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# Technical documentation as a service – An approach for integrating editorial and engineering processes of machinery and plant engineers

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**Abstract**

Delivery of technical documentation of manufacturing facilities is still mandatory for machinery and plant engineers as part of the compliance with legal regulations. In addition, current research and development indicate that digital technical documentation can be used as informative support for operating staff if contents are provided context-sensitive. Despite the importance and potentials of technical documentation for the engineering process, an integration of editorial staff into this process is not state of the art.
In this paper the authors propose a reference implementation for technical documentation developed within the collaborative research project Cyber System Connector in order to fill this gap both technically and organizationally. The aim is to redesign technical documentation into a service for all participants in product and production development. This new approach is based on a CPS-supported process of creating technical documentation and a virtual representation which serves as a platform for knowledge management in machinery and plant engineering. The benefits of implementing the proposed documentation strategy along the supply chain of manufacturing facilities are depicted by chosen application scenarios.


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*Keywords:* Technical documentation; cyber physical systems; supply chain; maintenance; AutomationML

## 1. Introduction

The creation of technical documentation in machinery and plant engineering not only leads to a tremendous workload for editors but proceeds often fragmentary. Technical modifications or upgrades arising from product change or other optimization or adjustment processes are not documented appropriately [1]. In most cases, changes or extensions are undocumented or at best added as separate documentation [2]. However, in today's rapidly evolving manufacturing industry, the instant provision of accurate information about specific plants, sensors or products is in demand. Thus, to guarantee topicality, an intelligent automatism for creation and provision of technical documentation is essential.

The joint research project CSC aimed at enhancing the creation and the use of smart technical documentation taking into account the possibilities of a smart factory [3-5]. The so-called CyberSystemConnector, that forms a CPS with each physical plant component, serves as a communication interface and contains a virtual representation. This virtual representation, based on the data exchange format AutomationML, includes all required information about the current machinery- or plant-configuration. To enable each process owner, concerning supplier and customer of machinery, to access this information easily, a configurable web interface is integrated. Rolling out the CSC technology along the supply chain of manufacturing facilities, generates new services and business models for all stakeholders.


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**Nomenclature**

| | |
|---|---|
| AR | Augmented Reality |
| CAD | Computer Aided Design |
| CMS | Content Management System |
| CPS | Cyber Physical System |
| CSC | Cyber System Connector |
| CSS | Cascading Style Sheets |
| ERP | Enterprise Resource Planning |
| GUI | Graphical User Interface |
| HMI | Human Machine Interface |
| HTML | Hyper Text Markup Language |
| MQTT | Message Queue Telemetry Transport |
| M2M | Machine to Machine |
| QR | Quick Response |
| SOP | Standard Operating Procedure |
| TDaaS | Technical Documentation as a Service |
| UML | Unified Modeling Language |
| XML | Extensible Markup Language |
| XSLT | Extensible Stylesheet Language Transformation |

## 2. Motivation & objectives

Future smart factories combine flexible production and transparency and bring new requirements for creating, updating and providing technical documentation contents. Hence, a complete and flawless description including i. e. instructions, maintenance procedures or engine drawings is required and also legally obligatory in Europe [6]. In addition, an up-to-date and accurate documentation is an important factor for the quality of planning and performing of maintenance, operation and service tasks. To maintain usability, the documentation has to be updated continuously throughout the plants lifetime while the contents must be provided situation-orientated and personalized. Today's CMS support editors in preparing documentation by offering a centralized management of modular documentation contents [7]. However, this is still an isolated process with mainly manual interfaces to product design and production planning departments. Thus, the documentation contents need to be structured manually referencing all relevant aspects of the current physical production environment. Consequently, today's static documentation does not meet these challenges. According to the introduced challenges, the project CSC focuses on three main objectives [2]:

1. Supporting the initial preparation of technical documentation by connecting editing and engineering
2. Keeping technical documentation up-to-date throughout the product lifecycle (Fig. 1) by feedback of the real plant
3. Providing documentation context-sensitive based on modern information technology

The project's results offer an opportunity to meet the mentioned requirements by implementing modern technological achievements into the documentation process. The following paragraphs describe this technological implementation and illustrate the benefit by presenting selected application scenarios and transferring them into future business models.

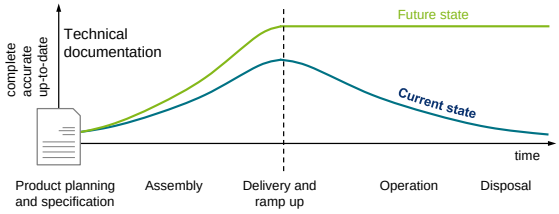


Fig. 1. Up-to-date technical documentation after machine ramp-up

## 3. CSC architecture

The research project CSC aims at supporting the technical documentation process by combining virtual and physical components. To achieve this goal, a complex software architecture has been implemented within the framework of the research project. In this context the user interaction including the human interface represents the highest layer of the overall CSC architecture. The exchange with a central information system (underlying layer) via XML documents has to be ensured. The user interaction serves the visualization of technical documentation content and also enables an active integration and control of various employees. Hence, different content has to be accessible from the information system which will be described in more detail in section 4.

### *3.1 Dynamic master-slave hierarchy*

In order to consistently provide an up-to-date data base for the mentioned information system constantly, a virtual representation, which contains all relevant information about the plant or machinery, has to be created and updated immediately if the configuration of the real system changes. In order to keep such a virtual representation up-to-date and to meet demands like flexible integration, scalability and real-time performance, Lenkenhoff et al. developed a suitable concept as an event-driven architecture [8]. The communication of different components within the CSC technology leads to a logical so-called dynamic master-slave hierarchy of CPS, explained in detail in [8].

Within this hierarchy, the slave components are located hierarchically under a master component. Each component serves its own technical documentation as described in the next paragraph. Slave components communicate their present virtual part of the representation to the master component. Whenever a new component is added in the real plant or machinery the system checks whether it has to be integrated hierarchically above or below an existing component. This is done by rules (e. g. rules of the "complex event processing" [9]) that have been defined on a central communication broker. This checking procedure takes place for each CPS and allows a dynamic construction of an entire virtual plant representation. The topicality is ensured via corresponding occurring events so that system failures or new CPS can be integrated directly into the hierarchy. The dynamic system reacts flexibly to higher-