

TOWARDS INDUSTRIALIZATION: SUPPORTING THE MANUFACTURING PROCESSES OF SUPERCONDUCTING CAVITIES AT DESY

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Abstract

Manufacturing high-gradient superconducting cavities for future accelerators requires detailed knowledge of the entire production process. This knowledge has to be transferred from the laboratories, which are developing the process, to industry in order to achieve reproducible results in the industrial production of large numbers of cavities. The paper introduces DESY's approach to process industrialization based on the use of an Engineering Data Management System (EDMS).

INTRODUCTION

About 1000 high-gradient s. c. cavities have to be produced by industry for the proposed European XFEL. The production process includes cavity fabrication and subsequent preparation activities for performance optimization (e.g. [1], [2]). A series of 30 cavities which are presently under production at DESY in collaboration with industry shall be used to study the general requirements on process control and documentation tools.

For the preparation of the XFEL project, an Engineering Data Management System (EDMS) has been introduced at DESY as a central information management platform. The EDMS is based on a commercial system which has been adapted to DESY's needs. It is used to support the cavity production processes, including external manufacturers, to enable quality management and to prepare knowledge transfer to industry. The EDMS also manages technical project documentation and supports other planning activities of the XFEL [3].

PROCESS INDUSTRIALIZATION

Process know-how includes task definitions, the task sequencing and the resulting process data. Transferring a process from DESY to an industrial company is foreseen to happen in three phases (cf. Figure 1 (a) – (c)).

First, a process has to be defined, established and optimized. The process steps are documented as so-called “work packages” (WP), which contain work instructions and templates for recording the results. Each WP is performed by a specific process team (a).

Next, the WPs are entered into the EDMS, which then takes over the process coordination (b). Each process is initiated by the process manager (e.g. when a new cavity is received). The EDMS is then sending the work instructions to the responsible process teams in the correct sequencing. The process teams perform the required work and record the results in the EDMS. Each WP result is inspected and approved by the process manager before the next WP is issued by the EDMS. The WP specifications in the EDMS are evolved with growing process experience.

As the EDMS is fully web-based, teams in remote locations can easily be included into the procedure. This way, process steps can be sourced out, and external collaborators and companies can be gradually integrated as the process matures (c). In the end the process can be fully executed in industry, while DESY can stay involved in the process coordination and supervision by taking the role of the process manager.

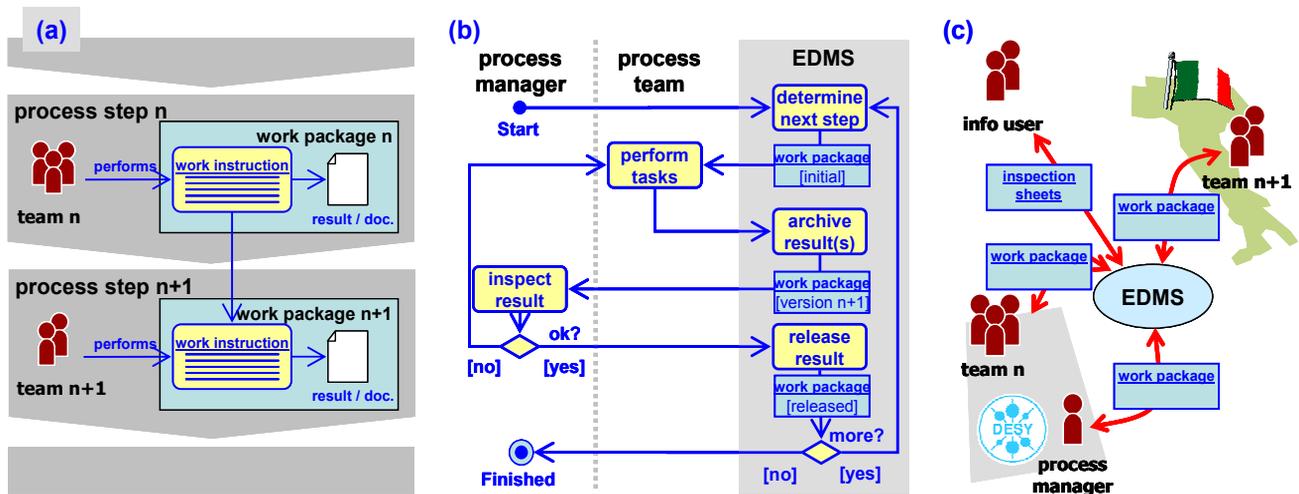


Figure 1: Three phases of industrializing the cavity preparation process: (a) process analysis and definition, (b) process coordination by an Engineering Data Management System (EDMS), and (c) process distribution.

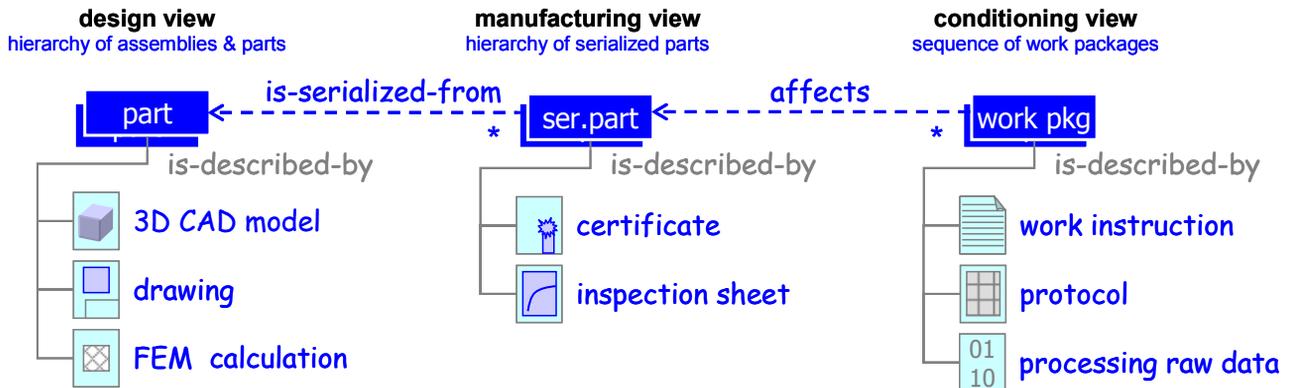


Figure 2: Organization of information in an Engineering Data Management System (EDMS).

EDMS OPERATION PRINCIPLE

An EDMS is an information system for managing the information and coordinating the processes of the entire product lifecycle. An EDMS offers workflows, databases and user interfaces for supporting activities such as specification, mechanical (3D CAD) design, manufacturing, conditioning or installation.

An EDMS provides so-called “views” which contain the relevant information for the different lifecycle activities, and it establishes traceability between these views (cf. Figure 2). Each view is organized around a hierarchical structure whose elements are associated with the necessary process data. For example, in the EDMS, a cavity corresponds to a “part”. The design view contains the hierarchical part breakdown structure (PBS) in which the parts are associated with their 3D CAD models, drawings, FEM calculations and further documents. For manufactured or “serialized” parts it can later be determined from which version of the design data they have been created by following the “is-serialized-from” relation. The mechanism is repeated for all the views in an EDMS.

EDMS-SUPPORTED CAVITY PRODUCTION

DESY has implemented design, manufacturing and conditioning views in its EDMS for supporting the production of s. c. cavities for the TTF/VUV-FEL facility.

Design View

The design view defines the cavity’s geometry and properties and is the source for simulations, calculations and manufacturing. Figure 3 shows the mechanical design of a cavity in a 3D CAD system and an excerpt of its PBS as seen in the EDMS. CAD users can access and modify the CAD models and the PBS through the CAD system, while other users can access and view the PBS and its associated 3D visualization models, drawings and documents through the EDMS web client.

Manufacturing View

Figure 4 shows the manufacturing view of a 9-cell cavity. For every individual cavity, so-called serialized cavities are created in the EDMS. They are built along serialized PBSs (sPBS): while the PBS contains e.g. one entry for a dumb-bell, which is re-used eight times in the cavity model, a sPBS contains eight entries carrying the serial numbers of the eight manufactured individual dumb-bells which are used in the specific cavity. They are associated with manufacturing certificates and inspection sheets. The XFEL requires ca. 1000 cavities which will contain about 70,000 serialized parts and relate to more than 200,000 QA documents.

Conditioning View

Cavities are treated according to a specific preparation procedure for optimizing the rf performance. It consists of 56 defined work packages, including e.g. polishing, baking and cleaning, which have been defined in and are coordinated by the EDMS according to Figure 1. Teams receive their work instructions for specific cavities in the EDMS, and they can access the process documentation

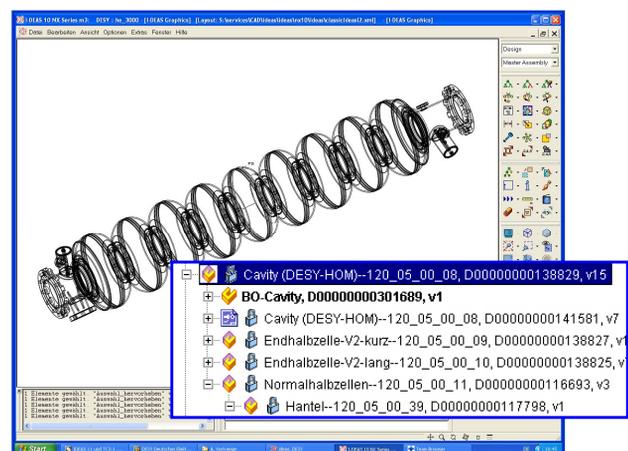


Figure 3: Design View of a cavity in a 3D CAD system and corresponding part breakdown structure in the EDMS.

