MAKING ENGINEERING DATA AVAILABLE AT THE EUROPEAN XFEL

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Abstract

One of the essential success factors for the European XFEL is up-to-date, complete and consistent engineering data which is readily accessible throughout the project. Such data include for example civil construction drawings of tunnels and buildings; integrated 3D models of accelerator sections; definitions of fabrication processes and test procedures; inspection sheets, test data, standards, contracts and other technical documentation. The data is kept in the DESY Engineering Data Management System (EDMS). The DESY EDMS is the central information platform for the European XFEL and provides procedures for e.g. review & approvals and change management. The paper presents an overview of Engineering Data Management and its benefits at the European XFEL. They result in better vision sharing, enhanced communication and tighter integration of the project team, ultimately leading to lower costs and shorter development time.

INTRODUCTION

Engineering Data Management, EDM, better known as Product Lifecycle Management, PLM, is a conceptual approach to information management and process automation in the product lifecycle, i.e. in the areas of design, development, fabrication, quality assurance, operation and maintenance, and recycling. The European XFEL has successfully adopted PLM concepts and solutions and in turn received large benefits. This paper highlights PLM applications in the XFEL project and points out their benefits and returned value. After briefly introducing the term engineering data, the paper addresses in particular collaborative design, decision making and recording, interacting with contractors and suppliers, parts tracking and documentation, and the importance of ubiquitous visualization.

ENGINEERING DATA

Engineering data is a generic term for information which is related to the engineering processes in the product lifecycle. It comprises:

- Product definition data, which specifies the geometry, materials, properties and behaviour of products;
- Product lifecycle data, which defines the processes for mastering the product through its lifecycle, such as e.g. design, fabrication, installation and operation, and records their history;
- Product metadata, which organizes the responsibilities, storage location, accessibility and other administrative aspects of product definition and lifecycle data.

Engineering data is the foundation for efficient engineering processes. The following sections provide examples for the application of engineering data management in the European XFEL project. They are based on the DESY Engineering Data Management System, DESY EDMS [1].

COLLABORATIVE DESIGN

Collaborative design provides a systematic approach for integrating the design contributions of multiple project teams, aiming to converge on a single design that is acceptable to all participants. The collaborative design process ensures that a complete, consistent and clash-free model of the facility is created and maintained.

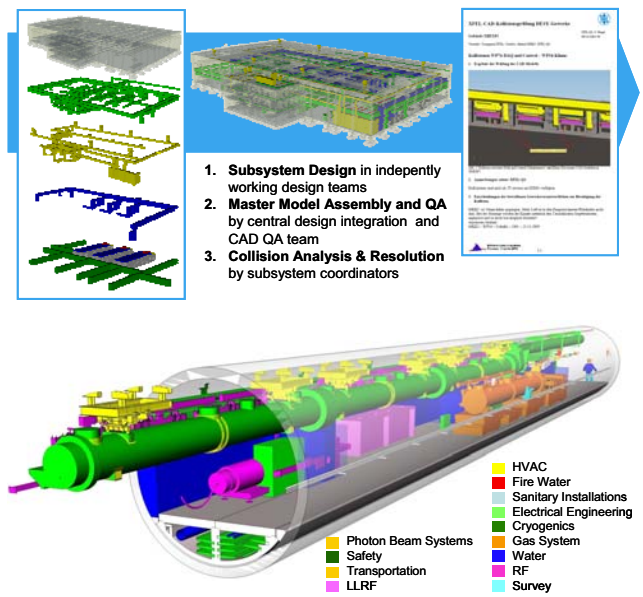

Figure 1: Master model with contributions from various disciplines (top) and collaborative design process at European

The collaborative design process at the European XFEL integrates more than a dozen subsystem design teams from trades such as e.g. civil and electrical engineering, plumbing, ventilation, safety, transportation, survey, cryogenics and various accelerator systems. A design integration team puts together the individual sub-system models into so-called master models, which are then analyzed by a QA team. Analysis results are distributed to subsystem coordinators, who negotiate strategies for conflict resolutions and design changes [2] [3]. Figure 1 shows the collaborative design process at XFEL (top) and

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an example of a resulting master model of a tunnel section with a list of the contributing trades (bottom).

The integration team manages more than 160 master models of different tunnel sections and building complexes, integrating more than 15 technical systems, which are published and made available to the entire project in the DESY EDMS. One of the benefits is resolving conflicts between e. g. mechanical, structural and accelerator-related disciplines at early design stages. Literature observes in construction projects savings of 0.5% up to 10% of the contract value due to early clash-checks [4] [5], which prevent conflicts from reaching the construction site and causing unbudgeted changes and delays in the project schedule.

DECISION MAKING & RECORDING

Decisions are the key instrument for establishing a reference configuration and for determining the course of action. They have to be taken in defined, reliable, predictable and reproducible procedures, and their results have to be recorded accurately.

The DESY EDMS provides general review and approval workflows for making and recording decisions and relating them with their impacted documents, and a change control workflow for conducting necessary changes in an orderly and consistent way. Figure 2 illustrates the processing of a document in such a workflow.

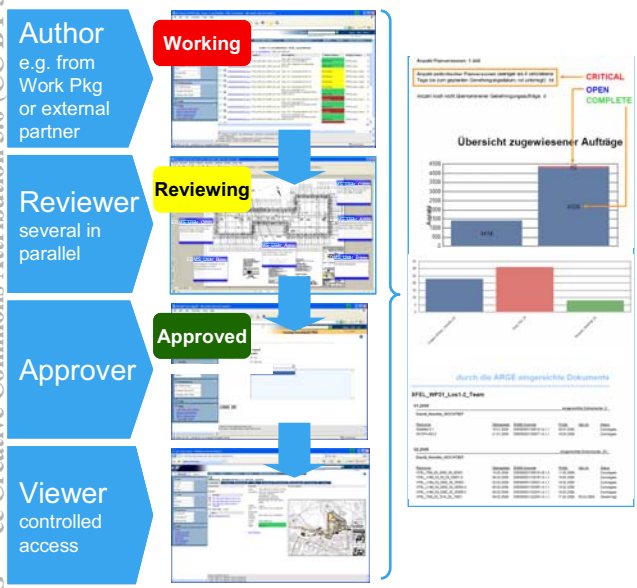

Figure 2: EDMS-based document review & approval workflow, and coordinator's report about pending and completed processes.

One important application area are reviews (e.g. conceptual design review, production readiness review), which are related to major milestones of XFEL Work Packages. The reviews are conducted by the XFEL Technical Coordination and used to capture mandatory documentation such as e.g. specifications, design and tendering documentation, safety concepts or quality

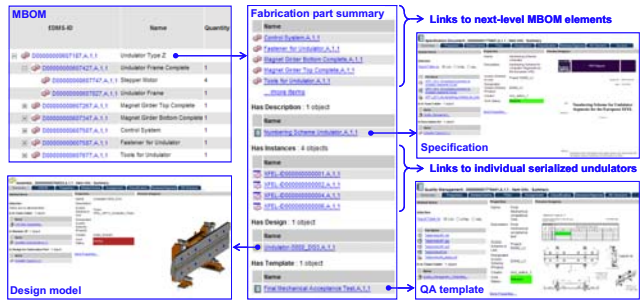

Figure 3: Sketch to illustrate information traceability in parts tracking and documentation: Seamless navigation from design model to individual physical parts and back (see text).

management plans. The documents are stored, processed and published and made available to the entire project in the DESY EDMS. They are accumulated and cross-referenced in one place, ensuring the facility documentation is produced as the project evolves. This is especially important as the facility is foreseen to operate for decades, implying the need to maintain and transfer knowledge and expertise over several staff generations.

INTERACTING WITH CONTRACTORS

Making and communicating decisions efficiently is especially important when interacting with partners, contractors and suppliers, as they often involve additional constraints regarding e.g. options and time. Failing to observe these constraints may quickly trigger schedule delays and increasing costs.

The XFEL uses general contractors for the civil construction efforts. The general contractors require the project team to review and approve every construction drawing before it is forwarded to the construction site for implementation. Each drawing has to obtain several signatures in a limited period of time. The DESY EDMS provides dedicated separate and access-controlled workspaces for collaboration and data exchange with the different contractors. The review and approval workflows enable several reviewers to process the same document in parallel and facilitate more than 10,000 signatures per year. The processing history is recorded and all document versions are archived, and status reporting is supporting process coordination and ensuring deadlines are met.

PARTS TRACKING & DOCUMENTATION

Parts tracking and documentation is a foundation for conducting Quality Assurance and Quality Control (QA/QC), for achieving compliance with legal regulations in certain areas, and for recording and coordinating operation, maintenance and upgrade activities. The XFEL has launched a PLM solution which provides procedures for reliably gathering, recording, processing and archiving the complete mandatory fabrication information. The solution concept has been proven in the cavity production for FLASH [6]. It is now extended to the series production of the XFEL cavities [7] and various other components.

Figure 3 illustrates parts documentation and traceability in the DESY EDMS with a demo example: For any type of part[1] (top left), users can reach a summary page (middle) which links to related documentation like e.g. manufacturing instructions and specifications (top right), templates for inspections (bottom right) or the design model (bottom left). The summary page also links to the inventory (middle right), which comprises all the individual physical parts that have been created according to the fabrication description which is related to the type of part. All links are bi-directional, enabling the same navigation in reverse direction.

Figure 4: Visualization example.

The EDMS guarantees so-called transaction safety[2], which is especially important for those parts facing legal documentation requirements, as e.g. the cavities which are subject to the pressurized equipment directive (PED).

UBIQUITOUS VISUALIZATION

Ubiquitous visualization aims to provide generally available and intuitively usable visual models of any part or region of the facility, and of any decision or activity of the project. Visual models [8] are published and thus generally available through the DESY EDMS web client. Figure 4 shows an example for visualization at the XFEL.

One of the key benefits of ubiquitous visualization is better vision sharing: All members of the project team share the same picture of the facility and the project, thus being able to better optimize their contributions to the overall performance of the facility, and to discover needs or opportunities for linking with other work packages.

Another important gain is improved design validation, which enables the project team to discover and remove collisions and check the compliance of interfaces in early project phases, avoiding later rework. In addition, visualization enhances the communication as it enables the team to address and describe specific parts of the facility more accurately and easily. As an overall result, visualization leads to better decision making.

[1] "Part" is a generic term for "component", "equipment", "device", etc.

[2] Transaction safety implies durability, immutability and accountability of information.

CONCLUSION

The European XFEL has successfully adopted PLM concepts and solutions based on the DESY Engineering Data Management System, DESY EDMS, and in turn received large benefits. PLM helps to clarify and agree on processes, and to standardize and establish procedures and tools. The key success factors include ubiquitous visualization, information integration, workflow support, and providing a fully web-based solution to ensure availability throughout the project team, independent of location and time. The examples demonstrate that the PLM solution at the XFEL yields large cost savings, establishes reliable and efficient workflows, results in better vision sharing, and helps to achieve compliance with legal regulations in specific areas.

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