1. Project context and constraints

In the automotive industry software has become more and more important in the past and it is expected that the importance will increase further. Thus a rigorous specification of requirements of the features will become more important as well.

Most publications and textbooks dealing with requirements engineering assume that systems are being built from scratch. However, in many business areas systems are built as increments, i.e. the next generation inherits the features, only enhancing the system with more or less additional innovations. The potential reuse of predecessor specifications is difficult because requirements are often not handled in a systematic way. Changes are not completely incorporated into the specification document, so it does not cover the complete functionality of the final product. The workload of the development engineers is often very high and usually they are not able to spend much time for the detailed elaboration of requirements specifications.

The basic question is, how to obtain high quality specification documents in a situation as described above, where engineers with domain expertise have to face technological challenges and hard deadlines. Furthermore, those core development teams are often not familiar with the techniques to be applied in systematic requirements engineering. For this reason, they would not only have to accept an additional task (“build those high quality requirements documents”), but also have an additional training on how to do so (“how to specify high quality requirements documents”).

In the following we describe a successful approach taken at Mercedes-Benz Technology Center (MTC), with the goal to obtain high quality requirements specifications in the outlined context while minimizing the additional workload of the core development teams. The basic idea is to assign and hire supplementary staff for doing the job.

2. The Process

The system to be specified was the set of embedded systems responsible for driver and passenger comfort. The focus of the specification process was on software requirements. The corresponding functionalities include features like in car illumination or wing mirror control. The domain knowledge for these different functionalities is distributed amongst several departments at MTC.

The overall behavior to be specified was clustered into some 70 features. The requirements specifications for these features were to be completed within 6 months, the overall effort was about 100 person months.

We derived a two phased specification process:

1. raw specification (document & consolidate scenarios)
2. fine specification (document detailed requirements & peer reviews)

Figure 1: General steps of the specification process.

3. The requirements specifications

The indicated activities resulted in about 50 feature requirements specifications. On average, each specification document covers about 40 pages. For values of progress during evolution see Figure 2.

We are able to distinguish several cases depending on the starting position for specification: (i) Most of the requirements could be extracted directly from other specifications. (ii) The needed information was available but distributed over different kinds of documents and people. In both cases, enhancements to such features could also be handled well. (iii) Highly innovative or completely new features were a more challenging task, because requirements analysts without domain expertise cannot specify such features without constant feedback and support by the domain experts. But even in this case the work load of the domain experts was dramatically decreased since the specification work was done by the requirements analysts.
4. The People

The overall process involved some 30 domain experts (each responsible for 1 to 6 features), 10 senior requirements analysts, 13 requirements analysts, and three additional persons responsible for change management, for quality management, for general RE matters, as well as for the requirements management tool (Figure 3).

Figure 3 Overall resources bound to requirements specification (both workload and persons)

Obviously, the domain experts played a crucial role for the overall success. There is a bunch of possible reasons for a domain expert for being not cooperative like for instance politics, time pressure, lack of understanding, lack of expertise or personal fear about losing individual influence. So the domain experts had to be convinced of the opportunities of the approach instead of only seeing the potential risks of making their implicit knowledge explicit.

The fact that the requirements analysts in the fine specification phase were inexperienced people, has been regarded as a risk at the beginning of the project, but turned out to be of advantage for the specification process. The requirements analysts were “naive” enough to have an unbiased view on the features. During the derivation of the functional requirements, they questioned the scenarios defined in the first phase of the process, which often led to a refinement of the scenarios and to the resolution of ambiguities.

Our final message in this context is quite obvious, but nevertheless important: there are different types of domain experts, different types of domains, different types of features, as well as different types of requirements analysts. It is worthwhile to spend some time thinking about which feature to assign to which analyst. Some combinations work, while others are bound to fail.

5. The Tools

In order to standardize the requirements specifications the analysts were provided with a requirements specification template, providing scenarios to document raw specification and tables for detailed requirements to document fine specification. To ensure the uniform use of the template, we additionally provided a detailed recipe how to use the template. Therefore not much practice was necessary, before the (senior) requirements analysts could start specifying the features. For the same reason a standard word processing program was used instead of a more uncommon requirements management tool.

The guideline for filling in the template, called the “recipe”, became one of the most important meta-documents within the process. To gain the optimal benefit, such a document has to be regularly updated, to account for misunderstandings or parts, that made the writers the most serious problems.

As expected, the first version of the template had ongoing to be improved. Minor changes and additions to the template caused tiresome rework for the analysts. This manual rework noticeably reduced the savings gained from not introducing a RM tool. In future similar projects, however, we will now start with a sophisticated template from the very beginning. The final migration from Word template to RM tool (DOORS) worked quite smoothly, and the corresponding requirements management information model (RMI) seems already quite stable.

A recurring point in the discussion about the template referred to the techniques used: We provided description by scenarios for raw specification and by formalized requirements for fine specification, but we observed that there was a large overlap between scenarios and functional requirements. Usually in phase 2 from each scenario only one functional requirement was derived, which we wouldn’t have expected in the beginning. Looking back we feel that this is a quite natural and predictable effect, as the clustering of the overall system into features zooms down the system on a level that is too detailed for using scenarios in the “standard” way.

Since it still seems appropriate to divide the process into two phases, we favour to stick to the scenario/functional requirements scheme in future projects, because for the new features this approach worked quite satisfactorily, and in mature features, where the problem of potential overlap between scenarios and corresponding functional requirements occurs first of all, we will not insist on strict differences or refinements in form or in content between the two parts.

6. Conclusions

At first glance, the overall effort of about 100 person months to obtain the requirements specifications needed may seem quite high. Nevertheless, we are convinced that this expense represents an excellent investment. The point is that the obtained high quality, uniform, and well structured requirements stored in a single requirements management database can be efficiently reused in subsequent development cycles for future passenger car models. This partial reuse of specifications promises two major advantages: better specifications in less time.