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Procedia CIRP 59 (2017) 240 – 245

www.elsevier.com/locate/procedia

The 5th International Conference on Through-life Engineering Services (TESConf 2016)

Interoperable information exchange as enabler of NFF related TES

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Abstract

The lifecycle of a product is managed through the Product Lifecycle Management (PLM) including the integration of Product Service Systems (PSS) as well as Through-life Engineering Services. Both activities are performed by staff throughout the entire lifecycle and require the input of knowledge of different product lifecycle phases. The authors demonstrate the necessity of information exchange between the beginning of life and the middle of life on the example of NFF. The provision of the right information in the middle of life should be an information based TES which can only be achieved if the interoperability challenges are solved between the life-cycle phases. This paper demonstrates how existing semantic data integration approaches could be applied to enable the required information exchange. For that purpose, the modelling of test process related knowledge as ontology and corresponding extraction methods are presented.

Peer-review under responsibility of the scientific committee of the The 5th International Conference on Through-life Engineering Services (TESConf 2016)

Keywords: TES; PSS; Interoperability; No Fault Found; Test Process; State Chart

1. Introduction

Megatrends like globalization, an increasing number of product variants, and the fasten integration of new technologies into products require that companies move to more agility and sustainability, especially in the provision and usage of product relevant knowledge. The lifecycle of a product is managed through the Product Lifecycle Management (PLM) including the integration of Product Service Systems (PSS) as well as the integration of Through-life Engineering Services (TES). A part of PES related services could be also defined as TES.

The PLM specific activities are performed by staff throughout the entire lifecycle and require the input of knowledge of different product lifecycle phases. This paper motivates the creation of TES which focus on the provision of the relevant amount of information to the right time in the product lifecycle phase to achieve a holistic view and in consequence, gain an added value.

The given heterogeneity both of tasks within PLM and the underlying IT-infrastructures forestalls the aggregation and exchange of information between the product lifecycle phases. Hereby, each lifecycle phase covers specify tasks and generates/requires specific information. The amount of information differs between phases, for instance, in content and format but it is not disjoint. All information views together result in a holistic view of the product.

This holistic view is required to establish PSS and TES which benefits by the possibilities of PLM. The paper shows on basis of the No Fault Found (NFF) phenomenon the necessity of holistic views in the maintenance of aircrafts. For that purpose, the article demonstrates the benefits of achieving

Peer-review under responsibility of the scientific committee of the The 5th International Conference on Through-life Engineering Services (TESConf 2016)
doi:10.1016/j.procir.2016.08.037

the interoperability of test relevant information between the test process and the maintenance. The interoperability enables the integration of test relevant information and therefore, to improve the quality of TES according to the monitoring and diagnostic methods for resolving NFFs. For that purpose, the paper is going to demonstrate the application of an ontology based modeling approach of PSS and TES related information to achieve the interoperability. The proposed ontology represents the necessary information for resolving the NFF phenomenon. Thus, the interoperable information exchange of test relevant information will be motivated and presented. The interoperable information exchange in PLM is the precondition to achieve the interoperability on the service and process level which is the foundation of any PSS and TES.

2. Interoperability in PLM

The product lifecycle of a PSS including the physical part as well as interweaved services foresees a sustainable information exchange between the physical part and the information based services. Thus, the necessary interoperability between and within enterprises is considered by ATHENA Interoperability Framework on four levels [1]:

- Data/information
  (for information interoperability)
- Services
  (for flexible execution and composition of services)
- Processes
  (for cross-organizational processes)
- Enterprise/business
  (for collaborative enterprise operations)

The interoperability on the first level is the precondition to enable the interoperability on the other 3 levels. To achieve the interoperability on the data information layer, a broad variety of data sources representing product relevant information has to be considered.

2.1. Amount and Heterogeneity of Data to be considered

The overall amount of data sources to support the product lifecycle management is high considering the internal data sources like manufacturer/supplier specific data sources as well as external/online data sources like Tweeter, Facebook or Blogs. The set of internal relevant data sources contains [2]: *"Most organizations of middle to large size have hundreds or, more probable, thousands of applications, each with its own various database and other data stores. Whether the data stores are from traditional technologies or document management systems, it is critical to the usefulness of these applications to the Phases of a closed-loop product lifecycle organization that they share information between them".* The amount of social media related content for PLM is also high. The current available 'blogosphere' is more than 100 million blogs and their interconnections has become an important source of public opinion [3]. In the application of micro-blogging, the leading company Twitter has achieved more than 145 million users who send more than 90 million 'tweets' per day, each consisting of 140 characters or less [4]. Consequently, a huge amount of information is available which is related to a wide range of consumer products and corresponding services. The data to be used contains product specific feedbacks including usage scenarios, technological hurdles from the perspective of the daily usage, best practises or the quality of product specific services like individualisation or maintenance. Thus, the data and the knowledge contained in it has a high value for manufactures and could be used to improve not only the product but also the overall product service system.

The given heterogeneity both of tasks within PLM and the underlying IT-infrastructures forestalls the exchange of information between the product lifecycle phases. An overview over the available product lifecycle phases is given in Fig. 1.

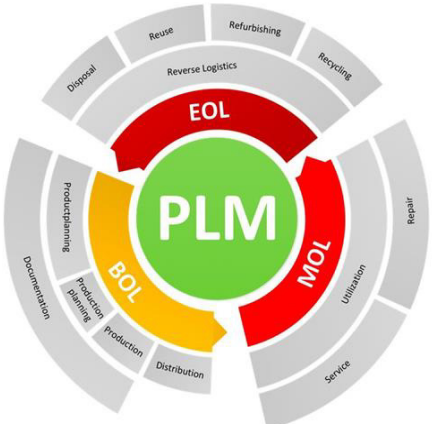

Fig. 1. Product Lifecycle phases by Franke et al. [19]

Each lifecycle phase covers specify tasks and generates (or requires) specific information. The kind of information differs between phases, for instance, in content (e.g. design specifications or maintenance reports) and format (e.g. text or numeric data) but the informative content is not disjoint between different kinds of information. All information views together result in a holistic view of the product. This holistic view is required in the case of No Fault Found in the application domain of aircrafts. The authors propose the improvement of the analysis capabilities to reduce No Fault Found through the provision of more and detailed information of the aircraft. The proposed information exchange must solve the interoperability challenges on all four ATHENA interoperability levels between the test process and the maintenance. In the following, the necessity for the information exchange, the interoperability challenges for the first ATHENA level and a corresponding approach are presented.