The TESLA Requirements Database

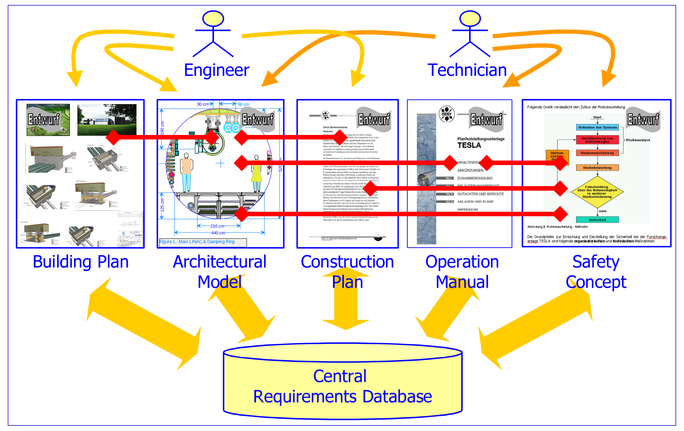
Lars Hagge, Jens Kreutzkamp, Kathrin Lappe, Deutsches Elektronen-Synchrotron (DESY), Hamburg

Mission

Planning a new accelerator, for example, involves among other designing the machine, performing civil engineering, planning the layout of the technical infrastructure, and handling public affairs (and is very similar to plant construction). Expert groups work on each topic, driven by experience, with solutions in their minds. As work proceeds, the areas begin to overlap. "The experimental hall has to be large enough for the detector and all its supplies, but as small as possible for environmental reasons." The detector should not use certain inflammable material for safety reasons, power and water supplies should be connected to the public networks, and so on. Each planning decision has to be documented and communicated, and impact analysis on other work in progress has to be performed. What is needed is an efficient toolset for creating documentation and for classifying, tracking, analysing and reporting every single documentation item, together with a set of rules for specification and tool usage.

If a requirements management system (RMS) – which does exactly what was described before – is available at this point, it will be used and probably adopted. If it is just being planned by then, it will arrive too late, as other (probably less efficient) methods would have been already established.

Planning Documents



The demand for Requirements Engineering (RE) has two causes:

- The working groups are distributed and perform their tasks to a large part independently, but they need to exchange information on requirements and boundary conditions with other groups in order to proceed with their work.
- Several of the facilities depend on each other at a technical level, and modifying one design changes the requirements for other dependent components.

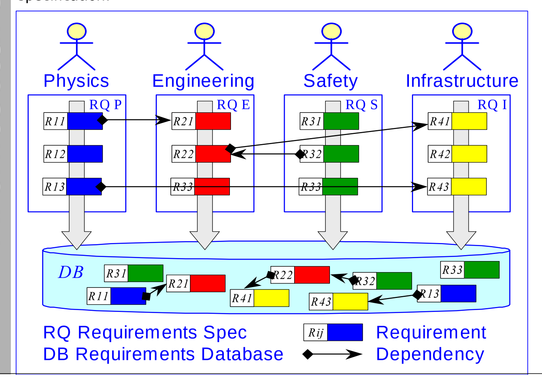
Requirements Engineering has been introduced to help the distributed working groups with requirements elicitation, negotiation, documentation, and verification. Particular goals included

- enabling concurrent specification of components by several independent working groups,
- providing methods and criteria for requirements validation and approval,
- providing a central communication and documen-tation platform available to all the participants, and
- ensuring long term archiving and availability of emerging knowledge.

Architecture

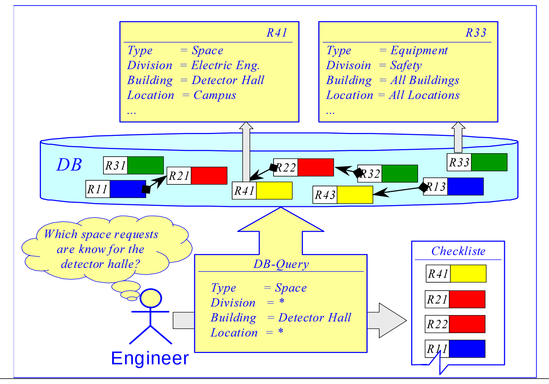
Requirements Specification

The RMS was selected to keep the impact on the expert groups as low as possible. Group requirements managers create their requirements specification in office word processors. The specifications of the different groups are kept in separate documents. The documents can be modified independently, thus allowing distributed specification.



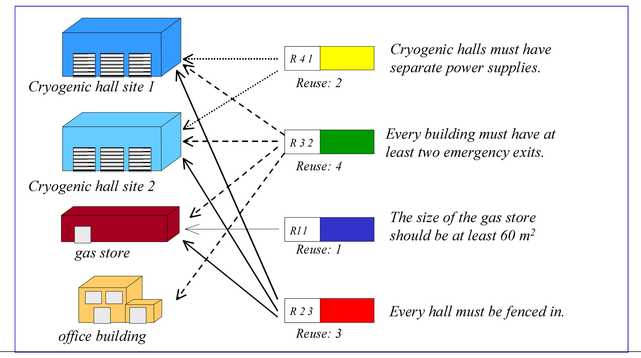
Requirements Retrieval

Once classified, requirements can be retrieved using queries. This way requirements which originate from different groups but address the same topic can be found in the database. The Figure shows an example for a civil engineer, who searches the database for all floor space requirements for a certain building (the experimental hall).



Reuse of Requirements

Effective reuse of requirements is enabled by requirement classification in the RMS database. Multiplevalue attributes allow to assign requirements to several locations or buildings. The availability of emergency exits is e.g. required for every building by entering the requirement into the database and then listing all the buildings in the corresponding attribute.



Experience

RE Introduction

•Promoting RE close to project milestones ensures strong management support. Near project milestones, the benefits of RE become especially visible when RE provides the essential inputs for validating approvals and contracts. Furthermore, the benefits are experienced personally by experts and management who have to take responsibility for the results.

•Users prefer RE tools to method training. Using a tool-centered approach and adapting the method to the contributors' experience level was essential for the successful introduction of RE. Many users do not distinguish between method and tool, so the first should be pushed forward through the latter. It is a crucial task of the RE team to configure the RMS in a way that it offers techniques which enforce a common way of working in the community. Establishing key users helps the RE-team to focus their support and facilitates creating an "RE-network" of distributed groups.

•RE methods should be introduced in phases. An RE introduction in phases could e.g. first encourage users to write specifications with office tools, then transfer the documents to an RMS, then categorize the requirements, and finally start using queries and traces. This way the team has sufficient time to fully adopt the method and at the same time value every single measure, while the RE-team can adjust the speed of the introduction to the team's learning curve.

Acceptance

•Availability and accessibility of specifications are key handles for increasing acceptance. Publishing (non-confidental) requirements specifications on the intranet enables anybody interested to follow the activities of the project team – and to provide feedback, giving people the feeling to participate. The latter helps to increase communication and motivation and to improve the visi-bility of the project.

•Authors are best convinced by short-term benefits. For authors, RE activities imply additional work in an area which does not contribute directly to the project goals. Important benefits can be generated by providing authors with relevant (pre-filtered) information from other groups, and by helping to discover potential conflicts in specifica-tions. In the initial phases it should be planned to let the RE-team perform some of the extra work like e.g. registering requirements in the RMS. It has to be stressed in this context that RE does not generate revenue, but "only" saves cost.

Elicitation

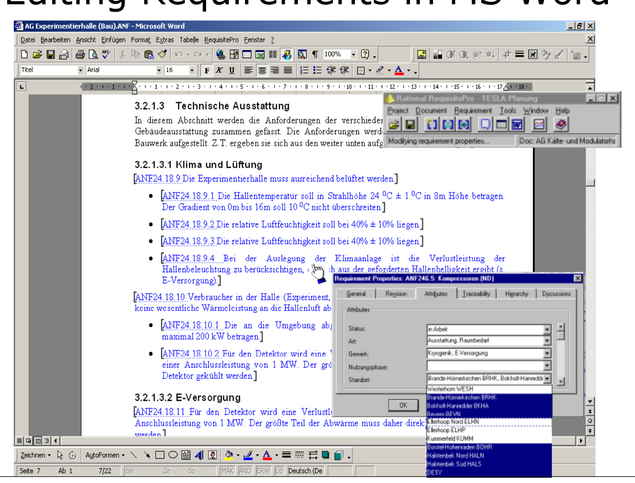
•Existing material should be used whenever possible. Existing material which has been reviewed within the user community is usually a reliable source for relevant infor-mation. The presentation format is often adapted to the community, which eases discussion and feedback.

•Stakeholders need to be convinced to enter vague requirements into the specification. Stakeholders refrain from specifying vague requirements in consideration of frequent future changes or of introducing unwanted constraints. On the other hand, vague requirements are essen-tial for developing and negotiating alternatives. The RE-team has to convince and support the stakeholders in specifying and exploiting the benefits of vague require-ments.

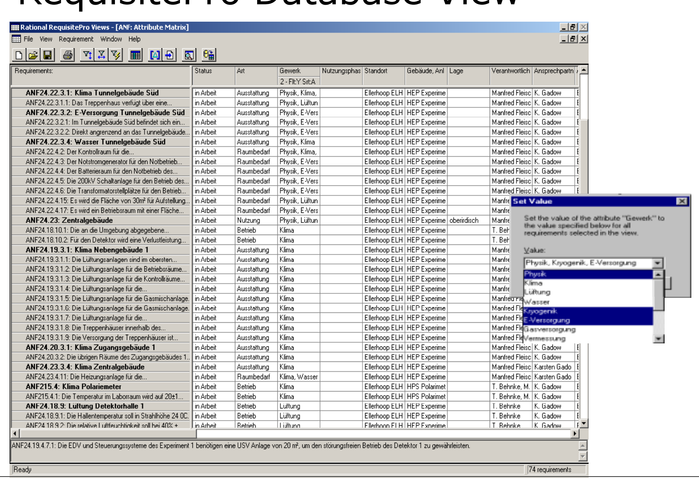
•Light-weight checklists and tools are important enablers for elicitation. Distributed groups work asynchronously and frequently meet for requirements specification just when no support is available. In such situations, specification work will only continue if checklists and tools which enable "auto-didactic" requirements elicitation are available.

Tool Support

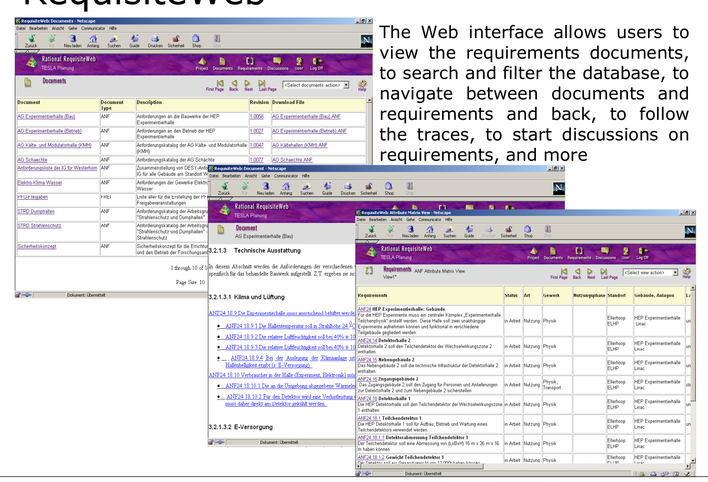
Editing Requirements in MS Word



RequisitePro Database View



RequisiteWeb

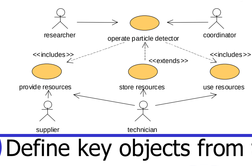


The Web interface allows users to view the requirements documents, to search and filter the database, to navigate between documents and requirements and back, to follow the traces, to start discussions on requirements, and more

Method

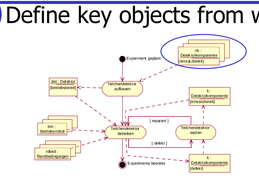
Requirements can be formaly expressed as a UML model, but to involve users in the specification a simplier method is needed. The following diagram illustrates the similarity of an evolving UML model and a well structured textual requirement specification. The modeling procedure can be expressed as a checklist which enables users to specify requirements directly as text - without having to create an UML model.

1 Define core functionality



ID	Requirement Text	Type
UR1	An experimental hall shall house the detectors and support its installation and operation procedures	Usage

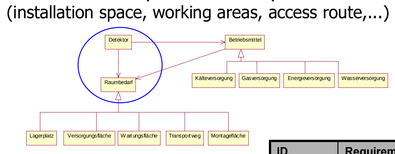
2 Define key objects from workflow



ID	Requirement Text	Type
UR1.1	For proper operation, the detector has to be provided with gases.	Usage

3 Determine required floor space

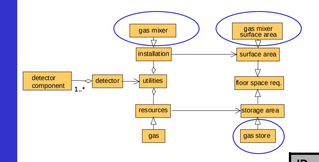
(installation space, working areas, access route,...)



ID	Requirement Text	Type
UR1.2	The detector shall have a size of 16*26*16 m³	Floor space

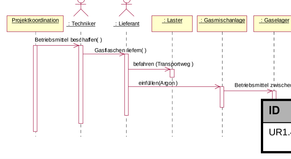
4 Determine required facilities

(electricity power, gas, water,...)



ID	Requirement Text	Type
UR1.3	Gas facilities which include a mixer and a gas store have to be created.	Infrastructure

5 Describe procedures for provision of resources



ID	Requirement Text	Type
UR1.4	Gases should be inserted into the mixer through a separate shaft	Floor space

6 Describe the installation procedure

ID	Requirement Text	Type
UR1.5	Components shall be commissioned outside of the experimental hall	Access

7 Determine additional room requirement

ID	Requirement Text	Type
UR1.6	The gas mixer requires a control room of ~30 m²	Floor space

8 Check for external constraints

(safety, policies)

ID	Requirement Text	Type
UR1.7	The gas installations should be kept in a separate building	Safety

9 Structure the requirements document

From this approach, a guideline can be developed which enables experts to create textual requirements directly, without having to create the model first:

1. **describe the important tasks and applications**
2. **describe scenarios (main flows) for each task**
3. **determine the objects which are involved**
4. **for each object specify the required floor space, access, safety precautions etc.**
5. **for each object describe the required installation, operation and maintenance procedures, for each procedure continue at step 2.**

The guideline is easy to follow and successfully reduced the complexity of visual modelling to a level adequate for requirements specification by distributed teams.

Light-weight checklist:

1. **Define core functionality**
2. **Define key objects from workflow**
3. **Determine required floor usage (installation space, working areas, access route,...)**
4. **Determine required facilities (electricity power, gas, water,...)**
5. **Describe procedure for provision of resources**
6. **Describe the installation procedure**
7. **Determine additional room requirement**
8. **Check for external constraints (safety, policies)**
9. **Structure the requirements document**