EXAMPLES FOR 3D CAD MODELS AT THE EUROPEAN XFEL

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Abstract

This paper analyses applications and benefits of 3D models in the planning and design of the European XFEL. 3D models are used in planning, design and integration activities, and they range from detailed models of individual accelerator components up to an integration model of the entire facility. Through DESY's Engineering Data Management System, DESY EDMS, all members of the project team have interactive access to all the models. Because of this general availability, the models are widely used and well accepted as communication tools. They support vision sharing and help discovering and resolving design issues early such as e. g. incompatible interfaces or overlapping geometries.

INTRODUCTION

3D CAD models are essential tools for managing the design complexity of the European XFEL. They have manifold applications throughout the entire project lifecycle, ranging from simple space allocations for the various subsystems in the earliest stages of the planning approval process, up to complex simulations and as-built modeling of the integrated facility.

DESY has established efficient design collaboration at the European XFEL for managing the large and complex design models. A dedicated design method decouples project-wide integration and negotiation activities from detailed design issues within the various work packages. A permanent process of design integration, clash-checks and negotiation ensures that the evolving designs are best-possible balanced towards the many different needs and interests [1] [2] [3]. 3D models and related information are easily accessible in the entire collaboration via the web-based DESY EDMS [4].

The XFEL Design Collaboration enables design teams to work independently at their locations and according to their own schedules. This way, the accelerator design can still be optimized while buildings are already erected and equipped with their technical infrastructure. The design teams remain the exclusive owners of their CAD data. They are able to contribute in the CAD system of their choice, but can still work in the context of the entire facility. The collaboration process ensures that all sub-systems are free of clashes and have matching interfaces.

This paper is based on an electronic poster, which highlights and animates selected applications of 3D CAD models at the European XFEL. The paper recollects some of the examples which were shown on the poster.

VISION SHARING

3D CAD models at the European XFEL are organized into about 150 so-called master models of different tunnel sections, shafts and buildings. The models have been created for design integration and optimization. They integrate more than 15 technical sub-systems. The master models are combined into a 3D CAD model of the entire facility, which assembles more than 170,000 parts. It allows the project team to interactively explore the XFEL from injector to experiments. It eases communication by being able to visualize any area of interest, and it ensures that every member of the project shares the same vision of the facility. Figure 1 shows some impressions from a bird eye's view and different positions in the model.

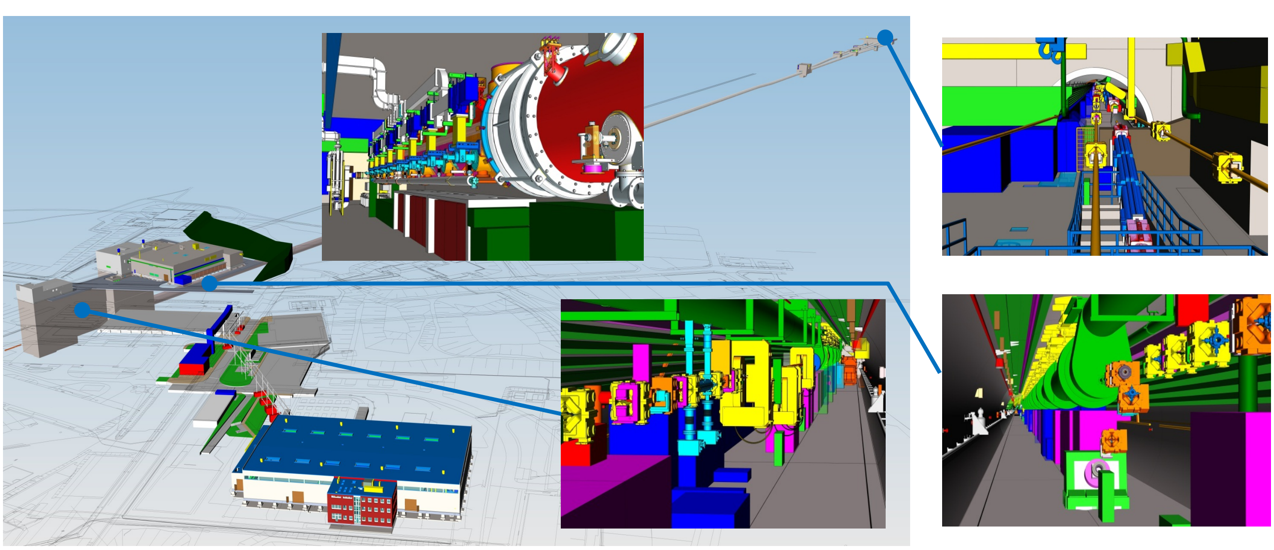

Figure 1: 3D CAD model enabling the project team to interactively explore any region of the facility. The model assembles more than 170,000 parts, color-coding is applied for quickly identifying the different sub-systems.

SPACE ALLOCATION

The various sub-systems have to allocate the space they need. This is done by introducing placeholders for space reservation into the CAD models. Placeholders include the space needed for installations, as well as space which must be kept clear e. g. for transportation, for emergency escape, or for survey activities. Placeholder models are the basis for integration and coordination. Coarse placeholders can be provided by every subsystem already in very early stages of the project. They are the conceptual basis for decoupling coordination and integration from detailed design. Figure 2 shows the space allocation in the injector complex as an example.

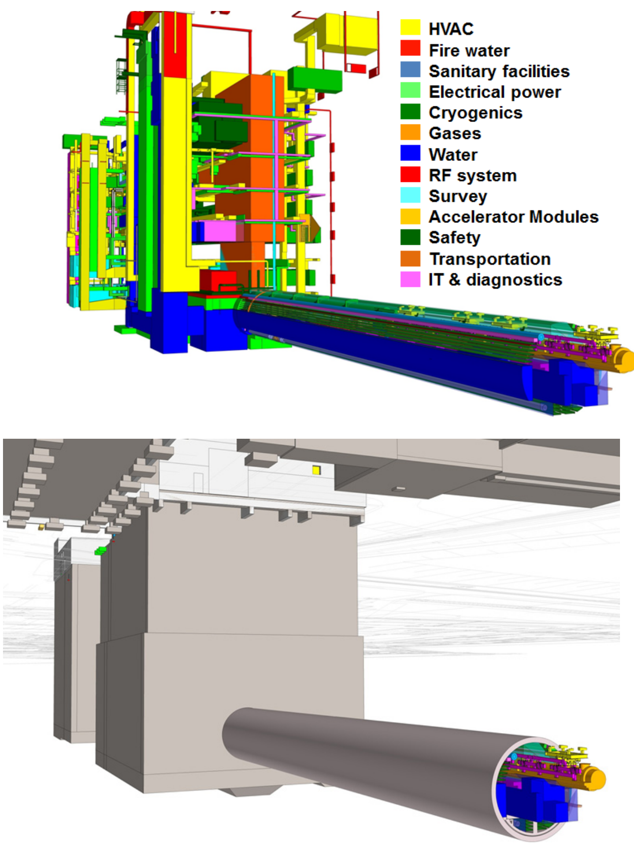

Figure 2: Space allocation in the XFEL injector complex.

CLASH CHECKS

Clash checks analyze the CAD models for overlapping geometries. They help designers to detect possible clashes before construction and production start and prevent unbudgeted changes from reaching the shop floors. Clash checks can lead to substantial savings in the overall project costs. Figure 3 shows as an example the result of an early clash check the central area of the injector complex. Overlapping geometries are colored, and the geometry of the clashing parts is shown in transparent grey. Most of the shown clashes result from a design update of the technical infrastructure, which had not yet been fully followed-up in the building design.

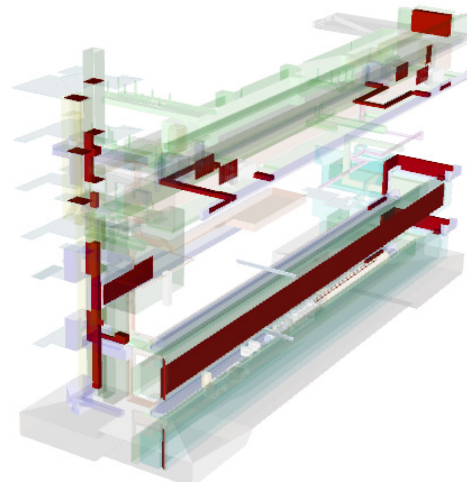

Figure 3: Clash check in the central injector building.

INTERFACE DEFINITION

Interface definition ensures that connected components will be matching at their interfaces. Detailed interface geometry can be provided and attached to the placeholders already during early design stages to make sure that evolving developments are compatible. Figure 4 shows as an example the placeholder of the accelerator module with a detailed connecting flange for the RF system.

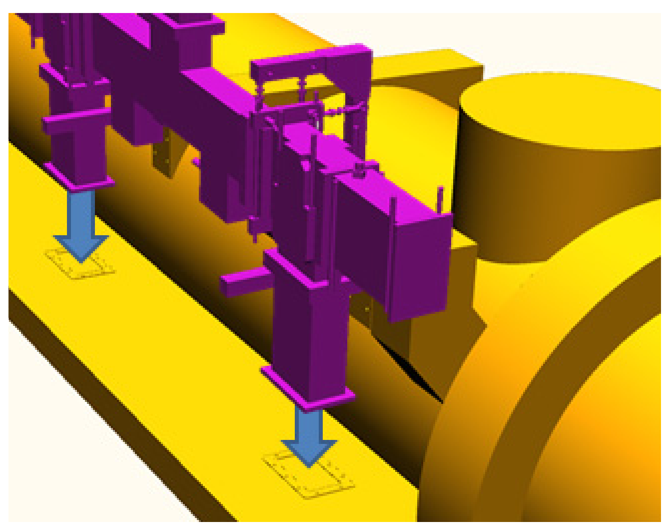

Figure 4: Interface definition with placeholder models.

SIMULATION

Simulations use CAD models to gain further insight into the behavior of the real system. Digital humans are inserted into models to better study interaction with the environment, and animation sequences and movies are created for investigating dynamic aspects of the environment. Figure 5 shows a simulated escape from an over-crowded area and a scene from an animated transportation and installation procedure.

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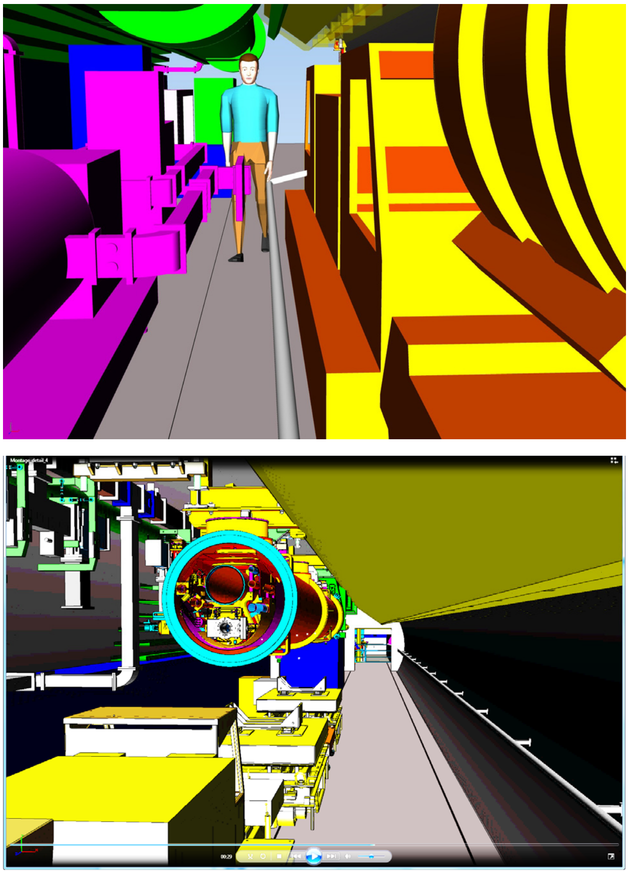

Figure 5: Examples for CAD-based simulations.

VIRTUAL REALITY

Virtual reality is a special case of simulation which aims at enabling users to perceive a modeled environment closer to reality. This can be achieved by adding textures and pictures to the model, and by using dedicates stereo projection equipment. Figure 6 shows an example of an accelerator module in a stereo projection room. Figure 7 shows two scenes from the injector complex, which overlay pictures of the completed structural work with models of the planned installations to verify they fit.

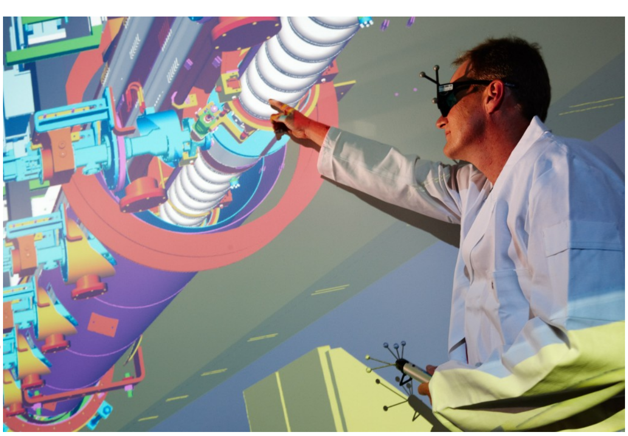

Figure 6: Accelerator module in virtual reality.

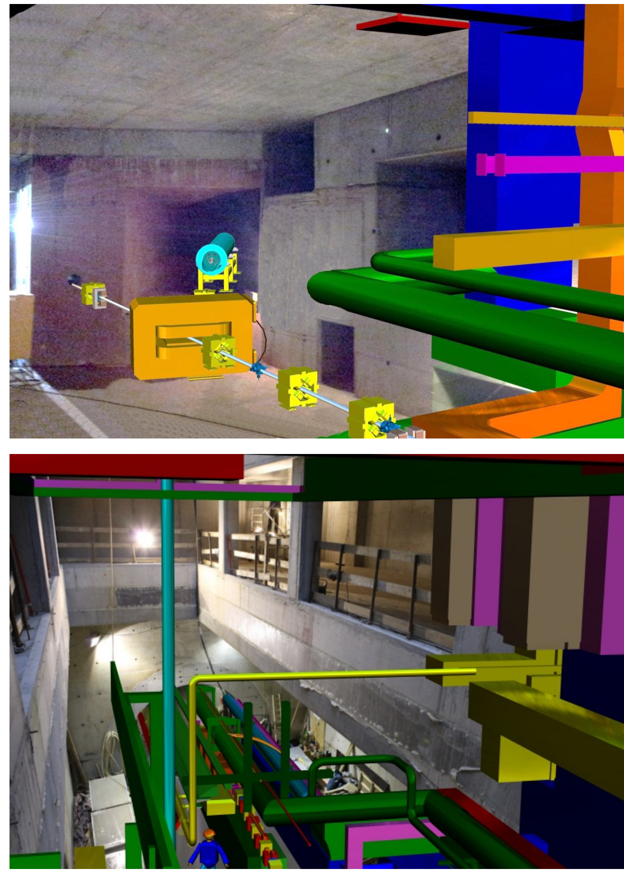

Figure 7: Planned installations and completed injector building nicely fit.

CONCLUSION

3D models are widely used and well accepted tools at the European XFEL. They support vision sharing, which leads to improved communication and better decision making. They help discovering and resolving design issues early, which yields savings in the project costs.

ACKNOWLEDGMENT

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