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Cyber Physical Systems for Life Cycle Continuous Technical Documentation of Manufacturing Facilities

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Abstract

Continuous rising of requirements to create technical documentation results in high effort in terms of time and costs to create a complete and up to date documentation for manufacturers. In case of any technical modifications of machines the technical documentation also has to be updated. In fact these updates are lacking in most cases.

In this paper, the authors propose a methodology for a self-organized creation of technical documentation to enable an up to date state throughout the Product Life Cycle. A complete and up to date technical documentation provides benefits to customers as well as suppliers of manufacturing facilities. The new approach is based on integration and communication of all components and modules such as machine tool, transportation and handling technology etc. via “Cyber Physical Systems”.

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1. Introduction

The accelerating global economy demands increasing product variety and shortened Product Life Cycles (PLC) for all kinds of consumption goods. To cope with these challenges, manufacturers need to reduce the production costs and the time to market by creating an adaptable and flexible production. Products in machinery and plant engineering need to become more flexible, while their complexity rises continuously.

In course of this the requirements to create technical documentation rise continuously. For manufacturers, this results in high effort in terms of time and costs to create a complete and up to date state on delivery. After delivery and initial startup of manufacturing facilities the technical documentation often cannot be kept up to date. Updates in consequence of technical modifications or upgrades arising from product change, optimization or production volume

adjustment are lacking. In most cases, these modifications are undocumented or, in best case, added as separate documentation. While arising in particular during the critical phase close to delivery of manufacturing facilities additional personnel capacity required for preparing the technical documentation has a large impact on total costs. In addition the planning and performing of maintenance and service tasks based on an up to date and accurate documentation is an important factor for staying competitive for suppliers. To satisfy manufacturer’s and customer’s needs in engineering, new approaches for creating and using technical documentation are required.

In this paper, the authors propose a methodology for a self-organized creation of technical documentation to enable an up to date state throughout the PLC. The new approach is based on networking of all components or modules via Cyber Physical Systems (CPS).

2. Technical documentation today

According to legal regulations producers from the field of machinery and plant engineering are committed to deliver a highly accurate technical documentation as an attachment to their products^[1-5] Regarding the preparation of maintenance and service operations, the supplier itself cannot abandon the use of documentation contents, which can be applied in various documentation types according to the nature of use. In first instance technical documentation can be separated into two fields:

- External technical documentation
- Internal technical documentation

The external technical documentation^[6-7] consists of all digital and print materials, that will be delivered with the products. For instance these include documentation types such as guidelines, security advises or maintenance timetables. Objectives of external documentation are knowledge-transfer and technical editing and illustration of security relevant customer related data, while meeting requirements referring to customers such as uniformity, high quality and mature structure. In practice the gain of creating both internal and external technical documentation cannot mess with its huge effort^[8].

The internal documentation can be considered as all information available for the machinery and plant supplier concerning their products. This information is used for planning and preparation of maintenance, service or follow-up jobs during operation.

In today's flexible production systems, number and short cycles of maintaining tasks cause that both external and internal technical documentation is not kept up to date. Therefore only an out of date state of the real machine is represented, which doesn't match with the current state anymore or never did. Fig.1 gives an example of the development of technical documentation along the PLC.

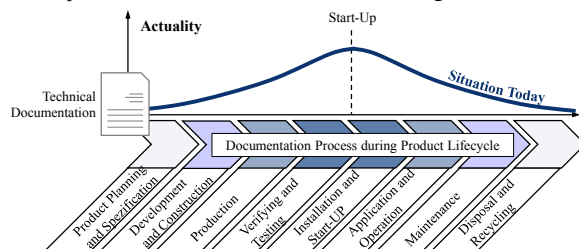


Fig. 1. Technical documentation along the PLC

3. Tasks and objectives

In order to address the introduced challenges for processes of technical documentation in the field of machinery and plant engineering, new approaches are required.

Different new approaches to advance networking and autonomy in production such as “Industrial Internet” by General Electric^[9], “Smart Manufacturing” by the Smart Manufacturing Leadership Coalition^[10] or the high-tech strategy “Industry 4.0” of the German government^[11-13]. These strategies and initiatives strive to automatically and

autonomous initiated processes on-demand throughout the production and supply chain. The methodology proposed in this paper contributes strategies for maintenance and documentation tasks according to these goals. The main objectives for the methodology can be summarized as keeping technical documentation up to date well as providing context sensitive data based on modern information technology.

3.1 Up to date documentation

To enable an up to date technical documentation throughout the PLC the corresponding documentation processes must be described. Therefore a standardized description of activities and owners of the processes is necessary.

Adjusting technical documentation automatically is worthwhile, but realizing interfaces between hardware components and software is still a big challenge. Therefore automatically adjustment cannot always be implemented. Due to current security requirements in addition confirming changes in documentation manually is still compulsory in some cases. Furthermore an up to date technical documentation should also contain data history arising from past technical modifications, maintenance operations, troubleshooting or changes in production programs.

3.2 Context sensitive data provision

Due to high quantity of information in conjunction with the various fields of application today's technical documentation is very complex. In particular data types are inconsistent and structure is lacking. Emerging, searching and weighting of relevant data restricts efficiency in all business processes using documentation contents. In addition critical content is not secured from misapplication. To take advantages of an up to date state in these processes, an effective usage and management of the actual data must be implemented. Therefore a context sensitive data provision for users and suppliers as well as customers is required. In this context following roles among others can be distinguished:

- Technical editor
- Internal user (e.g. service or operator)
- External user (e.g. maintenance planning)

The proposed methodology offers an opportunity to meet these requirements by implementing modern technological achievements into the documentation process. The following paragraphs describe the structure and technological approaches considered within the new methodology.

4. Methodology for creating und using an up to date technical documentation

The new approach is based on integration and communication of all components and modules such as machine tool, transportation and handling technology etc. via CPS. Management and provision of documentation contents is implemented by a digital representation of the real system (manufacturing facilities). The digital representation contains

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