example, a producer of special machinery combines his products with services like consulting services, training services, maintenance as well as refurbishing / retrofitting and recycling. These services have to be taken into account during the entire product lifecycle, for example a better maintainability has to be taken into account while the product-planning phase to improve the service maintenance. Hence, if a company wants to manage these services and the service-enhanced products successfully, we need to understand how services and tangible goods can be combined taking into account their lifecycles. Based on a theoretical description, we present a way to model services and their lifecycles in the context of a tangible good and its entire lifecycle. Our purpose is the description of the linkages between tangible goods and services beyond their lifecycles in a theoretical – more general – way.

We premised our work on a case study work realized in the field of engineering, especially in the special machinery domain. The scope of our work is limited to the domain of industrial goods, characterized through high customized material goods and services, intensive information exchange with the customer, low production volumes as well as high technology know-how.

2 Problem and Aim

"The traditional boundary between manufacturing and services is fast becoming obsolete. Manufacturing has traditionally meant the production of tangible goods, but for today's customers it is the bundling together of the tangible object with an array of intangible services that makes for the most desirable, 'service-enhanced product'"[7]. In summary, we need to manage tangible objects and intangible services to be successful, yet most companies neglect these services and don't take them into account like they do for tangible goods. This phenomenon is called "servitization" and was firstly introduced by Vandermerwe and Rada [8] 1988, and it's still an important topic in research and practice [9][10][11], even if the existence is not as new as it seems to be[1]. Servitization means "[t]he emergence of product-based services which blur the distinction between manufacturing and traditional service sector activities" [12].

On the other hand, there are different tools and methods used to manage products and services over entire lifecycles [2]. For the support of such methods, information systems like a PLM/PDM are often utilized and implemented. These PLM/PDM systems are primarily designed to manage tangible goods, supporting BOMs (Bill of Materials), traditional supply chains as well as supporting tools like CAD among others. In this way the information system solutions for tangible goods are sophisticated. These systems can raise efficiency and quality at affordable costs.

However, there is a need for further research on product-related services, which are premature in PLM/PDM systems. Services are not only practically neglected, but also are not accounted for in the relevant information systems, which should support them.

[1] "'servitization' […] has antecedents that stretch back 150 years" [13]

Tools for services are often isolated applications without integration in PDM/PLM solutions. Moreover, we need to rethink the modeling of PDM/PLM systems in a way that we can use them for services, especially for product-related services as well as for tangible goods. Therefore, the special characteristics of services need to be taken into account (like intangibility, perishable, inseparability and simultaneity [14]).

So far, we described the importance of product-related services for good producing enterprises. In a nutshell: services become a vital part for many enterprises and our objective is to reduce problems with product-related services.

In order to reduce these problems we need:

- a theoretical framework for the linkages between products and product-related services which take their lifecycles into account
- a model for this framework

Both, the theoretical approach and the resulting model will be essential parts of our paper. We will especially focus on the modeling of services and their lifecycles within a product lifecycle. Modeling product-related services helps to implement methods and tools into traditional tangible good based approaches. In that way we can solve problems for services like fitting cost estimation, matters of quality control and communication in-house or with the customer.

In order to archive our objectives, we formulate research questions. The following research questions will be answered within the scope of this work:

- How can product-related services be integrated in a Product-Lifecycle Management approach?
- How can product-related services be modeled for PLM/PDM systems?

3 Product-Service-Lifecycle Approach

Before modeling product-related services in a technical way, a theoretical framework for product-related services is needed. For the purpose of this paper we will name this framework the Product-Service-Lifecycle approach. Product-related services are understood as services performed in a product lifecycle, but having their own lifecycle as well (see Fig 1.)[15].

Both research objects – products and services – lifecycles contain different phases. For the object “product” the following phases can be classified: requirements, product planning, development, process planning, production, operation and recycling. For the research object “service” the following phases can be defined: definition, requirements, conception, realization, operational usage and change [16]. In every stage of the product lifecycle we identified different services, which have their own lifecycles. The different service and product lifecycles do not run synchronically. For example a service like a *customer consulting for product planning* is realized and operationally used in the product planning phase of the product. But a service like *maintenance* should be defined and designed in the requirements and product planning phase, and executed in the product’s operational phase. Following the presented framework, we need to model product-related services in a PDM/PLM system.

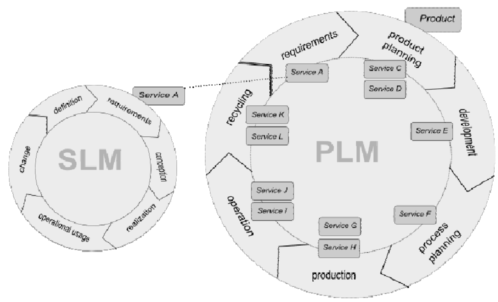


Fig. 1. Product-Service-Lifecycle

This approach is close to other scientific researches, namely the research on PSS (Product-Service Systems)[2] and the domain specific research on IPS² (Industrial Product-Service-Systems). PSS as well as IPS² have one lifecycle [17] [18] with different stages where PSS or IPS² service and product components are defined, planed and realized. The main target is to support the offering of product-service-bundle as one customer specific solution. Mainly, the design and modeling approaches focus on PSS or IPS² components [19] as new types of objects. In this paper, services and products have different lifecycles, which can be integrated and interlinked.

4 Model of Product-related Services

Our modeling approach is use-case drive. Therefore, after a criteria-based evaluation we choose the Aras Innovator [3] for our approach. So, the Aras Innovator is our use case to show, how services and tangible goods can be modeled. Firstly, we introduce the product model of the Aras Innovator. Secondly we model product-related services and thirdly we combine it with the product model.

Tangible goods

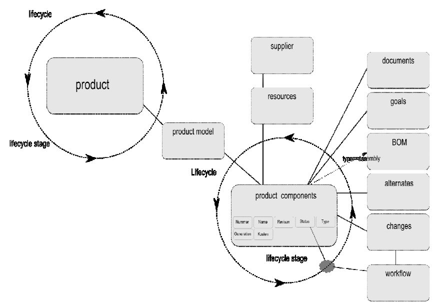
In Aras Innovator products – tangible goods – are mapped as a hierarchical product model. Thereby products are realized product models, which in turn are composed of product components ("parts"). Single components can represent different component types (e.g. "assembly"). Different component types have different connections to other item types[3] (e.g. the type "assembly" has a BOM[4] and a type "material" has no BOM). The product model as presented is component based, because the products consist of single clearly defined (modular) components with standardized interfaces

[2] PSS is defined as a realized value proposition, with the help of PSS-tangible components and/or software and/or processes and/or PSS-intangible components [18].

[3] An Item type is the base object in Aras Innovator.

[4] Bill of Materials

[20]. The described model is visualized in figure 2. This schema can be visualized in a more standardized way, as an UML (Unified Modeling Language), as follows (Fig. 3).



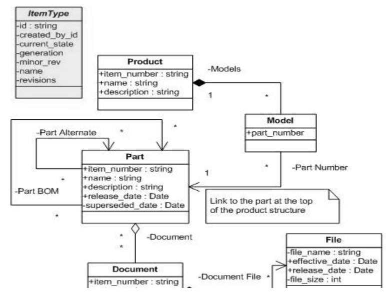


Fig. 2. Product model

Fig. 3. Product part UML [21]

Here we can see that a product has models, and a model is exactly one unit. These units can be single parts, complex parts or fully functioning machines. Thus, different parts can be reused in different products resulting in a modular product model.

Intangible services

The described product model architecture is potentially able to be combined with service models. Therefore, we need a model for services (see Fig. 4).

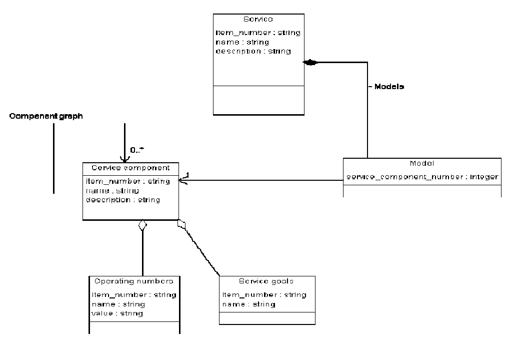


Fig. 4. Service components

The modularity guaranties the ability to join services to products. Services, in general, can be modularized, so services can be represented as components.

It can be seen, that the entity services includes service components, and service components can be linked with itself – service components. Thus, a service component tree is developed (see fig. 4).

It constitutes a simplified model of services, but presents the modularization, which allows integrating service modules in the PLM/PDM solution, namely the Aras Innovator. Integrating services allows us to use other Aras Innovator components like the lifecycle concept, the document management and the workflow engine.

Product-related services

In order to use the PLM-solution for hybrid products, both models have to be integrated. Therefore, we have implemented such an integration within the ARAS Innovator PLM systems. Firstly we visualize the integration of the models (see fig. 5).

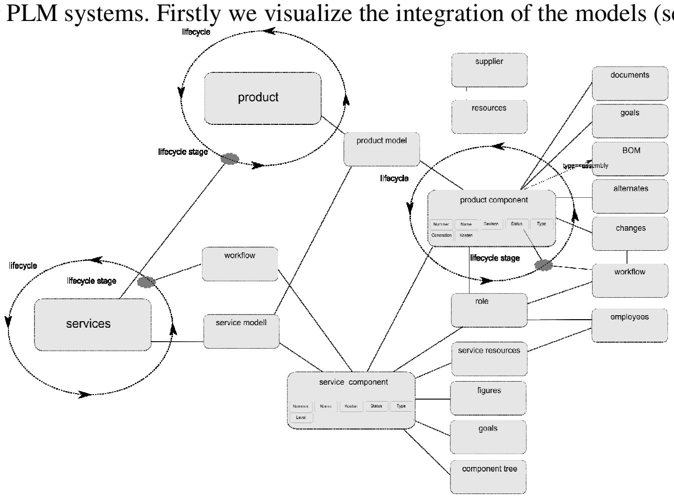


Fig. 5. Model of integrated services and products

Derived from our theoretical framework product-related services were modeled as services in single lifecycle stages of the product. These services have service components, which can be connected with product components, service goals and so on (see figure 5). Secondly, in a more formal way, it can again be visualized with UML as shown in figure 6.

As result, we have exemplarily shown how our service model can be integrated in an existing PLM/PDM system in consideration of the different lifecycle concepts. Only a small part of the integration has been described, focusing on the linkage between services, service components, products and product components. It has been done as presented, because it's the basic requirement for a more complex model of service-enhanced products. Based on our use-case we showed a potential integration of services in a Product-Lifecycle Management approach. Furthermore, we modeled product-related services. In conclusion we could find answers for our research questions with the help of the selected case-study approach.

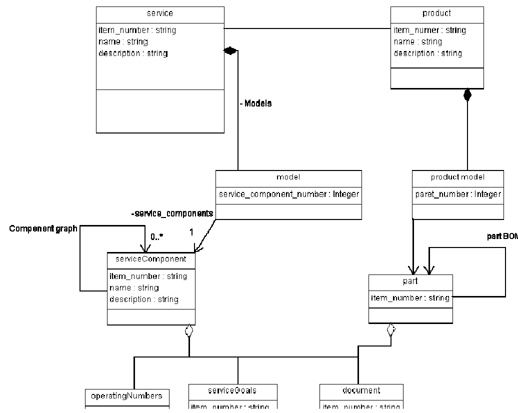


Fig. 6. UML product-related services

5 Perspective and Further Work

The presented model helps to integrate and manage services in PDM/PLM systems in general. This integration is one main step to enable computer-aided support of servitization in the direction of Product-Service Systems. With PDM/PLM systems extended according to the developed model, companies receive IT-Tools to create and manage the service and product portfolio for internal and external (customer) usage.

We identified two further steps that need to be taken, in order to model product-related services. On the one hand, our work has to be more generalized in order to use the framework and the model for further domains and applications. On the other hand, we are working on a full practical integration in a prototype to evaluate the benefit for enterprises with service-enhanced products. Therefore, we currently integrate service tools, like the service modeler [22], in the Aras Innovator. Furthermore, we will use the presented implementation for prototypical supporting a spare parts supply service in high technology special machinery domain.

In the future, the focus on tangible goods will be changed in a more general way and the supporting applications will include service and product lifecycle models. We are confident that this work can contribute to this path of development.

References

1. Wildemann, H.: Produkte und Services entwickeln und managen: Strate-gien, Konzepte, Methoden. TCW Transfer-Centrum-Verlag, München (2009)
2. Sendler, U.: Das PLM-Kompendium - Referenzbuch des Produkt-Lebenszyklus-Managements. Springer-Verlag, Berlin Heidelberg (2009)
3. Aras Corporation Aras Platform, http://www.aras.com/technology/platform/

4. Böhmann T., Krcmar H: Hybride Produkte: Merkmale und Herausforderungen. In Bruhn M., Stauss B. (eds.) Wertschöpfungsprozesse bei Dienstleistungen – Forum Dienstleistungsmanagement. Pp 239-255. Wiesbaden (2007)
5. Becker J., Beverungen D., Knackstedt R., Müller O., Müller S.: TCO-as-a-Service – Servicebasierte Lebenszyklusrechnung für hybride Leistungsbündel. In Becker J., Knackstedt R., Müller O., Winkelmann, A.: Vertriebsinformationssysteme. Pp 161-174. Springer. Berlin Heidelberg (2010)
6. Kersten W., Zink T., Kern E.-M-: Wertschöpfungsnetzwerke zur Entwicklung und Produktion hybrider Produkte: Ansatzpunkte und Forschungsbedarf, In: Becker T., Gemünden H.G. (eds.): Wertschöpfungsnetzwerke. Festschrift für Bernd Kaluza. pp. 189-291. Berlin (2006)
7. Lester, R.: The Productive Edge – How US Industries are Pointing the Way to a New Era of Economic Growth. Norton. New York (1998)
8. Vandermerwe, S., Rada, J.: Servitization of Business: Adding Value by Adding Services. European Management Journal 6. pp. 314-324 (1988)
9. Steunebrink, G.G.B.: The servitization of product-oriented companies, http://purl.utwente.nl/essays/62039 (2012)
10. Neely, A,, Benedittini, O., Visnjic, I: The Servitization of Manufacturing: Further Evidence. EuOMA Conference. Cambridge (2011)
11. Baines, T., Lightfoot, H., Peppard, J., Johnson, M., Tiwari, A., Shehab, E., Swink,M.: Towards an operations strategy for product-centric servitization. International Journal of Operations & Production Management. Vol. 29 Iss: 5. pp.494 – 519 (2009)
12. White, A.L., Stoughton, M., Feng, L.: Servicizing: The quiet transition to extended product responsibility. Tellus Institute. Boston (1999)
13. Schmenner, R. W: Manufacturing, service, and their integration: some history and theory. International Journal of Operations & Production Management, Vol. 29 Iss: 5 (2009)
14. Zeithaml, V., Parasuraman, A., Berry, L._ "Problems and strategies in services marketing", Journal of Marketing, Vol. 49, Spring, pp. 33-46 (1985)
15. Meyer K., Thieme M., Meyer L.-P., Zinke, Chr.: Computer Aided Lifecycle Management for Product-Related Services. In: Service and Economic Development: Local and Global Challenges. The 22nd RESER International Conference. pp. 17-40. Bukarest. (2012)
16. DIN: Service Engineering: Entwicklungsbegleitende Normung für Dienstleistungen. Berlin (1998)
17. Sadek, T., Köster, M.: Eine modellorientierte Methodik zur Unterstützung der Konzeptentwicklung industrieller Produkt-Service Systeme. In: Thomas, O., Nüttgens, M.: Dienstleistungsmodellierung 2010. Springer-Verlag. Berlin Heidelberg 2010
18. Katja L.: Wandel des traditionellen Dienstleistungsverständnisses. In: Thomas, O., Nüttgens, M.: Dienstleistungsmodellierung 2012 – Product-Service Systems und Produktivität. Springer Gabler. Wiesbaden (2013)
19. Abramovici, M., Neubach, M.; Schulze, M.; Spura, C.: Metadata Reference Model for IPS² Lifecycle Management. In: Proceedings of the 1st CIRP IPS² Conference. Cranfield, UK (2009)
20. Aras Corporation Self Help Guide, http://www.aras.com/university/SelfHelpGuides/Print%20of%20Online%20Help%20-%20Aras%20Product%20Engineering.pdf
21. Aras Corporation Discussion File, http://www.aras.com/Community/cfs-filesystemfile.ashx/__key/CommunityServer.Discussions.Components.Files/7/0361.aras_5F00_product_5F00_model.jpg
22. Klingner S., Böttcher M., Becker M., Döhler A., Schumacher, F.: Managing complex service portfolios: A business case from a full service provider. In: Reser 2011 Proceedings. Hamburg (2011)