INFORMATION MANAGEMENT IN THE CIVIL CONSTRUCTION OF THE EUROPEAN XFEL

Nils Bergel, Jasper A. Dammann, Silke Eucker, Lars Hagge*, Jens Kreutzkamp, Stefan Sühl, Daniel Szepielak, Przemysław Tumidajewicz, Norbert Welle, DESY, Hamburg, Germany

Abstract

DESY has established and received large benefits from an advanced information management solution for civil construction of the European XFEL. It is based on methods and tools which are known from concurrent engineering in plant construction, relying on the DESY Engineering Data Management Systems (EDMS) as its key component. The EDMS contains 3D models of the entire facility with related additional documentation, and it provides workflow management, traceability, revision control, and change management. One of the key concepts is ubiquitous visualization, which promotes vision sharing and enhances design validation and general communication. The paper describes the information management procedures, tools and experience in the civil construction of the European XFEL.

INTRODUCTION

Building an accelerator facility brings together civil construction and mechanical engineering, two trades with very different working cultures, practices and tool sets: While construction sites are traditionally paper-based and 2D oriented, the accelerator and its infrastructure are completely modeled in 3D. At the European XFEL, methods and tools known from plant construction were introduced to civil construction to enable efficient collaboration of all trades. Integrated 3D models encompass design models of all technical subsystems. An electronic "XFEL room book" [1] captures requirements and manages assignments of space and equipments in the buildings. An Engineering Data Management System, the DESY EDMS [2], manages and links the information with additional documentation. Electronic workflows coordinate e.g. reviews and approvals. 3D models, room book and documentation databases together constitute the so-called "Building Information Model" (BIM). The BIM addresses the entire building lifecycle and is a basis for later operation of the facility [3] [4]. The paper introduces the solution architecture, describes selected engineering and communication processes, and concludes with experience, observed benefits and cultural impressions.

OVERVIEW

The core element in the information management architecture is the DESY EDMS [2], which contains and manages all documents and CAD models and coordinates the workflows. The EDMS is a web-based information system through which all collaboration partners can access, review and work with the 3D models and their accompanying documentation. The web client is also used to easily integrate sub-contractors in e.g. communication and data exchange processes. In addition, the EDMS offers dedicated interfaces to selected applications with specific relevance to civil construction activities, such as e.g. mechanical and architectural CAD systems, or a facility management system. Figure 1 summarizes the information management architecture for civil construction at the European XFEL.

REQUIREMENTS ENGINEERING

Requirements Engineering, RE, is a general and systematic approach for evolving a vision into a concise project specification. DESY has established RE processes which are specifically tailored to civil construction (Figure 2): Requirements are elicited on a per-group basis. Groups which are responsible e.g. for certain accelerator devices, power supplies, transportation or general safety, issue requirements on different buildings. The requirements are classified by various attributes, e.g. their nature, and the location and technical system they are affecting, and stored in a central requirements database. The "XFEL room book" [1] provides an intuitive user interface for filtering and accessing the requirements e.g. by building, by floor or by room. It helps analyzing requirements for completeness, and identifying double or contradicting entries from different groups. Complete and consistent sets of requirements are summarized into a specification documents and transferred to the DESY EDMS, where they are reviewed, approved and distributed for use in subsequent processes.

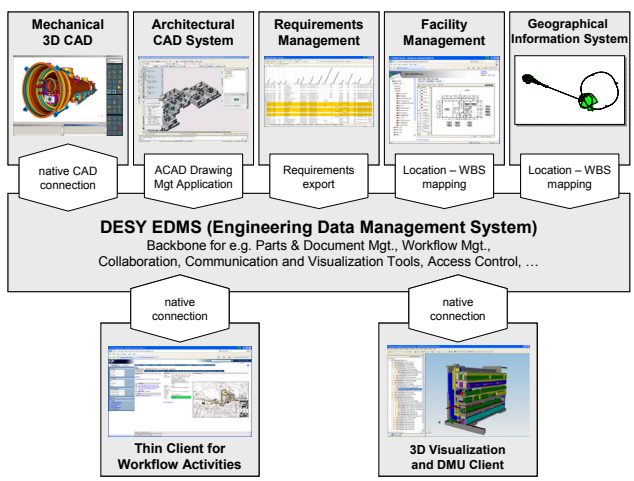

Figure 1: Information management architecture for civil construction of the European XFEL.

* Communicating author, lars.hagge@desy.de

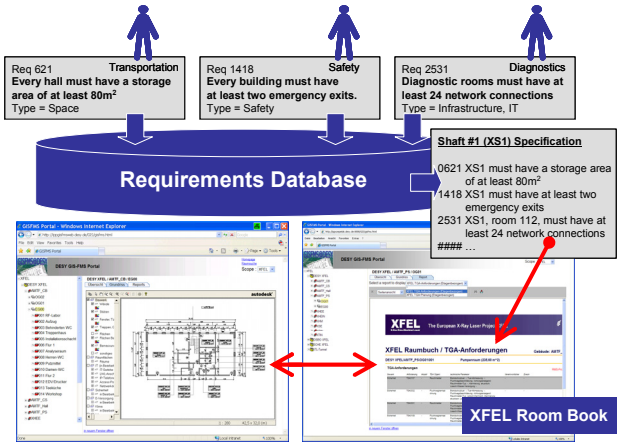

Figure 2: Concurrent requirements engineering.

COLLABORATIVE DESIGN

DESY has established a collaborative design process which integrates more than a dozen subsystem design teams from trades such as e.g. architecture, electrics, water, ventilation, safety, transportation, survey, cryogenics and various accelerator systems (Figure 3, [5]). A design integration team puts together 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. At the end of the conceptual design phase, more than 150 master models of different tunnel sections and building complexes are managed by this process and updated and analyzed at bi-weekly intervals and published in the DESY EDMS, where they are accessible throughout the collaboration. The resulting 3D models are the basis for follow-up activities such as visualization, simulation or creating virtual environments. Figure 5 shows several examples for visual modeling in civil construction of the European XFEL.

SUB-CONTRACTOR COORDINATION & COMMUNICATION PROCEDURES

Civil construction is mostly contracted out at the European XFEL 0[6]. Interaction with contractors, such as handing over and receiving back CAD models,

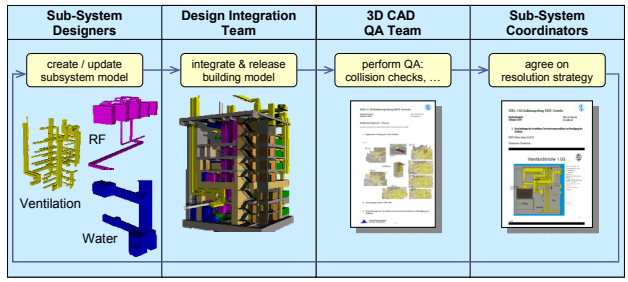

Figure 3: Collaborative design process.

construction drawings and general documentation, is carried out through the DESY EDMS. Figure 4 illustrates the general-purpose review and approval workflow for document exchange: Sub-contractors create documents (e.g. construction drawings) and submit them to the EDMS workflow. The EDMS assigns the document to one or more reviewers (e.g. safety engineers, technical experts) which can act in parallel and attach comments and mark-ups to the drawings. Then, document and comments are promoted to a responsible person (e.g. project leader, deputy) who takes a final decision on the acceptance of the document. The EDMS ensures that every transaction is logged and stored in the document history, and it provides versioning to ensure changes can be organized and conducted in a controlled manner.

BUILDING INFORMATION MODEL

The DESY EDMS accumulates information over the entire building lifecycle, from first ideas and requirements throughout design and construction into later facility operation. It offers a single point of information access and enables users to seamlessly navigate 3D models and documentation from any lifecycle phase. As such, it constitutes a so-called Building Information Model, BIM, which provides an invaluable basis for efficient and effective planning, construction, and later operation and maintenance.

CONCLUSION

DESY has established a powerful information management solution for the civil construction of the European XFEL, which enables efficient planning and

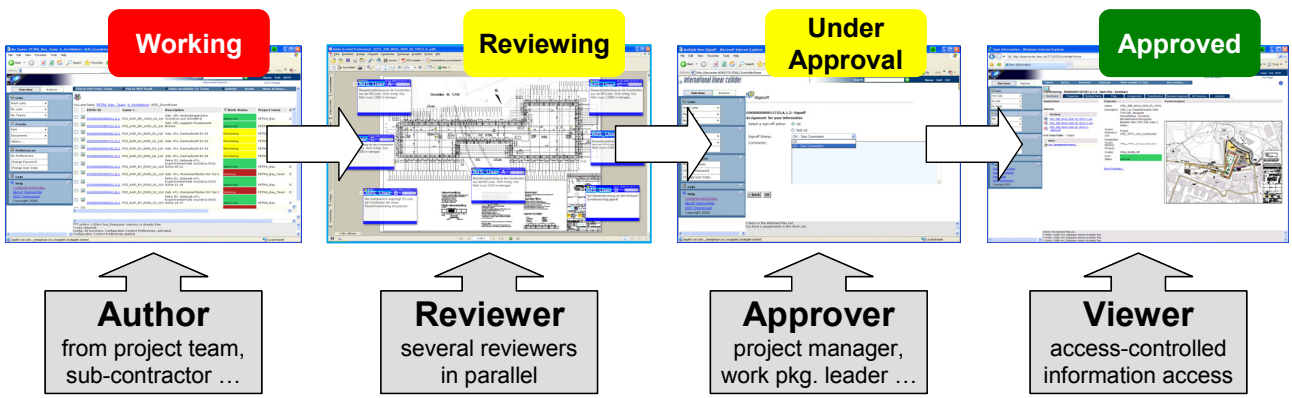

Figure 4: General-purpose review and approval workflow for exchanging and validating documents.

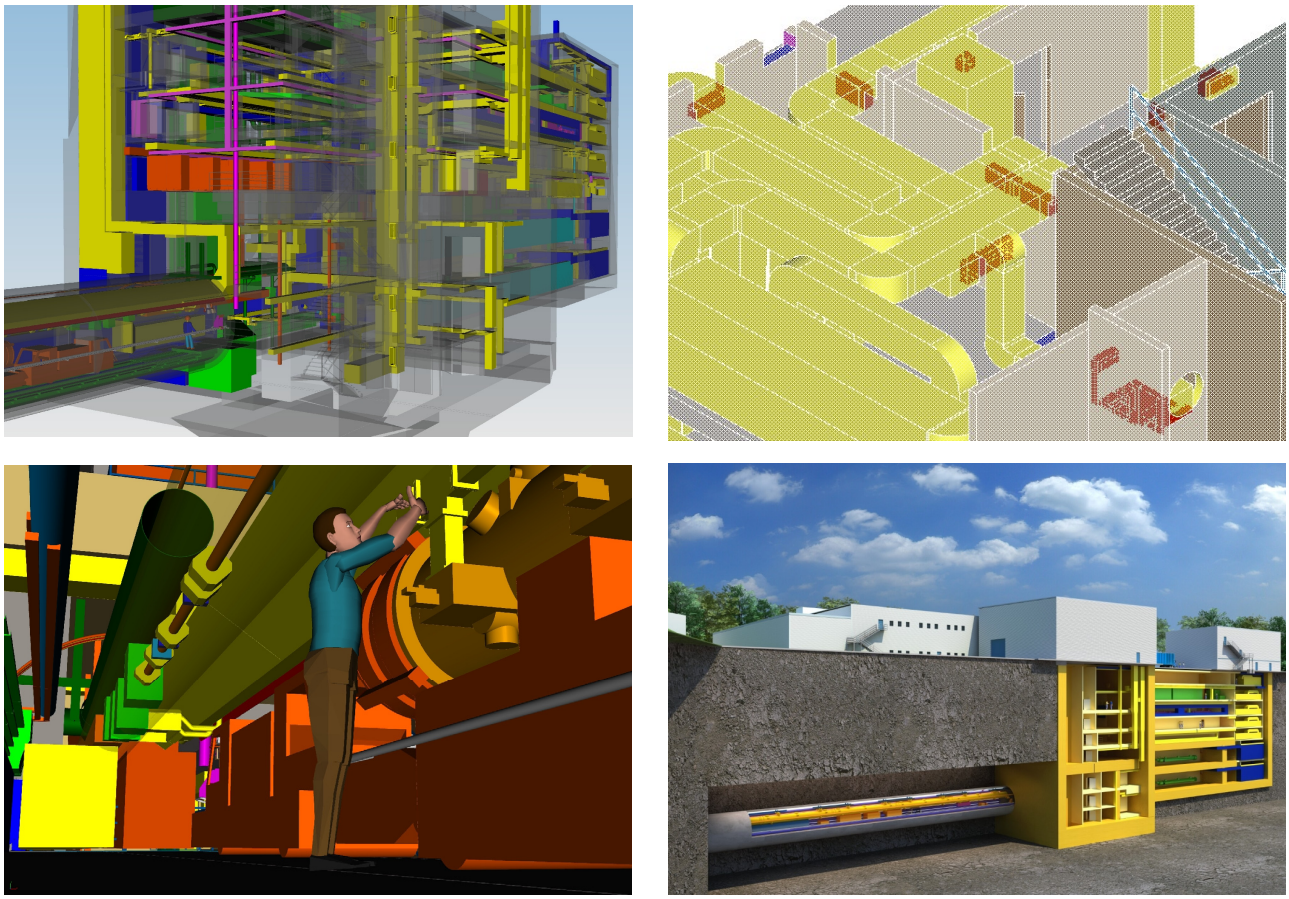

Figure 5 : Examples for visual modeling in civil construction of the European XFEL: Design integration, collision analysis, process simulation, and virtual reality.

steering of the construction project. The major concepts are ubiquitous visualization, information integration, and a web-based solution.

Visual models are published and generally accessible through the DESY EDMS. They promote vision sharing, improve design validation and enhance general communication, which in turn leads to more efficient collaboration in the entire project team.

Integrating the different types of information enables users to seamlessly navigate from visual models to corresponding specifications, design drawings, contracts, change requests, or progress reports. As result, decision-making becomes faster, design documents are less error-prone, information distribution is easy, and review and communication processes can be partially automated, which in turn leads to lower costs and shorter development time.

Most interactions are done through the DESY EDMS web client. Using a web-based system with shallow tool integration minimizes the impact on the established IT infrastructures, thus lowering the entry barriers for partners and sub-contractors to using the solution.

. Building information modelling, i.e. addresseing "the process of creating and using digital models for design, construction and/or operations of projects", and combining geometrical models with scheduling and cost information, is an emerging business discipline in the construction market. While some vendors enhance their architectural CAD systems with according functionalities, and EDMS-based solution is significantly more powerful as it separates aggregation of information from process coordination and automation [4].

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