MANAGING THE QUALITY ASSURANCE DOCUMENTATION OF ACCELERATOR COMPONENTS USING AN EDMS

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Abstract

Quality assurance (QA) documents are often collected locally on a per-component basis by the manufacturing teams, while project engineers require global evaluations of the QA documents e.g. for production control or during installation and commissioning of the machine. DESY is using an Engineering Data Management System (EDMS) for supporting and unifying the QA documentation of different accelerator components. The paper introduces the general structure of QA procedures, describes the benefits of using an EDMS for QA documentation and describes examples from different applications at XFEL and PETRA III.

QUALITY ASSURANCE

Quality assurance (QA) covers the activities which are necessary to provide confidence that a physical component will meet its requirements and perform satisfactorily in operation. QA activities are performed e.g. after production steps for inspecting a component's compatibility with its technical specification and during commissioning for checking operational requirements.

QA Activities and Manufacturing Procedure

Manufacturing is organized into production steps which perform the same operation on a large number of components. They are optimized for series production. QA activities focus on the history of individual components, attempting to record the component's properties after each production step. Figure 1 illustrates the interplay of QA activities and production processes as a matrix, where QA activities follow horizontally individual component lifecycles while manufacturing steps act vertically across several physical components.

The analysis of QA data is again a vertical activity which aggregates the results of different inspections to compute for example averages and spreads of physical properties for a set of components.

QA Conceptual Model

Figure 2 shows a conceptual model for QA activities as a UML [1] class diagram (a) with example objects (b). A physical component (e.g. a specific superconducting (s.c.) cavity with a serial number) is built according to a certain type (e.g. TESLA cavity). Types are identified by a set of characteristic properties which are described by models (e.g. mechanical 3D CAD, FEM calculations, field simulations). QA activities are essentially comparisons of of physical component's actual properties with their type's design values. The results are recorded in QA

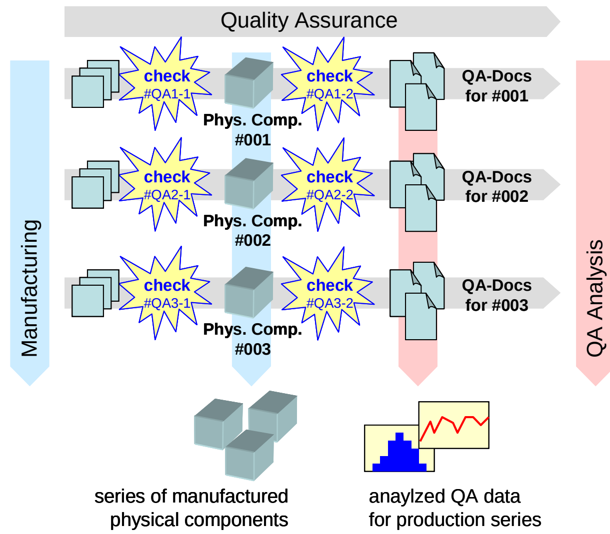

Figure 1: Process coordination using an Engineering Data Management System.

documents (e.g. inspection sheets listing mechanical dimensions and deviations from design).

EDMS-BASED QA PROCEDURES

Engineering Data Management

An Engineering Data Management System (EDMS) is an information system for managing the information and coordinating the processes of an entire product lifecycle. It offers workflows, databases and user interfaces for supporting activities such as specification, mechanical (3D CAD) design, manufacturing, conditioning or installation. An EDMS aims to achieve the highest possible degree of process automation in the product lifecycle.

DESY uses an EDMS e.g. for supporting XFEL planning and the production of s.c. cavities. Tight integration with 3D CAD, data management for the decentralized production of system-critical components and project documentation establish the core-functionalities of the system. The EDMS provides dedicated user interfaces which are optimized for the needs of the specific engineering teams which are working on the physical components (including industrial manufacturers), and at the same time integrates the QA documents into a central database for further overall analysis and applications [2] [3].

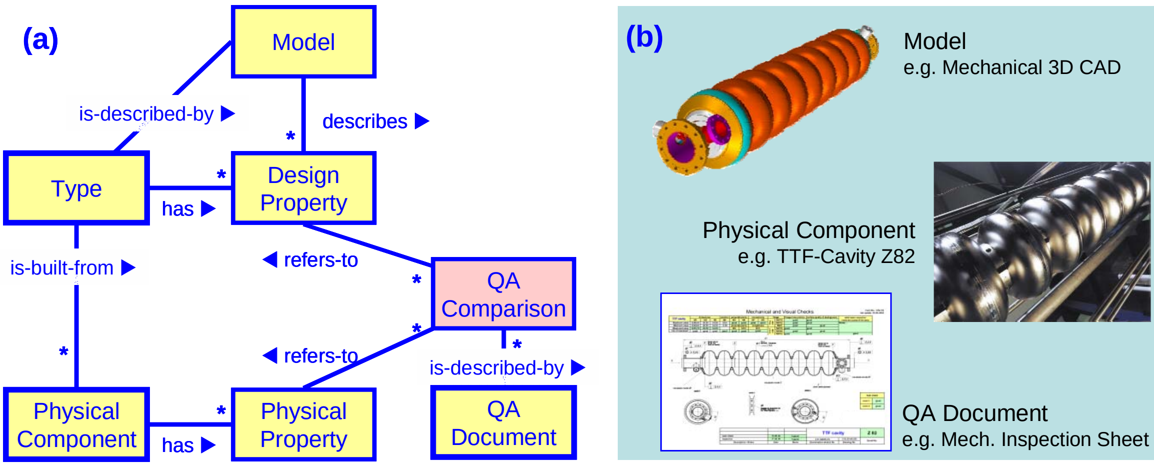

Figure 2: (a) Conceptual model for quality assurance (UML class diagram) and (b) examples.

Process Support with EDMS

DESY's EDMS takes over two major tasks in QA:

- It keeps track of manufacturing and quality assurance activities by distributing work packages to teams.
- It manages the resulting QA documentation.

Figure 3 describes the general concept for EDMS-supported QA activities. Physical components are first received and registered in the system. Then, the comparison of actual with design properties is performed. The resulting QA documents and status changes are stored in the EDMS.

Figure 5 illustrates how the EDMS handles the interplay of manufacturing and QA activities. After QA has been performed on a sub-component, the component is included into its next upper-level assembly. This assembly is then issued again to QA, and the procedure repeats until the assembly is complete (a). The example (b) shows the simplified sequencing of activities for the assembly of a quadrupole magnet for which the coils shall be checked before the magnet is assembled. The EDMS triggers the activities and collects the QA documents. It acts across departments and can seamlessly include suppliers. The EDMS keeps track of the issued work packages (c) and organizes the emerging documentation into a tree-structure for easy and intuitive later retrieval.

Automatic procedures extract the values of selected component properties from the QA documents and transfer them into a database for subsequent analysis [4].

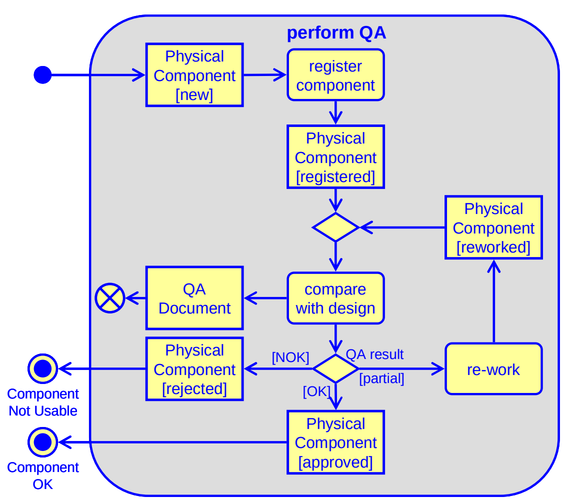

Figure 3: Process coordination using an Engineering Data Management System

EXAMPLES

The described procedures have been first developed for the preparation of s.c. cavities for TTF. They were then extended for production processes and for the QA of other accelerator components. The EDMS is in use at TTF and XFEL and currently being deployed at PETRA III.

Figure 4 shows an excerpt of the QA documentation of a s.c. TTF cavity (resonator). The root element of the hierarchy is the type element for the resonator. The "has instance" relation lists all the physical components of this type which are registered in the EDMS. For each component, the "is-described-by" relation delivers its QA documents, in this case work packages and inspection sheets. Work packages contain instructions for performing preparation and QA activities and "attach" the results in spreadsheet, PDF and ASCII format. The spreadsheets are used by the QA teams for recording the results, the other formats are automatically generated by the EDMS for

Figure 4: QA documents of TTF s.c. cavity in DESY's EDMS

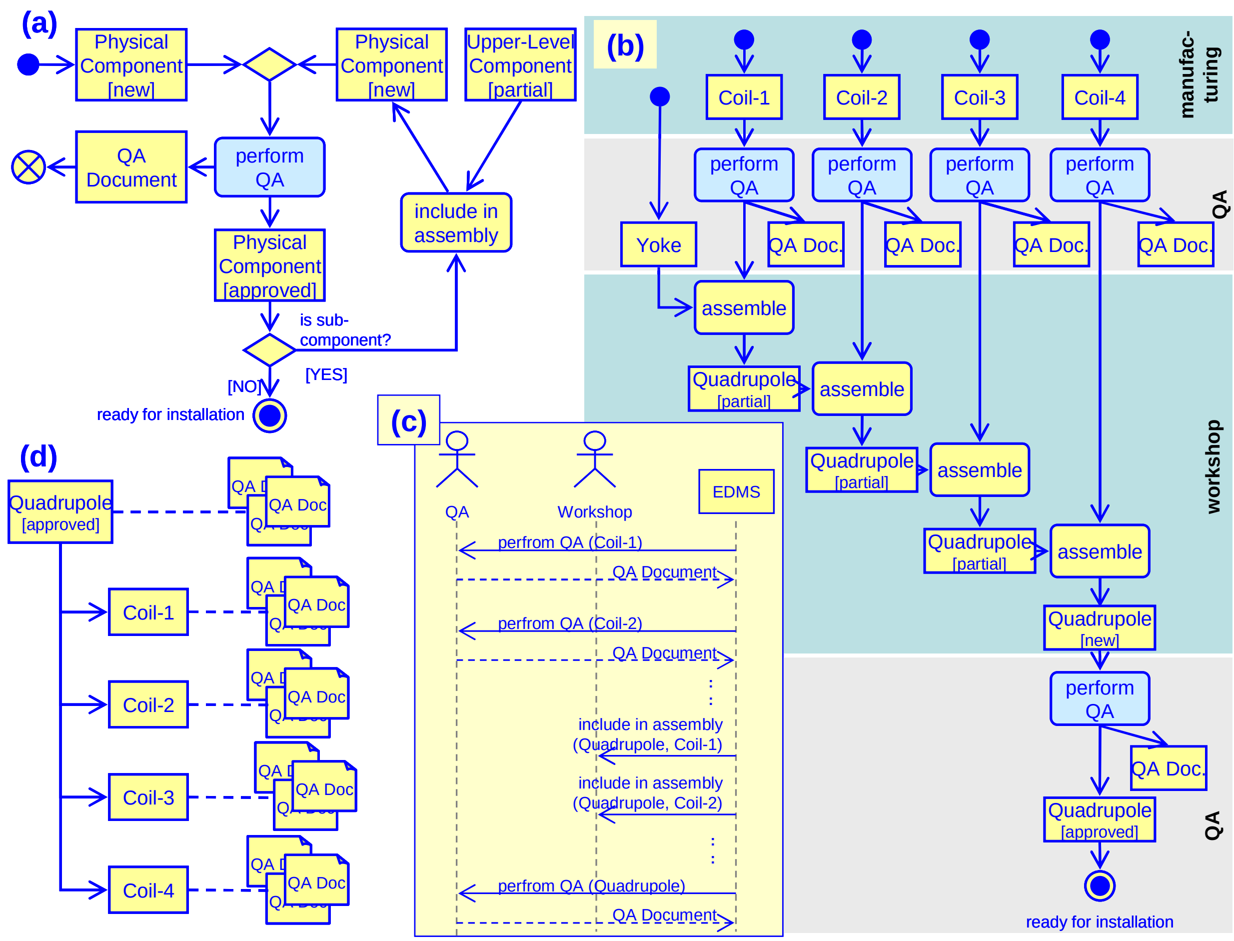

Figure 5: EDMS-based documentation of QA activities: (a) performing QA during manufacturing and assembly, (b) simplified example for quadrupole assembly, (c) EDMS coordinates process and records history, (d) final QA documentation objects in EDMS (Notation: UML).

viewing and for interpretation by data analysis tasks.

The hierarchy could be further expanded to navigate to the cavity's sub-components down to the Nb-sheets from which the cavity has been built. Also, the hierarchy could be expanded from any element as root element. For the XFEL, about 1000 cavities with more than 200,000 QA documents will be managed in the EDMS.

Following the same principles, the EDMS has been set up for the QA of vacuum components at PETRA III. Users record QA results in spreadsheets, which are automatically uploaded to and further processed in the EDMS. Extending the system to managing additional types of components requires definition of the types and their corresponding spreadsheet templates in the system.

EXPERIENCE

The benefits of supporting QA activities with an EDMS are manifold, including:

- The EDMS provides a central access point to information. It helps collecting and ensuring completeness of information.
- Using an EDMS stipulates process optimization and standardization, yielding increased efficiency of production. The EDMS delivers actual process states for any component at any time.
- The EDMS acts as an integration platform which establishes the information flow among different teams, including external suppliers.
- The EDMS enables reuse of knowledge and tools.

Standardizing the QA procedures and providing tools in advance are essential to achieve the intended benefits.

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