ESTABLISHING A COLLABORATIVE PLANNING PROCEDURE FOR THE EUROPEAN XFEL

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Abstract

Building a new accelerator requires a consistent common design of the entire complex, including machine, tunnels, buildings and infrastructure. The efforts involve experts from many disciplines. A dedicated planning and design procedure has to be established which provides "just-enough" details where needed while preserving maximum flexibility for ongoing R&D efforts, and which can also manage later changes if they become necessary. The paper presents experience from establishing such a collaborative planning process for the European XFEL.

PLANNING PROCESSES

Planning is an activity which is regularly carried out at an individual level, and almost every individual has developed habits regarding planning activities. A collaborative planning process should try to maintain these preferences of the involved teams and individuals to achieve good acceptance, but also has to respond to formal requirements. This section discusses some boundary conditions which need to be accounted for in collaborative planning.

Cultural Issues

Figure 1a illustrates the idea of market place collaboration: It is founded on the common interest of the participants in the intended result. Contributors self-organize around the subject, and every unit contributes according to its understanding and its capabilities. Work flow and information flow are coordinated through informal ad-hoc processes, which are initiated by common understanding.

For the planning process itself, prototyping methods have become popular (Figure 1b). They are based on the assumption that individuals can better specify their needs and develop ideas once they see a prototype, a preliminary manifestation of a project idea. Prototypes are analyzed and subsequently refined, leading to an iterative and incremental development process.

A good collaborative planning procedure has to incorporate aspects of both market place collaboration and iterative incremental prototyping.

Formal Requirements

Large-scale projects put formal requirements on the planning process. Several approvals requiring formal documents are necessary before construction can start. Approval procedures are pre-defined and usually partitioned into phases, and each phase has to produce mandatory deliverables in order to enter the next phase. Figure 1c illustrates formal approaches consisting of phases (blue arrows), where each phase follows defined processes for creating the required deliverables (pink boxes). A collaborative planning process also has to be compatible with such formal conditions.

Changes According to Ongoing R&D

Additional complication arises as different expert groups are contributing at different project phases: buildings and technical infrastructure are constructed first, thus their design has to be fixed early in the project and is then imposing constraints e.g. on the machine layout while accelerator R&D is still being continued.

Figure 2a illustrates the dilemma: tunnels and buildings depend on the layout of the technical infrastructure, which in turn depends on the accelerator design. Hence strictly speaking, the accelerator would have to be specified before planning the technical infrastructure and the construction could commence.

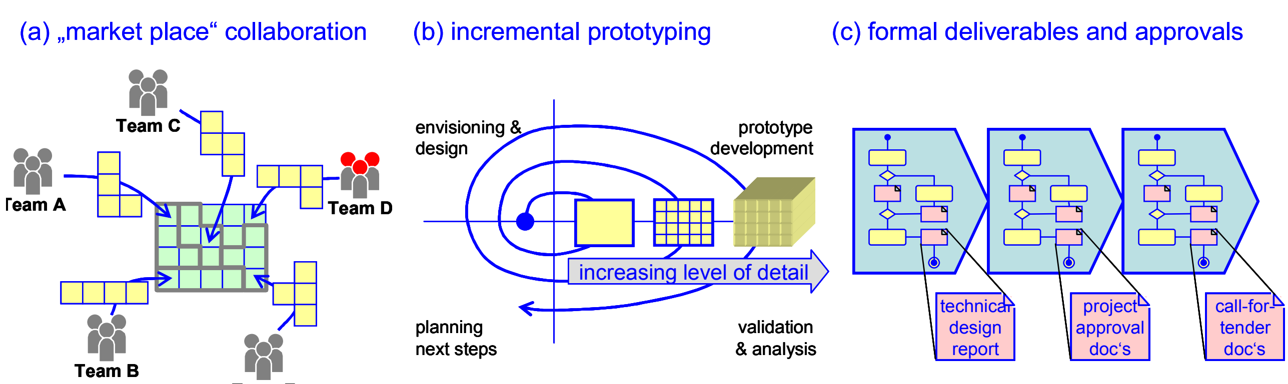

Figure 1: Boundary conditions on collaborative planning procedures: (a) groups self-organize into expert teams for specific tasks, introducing the need for coordination; (b) planning benefits from prototypes which are analyzed and iteratively and incrementally detailed; (c) authorities expect pre-defined deliverables for project approvals.

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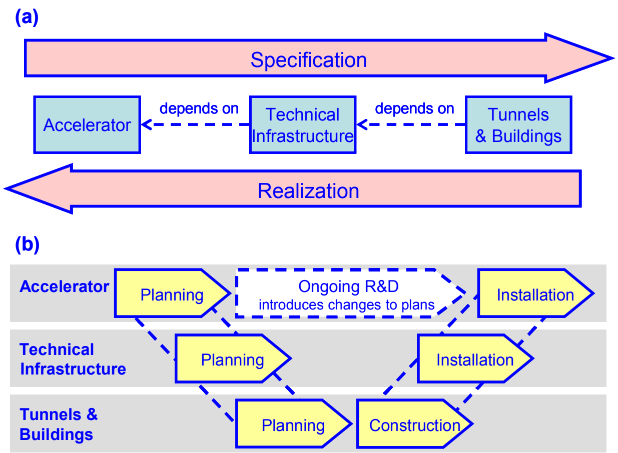

Figure 2: Dependencies of planning activities.

Figure 2b shows the cascading of the planning and construction activities. For the accelerator, a large gap occurs between the completion of planning and the beginning of installation. The time is used for ongoing research and development activities, which will lead to changes in the plans at the time the accelerator installation starts.

A collaborative planning procedure has to take the ongoing R&D efforts into account and needs to be flexible enough to accommodate later changes. One way of realization is keeping the entire planning at a high ("placeholder") level and adding details only where unavoidable. Another measure is enforcing synchronization of the planning documents at formal occasions, using these opportunities for entering and implementing changes.

PLANNING THE XFEL

Figure 4 shows the procedure for planning the construction of the European XFEL. It consists of four major activities:

1. *Local planning*: expert groups create and maintain separate design models of specific components.
2. *Synchronization*: results of local planning groups are combined into a common overall model.
3. *Coordination and Analysis*: the design model is checked e.g. for collisions of components and compatibility with formal design rules.
4. *Publication*: after approval, formal documents are derived from the common design model.

The local planning (step 1) maintains the marketplace approach, while repeated synchronization and analysis (steps 2 and 3) imposes iterative incremental planning on the team. Publication (step 4) ensures that the required formal documents are produced.

Steps 2-4 are additional efforts compared to a simple market place approach; they account for the exponentially growing communication and coordination demands as the number of participating teams increases. The quality assurance is assigned to internal resources to maintain the emerging knowledge, while synchronization, coordination

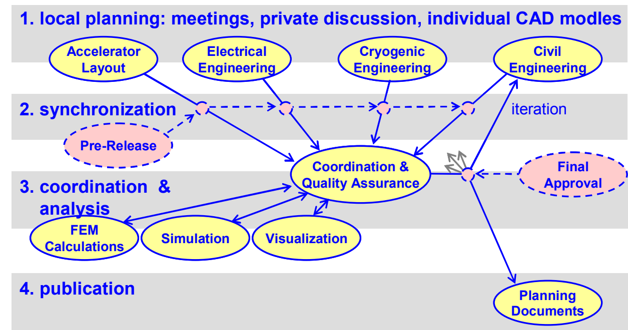

Figure 4: Planning process for the XFEL.

and publication are temporary activities which can well be assigned to external engineers.

PLANNING TOOLS

The planning procedure relies on commercial tools used in industry which are being adapted to the culture and organization of a global scientific collaboration. This section gives a brief overview of some of the tools.

Requirements Management

A requirements management system (RMS) supports the elicitation and documentation of requirements on components. Project teams create specifications using their accustomed office tools, while the RMS replicates individual paragraphs from the specification in a requirements database. One person per team is responsible for classifying the requirements in the database according to pre-defined categories. This way, teams are able to retrieve from the database all the requirements which are relevant for a given facility or building [1]. The RMS presents the requirements as checklists which can be used for negotiation and approval. Figure 3 illustrates the RMS operation principle.

The RMS includes a Web client which offers access to the specification documents and to the requirements database.

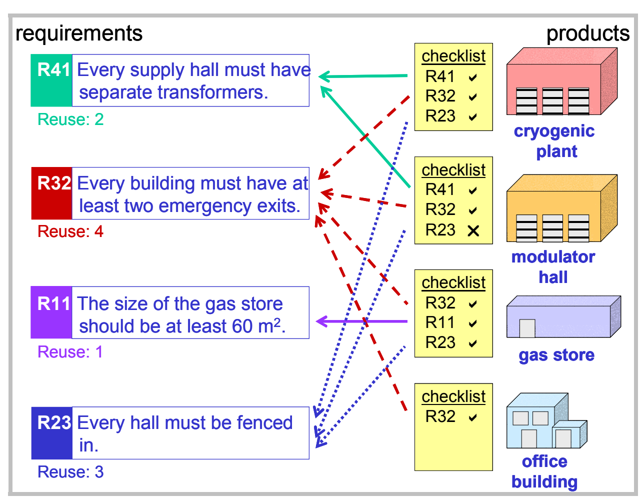

Figure 3: Requirements Management System.

Engineering Data Management

An Engineering Data Management System (EDMS) manages the technical project documentation and coordinates the overall planning process. CAD models, technical drawings and other documents are stored in the EDMS, which keeps track of their history and maintains relations that show the dependencies between documents [2].

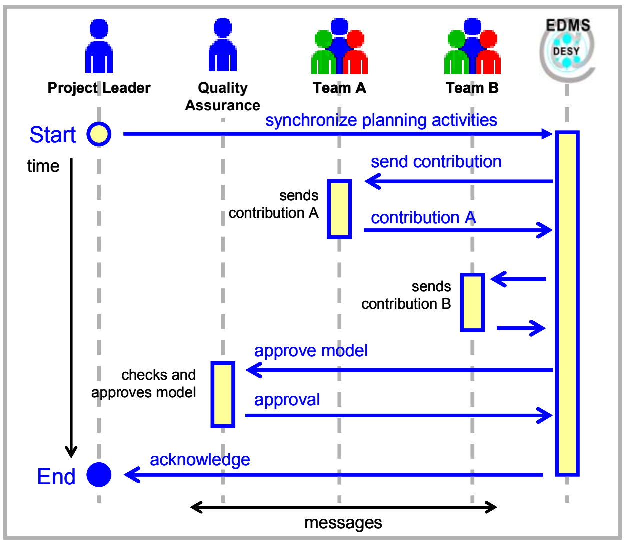

Figure 5: Process coordination using an Engineering Data Management System.

The EDMS includes a Web client for searching, modifying and relating documents and for starting and coordinating approval procedures. It also contains an interface to a 3D CAD, which enables relating project documents with engineering data and which makes CAD models accessible to the entire project for visualization. Figure 5 illustrates process coordination by the EDMS.

3D CAD and Visualization

Visualization is an essential ingredient for coordination and for establishing mutual agreement about the planned facility. Figure 6 illustrates some of the visualization tools which are used for supporting the planning process: a Web-based Geographical Information System generates dynamic maps of the route and the sites, including the planned XFEL buildings. A 3D viewer enables general access to CAD models, and VR tools use the CAD data to create a virtual-reality mock-up of the final lab site. The 3D models are accessible through the EDMS, which launches the appropriate viewer.

RESULTS AND EXPERIENCE

The planning process has been successfully established as described, and the planning tools are working reliably. The local planning has been performed by expert groups from DESY, while synchronization, coordination and publication activities have been assigned to external engineers. With this cultural mix the project team succeeded in fulfilling all the formal requirements while at the same time keeping a maximum flexibility for R&D work.

When establishing the process, it turned out that most of the team members were not used to discussing processes. Procedures were mixed with organizational structures, and people did not properly disentangle methods and tools. The process has therefore been promoted through tools and rules for their usage. For example, requirements checklists have been used to involve all the teams in the coordination efforts, while EDMS versioning helped introducing approval processes.

The process needs continuous adaptation as further planning tasks arise and the required level of detail increases. Dedicated resources are necessary for process definition and implementation in the tools. Benefits were gained from offering tool training and user support, which led to generally available up-to-date project documentation and improved information exchange.

The iterative planning is performing well: Procedures, tools and results from an earlier conceptual design phase could easily be picked-up and advanced for preparing the formal project approval. The process became well-known to and accepted by the team and is seamlessly being continued into the next activity, the preparation of the call for tender for the construction work.

REFERENCES

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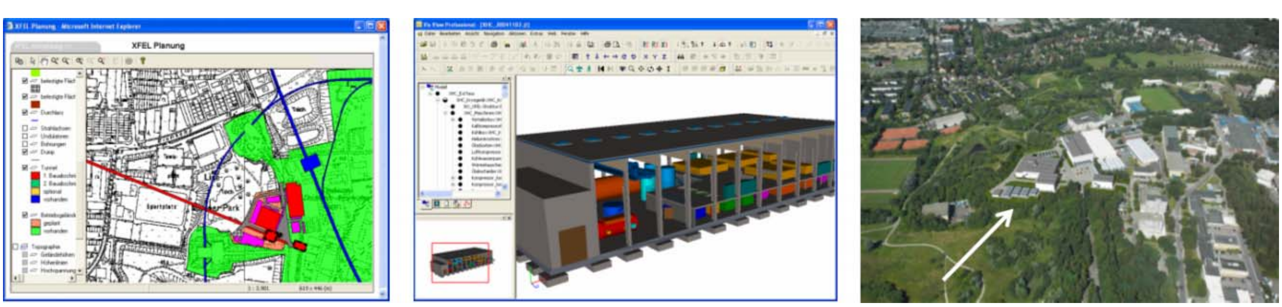

Figure 6: Examples for visualization tools: Web-GIS for creating maps (left), 3D viewer for inspecting buildings and installations (middle), virtual reality mock-up of future lab site (right).

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