THE XFEL ROOMBOOK - PROCESSES AND TOOLS FOR DESIGNING THE TECHNICAL INFRASTRUCTURE OF THE EUROPEAN XFEL

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Abstract

The European XFEL has started the construction of the underground buildings. Now, the detailed design of the technical infrastructure has to be completed. The design process is centered on the XFEL Roombook, which contains a complete catalog of XFEL buildings, floors and rooms. Future user groups specify requirements on rooms, which are collected in a central specification database. Engineers design the infrastructure and create floor plans and design drawings according to the requirements. Project members can access room information, requirements and floor plans through the Web interface of the XFEL Roombook. The XFEL Roombook is in production since summer 2008 and has become a well accepted information platform for infrastructure design.

INTRODUCTION

The European XFEL is a complex facility, where accelerator, buildings and technical infrastructure are tightly interwoven and have to be designed and developed like a single system [1]. This paper addresses the design process of the technical infrastructure, which includes heating, ventilation, and air conditioning (HVAC), mechanical, electrical and plumbing infrastructures (MEP), and communication, transportation and safety.

The work packages (WPs) which are responsible for the technical infrastructure need complete and definite requirements from their consumer groups for planning and building the technical infrastructure on time and in budget. The aim of the XFEL Roombook is to provide methods and tools for the detailed design of the technical infrastructure, and to consolidate a complete and definite set of requirements for the XFEL buildings.

PLANNING AND DESIGNING TECHNICAL INFRASTRUCTURE

The essential tasks in designing the technical infrastructure have been identified in a process analysis. They include:

- **Capturing requirements** for each sub-system
- **Negotiating requirements** among all WPs
- **Creating & optimizing designs** for each sub-system
- **Integrating & approving** the designs for all WPs

The process involves four major roles:

- **Stakeholders** define infrastructure requirements
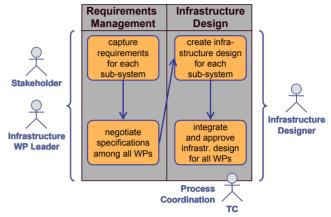- **WP leaders** create and maintain specifications

Figure 1: Process for planning and designing the technical infrastructure at the European XFEL.

- **Designers** create sub-system designs
- **Process coordinator** supervises process

Stakeholders are typically leaders or representatives of work packages who are responsible for technical sub-systems or components. They need to specify the resource requirements for their systems, for example consumption of power, water and gases, necessary connection points to supply and communication networks, and required space and tools for e.g. transportation and installation.

Work package leaders from infrastructure work packages have to consolidate the requirements, for example eliminate double counting, identify and resolve contradictions (e.g. required power vs. acceptable cooling) and match the emerging infrastructure with available budgets.

Designers are dimensioning the systems and provide a general layout. Once an initial design is available, they have to check the compliance with other subsystems, i.e. ensure that different systems are not interfering and connect as expected. At the end, they have to get back to the stakeholders and ensure that no essential requirements have been accidentally dropped or modified during negotiation and design optimization.

The **Process Coordinator** has to ensure the timely delivery of the requirements specification take care that the process is conducted as agreed. Most emphasis is put on ensuring communication and a continuously high level of interaction among all process workers. The process coordinator is part of the technical coordination team of the XFEL.

Figure 1 summarizes the process and the responsibilities of the different roles.

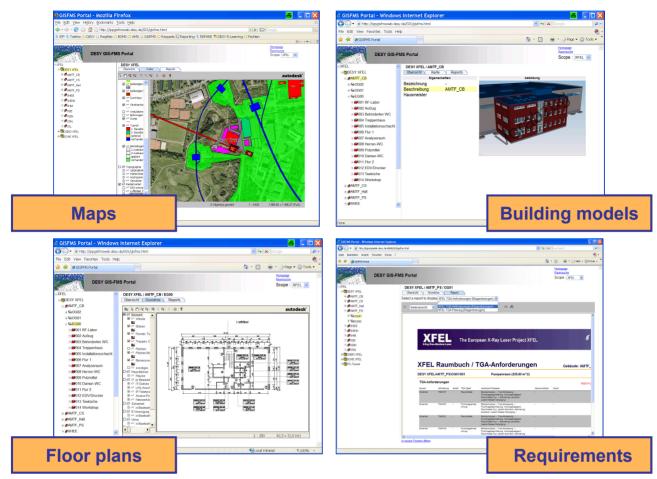*communicating author, jens.kreutzkamp@desy.de

Figure 2: Screenshots of the XFEL Roombook (partially in German).

THE XFEL ROOMBOOK

The XFEL Roombook is a central information access point in infrastructure planning of the XFEL. It enables members of the collaboration to access requirements and emerging designs through a web interface in the DESY Intranet.

The Roombook is built on top of DESY's Geographic Information and Facility Management System, GISFMS, which supports the planning, construction and maintenance of buildings and their technical installations, as well as realties [2]. It integrates additional databases for storing process information Features and functions of the XFEL Roombook include:

- Enable access to building information such as digital maps, floor plans, and technical details of rooms, such as size, type, intended usage and status
- Provide tree browsing, tabbed navigation and advances search capabilities for filtering and accessing information by building, floor and room.
- Provide general mechanisms for relating structured data from external databases with building information and display their content in the Roombook.

The latter is used for integrating access to various operational and design information, such as:

- Requirements: Extract required installations from a requirements management system, in particular list the required connections to e.g. water and gas supplies, communication network
- Inventory: Extract planned or installed connections from different sub-systems from a design database
- Documents : Link with documents in the central documentation database
- Personnel: Display intended users and responsible persons (e.g. for safety, facility management) as defined in a central personnel database.

Figure 2 illustrates some of the information options of the XFEL Roombook.

WORKING WITH THE XFEL ROOMBOOK

The XFEL Roombook is optimized for easy information access, which meets the demands of most of the users. The entire design team can access all the information they need through the intranet web interface. For capturing information, the Roombook connects with additional external tools, such as spreadsheets, external databases and CAD systems. Those tools are used by

Accelerator Technology - Subsystems

WPLs use Excel for working with requirements — Everybody uses the GISFMS web for accessing information — Designers use CAD for planning infrastr. objects

Figure 3: Architecture of the XFEL Roombook.

Figure 4: Example for a spreadsheet for capturing and classifying requirements.

experts only, and the tools are already in place at the expert's work locations, and nobody had to learn using new tools because of the Roombook.

Figure 3 illustrates the operation principle of the XFEL Roombook:

- Most of the design team correspond to casual users, who access the Roombook only for retrieving information through the GISFMS web interface as their central information access point.
- Work package leaders provide and update requirements through spreadsheets
- Design Engineers use their available Architectural CAD system for inserting infrastructure designs into floor plans.

The additional information systems, which are connected to the Roombook, are operated by the process coordinator only:

A Requirements Management System, RMS, is used for capturing, classifying and analyzing requirements and, most important, establish traceability between requirements [3][4]. Stakeholders use spreadsheet templates for contributing requirements (Figure 4). The spreadsheets are imported to the requirements database, where their data is aggregated and filtered according to sub-system. Work package leaders receive extracts from the RMS which list the requirements on their sub-systems, again as spreadsheets, for reviewing and consolidating the requirements. The RMS tracks the requirements history and determines the impact and potential side-effects of requirements changes.

The final specifications are stored in the DESY Engineering Data Management System, EDMS. The EDMS providing version control, enables linking specifications with additional design documentation, and provides workflows review and release procedures [5][6].

BENEFITS AND EXPERIENCE

The XFEL Roombook is a well-established tool which ensures transparent and reliable planning. All project members are able to easily retrieve latest working information on the planned infrastructure, which reduces efforts for communication and information retrieval.

The Roombook offers a complete and consolidated requirements view, which is the foundation for cost-efficient planning: The design quality is increased by preventing incomplete designs or over-dimensioned
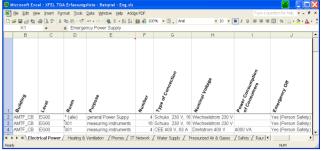
installations due to missing requirements or multiple, independently added contingencies.

The captured information automatically evolves into a complete documentation of the XFEL buildings and their installations. This documentation is passed to the facility managers when construction is complete and the buildings are put into operation and maintenance. Creating this documentation along with design and construction is an especially beneficial long-term investment, as a lot of the information (e.g. design decisions regarding dimensioning, layout, operability) cannot be re-generated once the construction of the buildings is completed and the design and construction teams are disbanded.

REFERENCES

[1] N. Bergel, L. Hagge, T. Hott, J. Kreutzkamp. S. Sühl, N. Welle, "Inter-Disciplinary Mechanical and Architectural 3D CAD Design Process at the European XFEL", EPAC'08, Genoa, June 2008

[2] S. Eucker, L. Hagge, J. Kreutzkamp, B. Singer, D. Szepielak, P. Tumidajewicz, "Integriertes gewerke-übergreifendes Facility Management für Gebäude und Anlagen am Deutschen Elektronen-Synchrotron DESY" (in German), Facility Management 2008, Frankfurt, May 2008

[3] L. Hagge, J. Kreutzkamp, K. Lappe, "The TESLA Requirements Database" Int. Conf. on Computing in High Energy Physics, CHEP 2003, La Jolla, CA, March 2003

[4] L. Hagge, K. Lappe, "Sharing Requirements Engineering Experience Using Patterns", IEEE Software 22,1(2005)24-31

[5] J. Bürger, J. A. Dammann, L. Hagge, A. Herz, J. Kreutzkamp, S. Pantó, D. Szepielak, P. Tumida-jewicz, N. Welle, "Managing the Complexity in Large Scientific Collaborations with PLM Systems", PLM08, Seoul, July 2008

[6] J. Bürger, J. A. Dammann, S. Eucker, L. Hagge, A. Herz, J. Kreutzkamp, S. Pantó, S. Sühl, D. Szepielak, P. Tumidajewicz, N. Welle, "DESY EDMS: Information Management for World-Wide Projects" PAC'09, Vancouver, May 2009