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PRODUCT LIFE-CYCLE MANAGEMENT DATA INTEGRATION FOR THE OVERHAUL OF RAILWAY BRAKING DEVICES

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Abstract. *The railway braking devices are going through different phases of their product lifecycle, from production and exploitation through the overhaul and finally to the disposal. Overhaul of railway braking devices presents the phase where all information is integrated. Data integration for an overhaul of the railway braking devices presents a complex matter, because it involves different file formats created by various participants in different phases of the product life-cycle. The key point is to organize all the created data in one place so that all process participants can access it. This paper presents a possible solution for managing and integrating all important data for the railway braking devices during all phases of the products lifecycle.*
Key words: *railway braking device; overhaul; data integration; product lifecycle management.*

1. INTRODUCTION

Railway braking devices present an important safety component of the trains. Its overhaul consists of several phases such as visual inspection of the device, its disassembly and replacement of worn or damaged parts, its assembly and testing. Overhaul process for railway braking devices involves many participants such as production companies, railway companies and overhaul service companies. Every participant generates certain data which is relevant to the successful operation of the braking device. Also every participant operates from different location and the trains itself are operating in railway transport. The data involves bill of materials data, CAD drawings data, exploitation information, defect information, lists of parts for overhaul, overhaul work orders and schedules, testing results information and etc. To successfully manage all the necessary information a product life-cycle management (PLM) approach can be used. It is important to identify what are the PLM phases for railway braking devices and to identify all information flows in every phase and between phases. Then the information can be managed through the appropriate PLM software through the application of item revision system and defined workflow processes.

This paper is organized as follows. Second section presents overview of exploitation and overhaul of railway braking devices and how are these processes observed through the application of product lifecycle management approach. Third section presents a case study with a proposed PLM solution for the presented problem. Fourth section presents conclusions and future work and the last section presents literature references.

2. LITERATURE REVIEW

Product lifecycle management approach

The products change through its life-cycle and also change all the data that is tied to product. The generated product data is can exist in more than one copies and they are often incosistent in the terms of its contents. The problem of data integration and management is the core feature of the PLM approach. PLM approach tries to solve problems concerning data access and availability, data archiving, copying and confidetiality, and data exchange [6].

The product life-cycle management presents the approach which has evolved from the enterprise need for data management through the various information systems (such as material requirements planning (MRP), enterprise resource planning (ERP), customer relationship management (CRM) and supply chain management (SCM)) and from the data creation in different product life-cycle phases [5]. PLM approach enables better collaboration between all the participants in the supply chain, like suppliers, industrial companies and customers. PLM approach is based on the product data management,

with products drawings (CAD data) and products bills of materials (BOM's) as basic data. PLM manages data through processes. One of fundamental processes of PLM data management is the engineering change process as described in [7]. Based on this process every changes tied to the product can be traced through items and its revisions, and also the responsible persons can be identified quickly.

Lifecycle of the railway braking devices

Since the railway transport has significant impact in national and international transport of goods it is vital that it operates successfully and safely. Most of the trains operate with the pneumatic brakes [10].

The performance of the railway braking devices used on trains is subject to many influences caused by its exploitation use and conditions. Previous research on the subject of railway braking includes the exploitation characteristics [9], failure analysis [2], materials appliance and environmental issues [1], testing and simulation of the braking systems [3].

Life-cycle management of the railway braking devices has been covered poorly in the literature and in scientific research. Most authors observed only certain aspects or certain life-cycle phases, and mostly the life-cycle assesment has been done for the whole trains like heavy metro trains [4]. It would be interesting to investigate how the railway braking devices change through its lifecycle and how to manage all the informations which are generated in each lifecycle phase. As identified in [8], lifecycle phases of railway braking devices include:

- production phase,
- first exploitation phase,
- overhaul and exploitation phases,
- disposal phase.

The overhaul and exploitation phases repeat as long as the braking device can operate, until it is ready for the product disposal phase.

The case study presented in the next section uses the engineering change process as a basis for the product lifecycle management. The case study shows a possible solution of how the braking devices data could be managed by using the PLM software through the identified life-cycle phases. Overhaul process decisions are simulated with PLM software.

3. CASE STUDY

Overhaul process

The case study describes the overhaul process for the railway braking devices at the overhaul service company in Serbia. The overhaul process of the braking devices consists of four main activities:

- Reception and visual inspection of the braking device,
- Disassembly of the braking device and defect detection,
- Parts preparation and assembly,
- Braking device inspection and functional testing.

Reception and visual inspection of the braking device is the first activity where the customer brings the braking device and the braking technician specialist inspects it. After the visual inspection is done, braking specialist makes the record of receipt and visual review.

Second activity is the braking device cleaning and disassembly. Technical documentation for the overhaul process is used for this activity. It presents the manual for the overhaul process of the braking device. For the railway braking device there are two types of parts which can be replaced:

- Type of parts which are replaced every time the braking devices goes to overhaul (rubber parts),
- Type of parts which are replaced only when needed that is only when they are damaged (metal parts).

Braking devise specialist makes the document of the noted defects and the spare parts list. The work order for the overhaul of the braking device is issued.

After the spare parts are retrieved from the warehouse, the assembly of the braking device can start. The assembled braking device is sent to testing. Inspection and functional testing is done on the testing table. The braking device is tested with different levels of working pressures within the controlled environment. Test results are printed in the form of functional testing diagram and in the form of the inspection protocol which serves like a table for inputting actual parameters.

Braking device data has been inputted into PLM software. The PLM software enables defining the braking device as an item, enables the overhaul process creation, and enables the PLM phases changed through the item revisions.

PLM software process

In the PLM software solution (Siemens Teamcenter®), folders are consisted of items, and every item has its revisions, which are consisted of any kinds of datasets. In this example, the monitoring of the life-cycle phases for the braking device and the execution of each phase is shown (Figure 1). When the braking device of a certain serial number is commissioned, the monitoring of its lifecycle can start. First item revision (A;1-Production), which contains important documents for that phase (bill of materials, drawings, etc.) is created, and it represents the first PLM phase of the braking device life-cycle. When the first exploitation phase starts, the revision of the first item revision (A;1) is executed, and the new revision is created (B;1-First exploitation). The new revision represents the second lifecycle phase of braking devices. During the implementation of revision, administrator chooses which documents will be copied from the previous revision and which will not, and adds new, specific documents for that new PLM phase. This

process is repeated through all phases (production, first exploitation, overhaul, exploitation, overhaul and disposal).

The overhaul is the third life-cycle phase and its item (C;1-Overhaul) is also obtained with the revision of the item from the previous phase (B;1). After five years of use, every braking device needs to be serviced. The overhaul process for the railway braking device is created and conducted through the PLM software. In the PLM software this process has seven activities (reception and visual inspection; disassembly of the braking device and defect detection; part preparation and assembly; inspection and functional testing; review; status adding; notification) which are shown in Figure 2. Each of activities is done of one or more workers, and only the last activity is carried out automatically on the basis of results from previous stages. If all the activities are completed successfully, a flag appears next to the item revision (C;1), which symbolizes that the activities execution was successful, and therefore the process of overhaul is completed (Figure 3). After the overhaul, the braking device goes to reuse, therefore the forth revision is done, and the item revision (D;1-Exploitation) is created. The processes of the overhaul and the exploitation are repeated until it is decided that device has to be withdrawn from use. The fifth phase is the overhaul, the sixth phase is the disposal, and for each of them is made one item revision (E;1 and F;1), with the relevant documents within them. If the braking device is ready for disposal, then in the previous overhaul phase it is not overhauled and tested. In this way, very quickly and at any moment it is possible to see in which phase is a specific device and to see the whole product history, with the required supporting documents. Also, the problem of avoidance of the responsibility by workers is eliminated, because it is possible to see when was each phase performed and by whom.

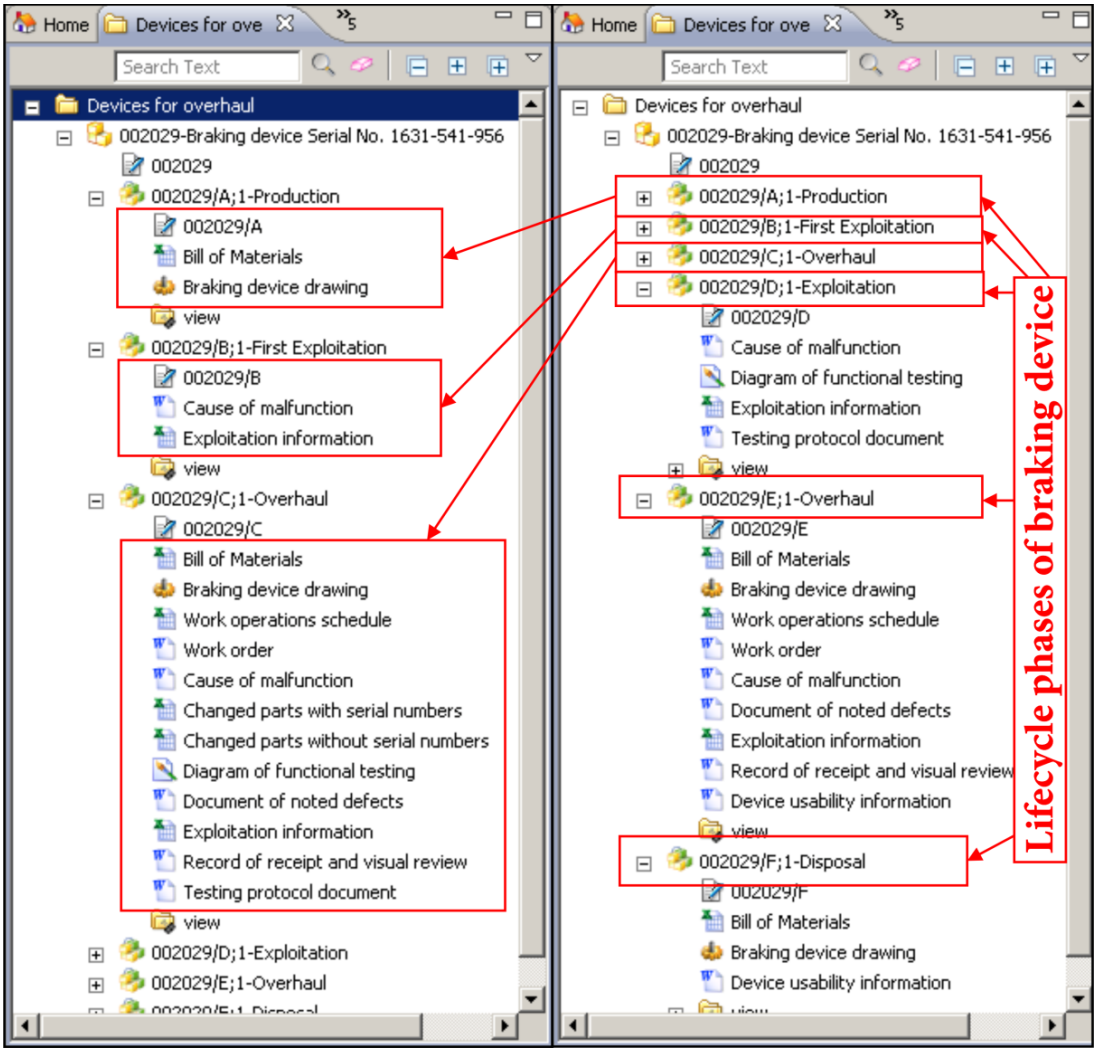

Figure 1. *Lifecycle phases of braking device conducted in PLM software*

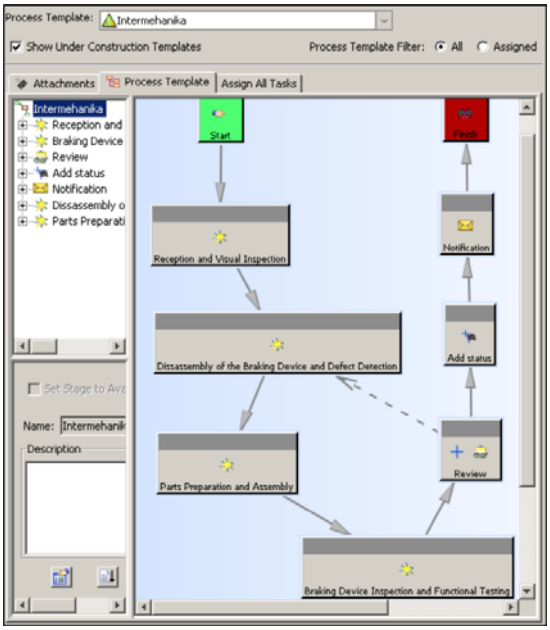

Figure 2. *Overhaul process for the braking device*

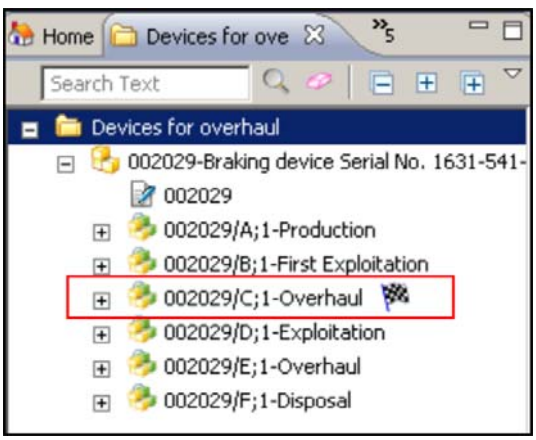

Figure 3. *Successfully completed the overhaul process*

4. CONCLUSION

The paper presents engineering change process on the example of the railway braking devices. All the life-cycle phases of braking devices and its data management through PLM software were presented. Future work will include the investigation of the possibilities of further integration of the PLM software with existing software in the enterprise and with the supply chain participants.

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