Requirements Engineering Process Improvement Based on an Information Model

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Abstract

Requirements Engineering (RE) process improvement methods typically work with explicit process models describing activities and document flow between the stakeholders involved, and with explicit document definitions. In complex, multi-project contexts, however, the RE process is better characterized as intertwining of design, negotiation, and sense-making. In the first part of this paper, we present the concepts of a workshop-based RE process improvement technique suitable for a multi-project context. In the second part, we show the experiences made in an industrial case study conducted with Nokia Smart Traffic Products.

The major innovations of our approach are: (i) instead of a process model, an information model is created, which focuses solely on the responsibilities of stakeholders with regard to the major documents; (ii) instead of document details, only the major point of view of the documents is defined.

1. Introduction

Requirements Engineering (RE) process improvement methods – like general software process improvement methods [2] – typically work with explicitly documented process models and with explicit document definitions. These process models capture stakeholders, their activities, and work products handled within these activities. One example for such a method tailored to RE is RE-KIT-FRAIME developed at Fraunhofer IESE [5]. It is based on the Quality Improvement Paradigm [6] as the general process improvement framework and gives guidance on the facets of the RE process to be characterized as well as on the priority that should be given to specific improvement actions. A similar approach is followed in the REAIMS project which defines maturity levels for RE processes based on the practices they adhere to [3]. REAIMS recommends to define a process model after the basic practices have been adopted [4]. In several companies these methods worked well for determining the process *within one project or a set of similar projects*, as they are based on the paradigm of interaction and interfaces between different parties aiming at *common* goals. However, this paradigm is not adequate for *complex multi-project contexts* where requirement documents evolve in several projects concurrently and have to be synchronized. One example for such a context is a supplier company that develops several products in several variants for several, different customers. In this context, on the one hand, projects focus on their own goal (customer satisfaction and technological enhancements), on the other hand projects have to be synchronized to avoid redundant development work and to implement the overall strategy of the company. In such a context, it can be difficult to elicit and specify explicit process models for several reasons: (i) the models can get quite large because of the high number of stakeholders involved; (ii) it is almost not feasible and to some extent not even desirable to define a fixed number and fixed schedule of activities and document flow because of the complexity of the factors and issues evolving during multi-project execution; (iii) most stakeholders cannot spend the necessary time needed to define a comprehensive process model. If the stakeholders are not sufficiently involved in the improvement effort, they are not sufficiently motivated for change.

As argued forcefully in [1], the RE process in complex multi-project contexts is better characterized as *design, negotiation and sense-making* on different levels. *Design* is concerned with decisions about the scope and features of the system to be developed (note that we use the term design, although we speak of decisions on the level of requirements). *Negotiation* is concerned with trade-offs in terms of strategic goals. *Sense-making*, as a step towards understanding the meaning of the requirements, helps to bridge the communication gap between the different roles involved. Thus, it facilitates design and negotiation. In multi-project contexts, design decisions within one project must be communicated very early to allow other projects to build on them. A feature developed in one project, for instance, can be reused in another project. The strategic view underlying negotiation should be communicated early and coherently to all projects so that they can adapt their negotiation with their customers to the strategy. Vice versa, features requested by one customer can be brought into the overall product strategy of the company through early negotiation between the projects.

While the activity and document focus of traditional RE process improvement methods helps to understand the actual work activities of the roles in one project, the design, negotiation, and sense-making focus is necessary to understand how the individual projects can be combined in order to achieve the overall company goals. The understanding of the latter is a prerequisite to define the former.

As exemplified in [1], it is quite complex to describe the intertwining of design, negotiation and sense-making in detail. However, it is important that all involved stakeholders have a clear picture of which requirements are designed and negotiated by whom and who needs which information for performing an activity. Otherwise, important information for the synchronization between the projects will be lost or will not be available in time. Therefore, we have developed the notion of an *information model* that captures the information, in terms of documents, created and needed by the stakeholders, as well as the responsibilities for information exchange.

We propose to use the information model as the focus of RE process improvement in multi-project contexts. Therefore, we have developed representations of the information model in terms of a document matrix and tables. We have also designed a two-day workshop to develop such an information model with the stakeholders involved, and performed such workshops in several projects.

In Section 2, we describe the concepts of the information model and how it makes the negotiation,

the design dimensions, and the sense-making steps explicit. In Section 3, we describe the outline of the two-day RE process improvement workshop focusing on the information model. Section 4 presents, as a case study, a description of a specific workshop, the specifics of the context, and the information model defined in the workshop. We discuss the experience from this workshop in Section 5. In Section 6, we conclude with the benefits and risks of information model-based RE process improvement.

2. The Information Model

The information model characterizes a set of requirements documents evolving in a company in different, but dependent projects. It also includes the authors and the users (audience) of the documents and their responsibilities in terms of authorship, review, approval, and change propagation. The information model consists of several sub-models, namely document matrix, document details, role details, and change process flow. Figure 1 shows an abstract example of a *document matrix:*
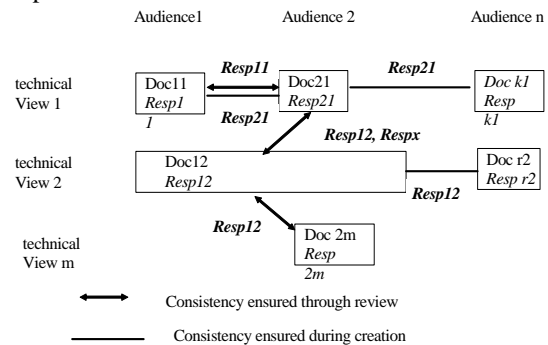

Figure 1. Abstract document matrix

The boxes represent documents from various projects and contain the names of the document and the authors. The rows and the columns characterize the viewpoints, namely the level of technical detail and the audience, the documents are intended for. The audience and authors can be stakeholder roles within one or across several projects. Note that not each viewpoint for each audience must be captured in a document. Note also that one document (e.g., doc12) can be aimed at several audiences. The arrows describe the responsibilities for consistency. As there are several documents evolving in parallel, someone has to ensure consistency between the documents. This can be performed either during the creation of the document or through explicit review after the creation. In the first case, the author of the document is

responsible for consistency (thus, the name is shown along the arrow). In the second case, other roles who need not be involved in document creation can take the responsibility for consistency review. Even though the reviewers' main goal is to check the consistency of the document with some other document, they can, in addition, check the document for other criteria like completeness or feasibility.

To keep the document matrix small, the reviewers and their criteria are not captured in the document matrix, but in an additional *document details* table. An example of such a document details table is given in Section 4 (Table 1). More details on the responsibilities of one stakeholder role are described in a *role details* table. An example is given in Section 4 (Table 2). Consistency is especially important in case of change. Therefore, in addition to the above responsibilities, it has to be defined who has to approve changes and who is responsible for propagating the changes to the other projects. For reasons of understandability, again, this is not described in the document matrix, but in a separate description of the change process. An example of such a change process description is given in Section 4 (Figure 4). Altogether the information model describes succinctly:

- Who creates which requirements document and for which audience
- Who approves the documents
- Who reviews the documents
- Who is responsible for consistency
- Who is responsible for approving and propagating change
- The document viewpoints.

Such a model is particularly suited to capture the design, negotiation and sense-making steps in multi-project contexts of big companies that typically sell their products to several customers. As described in [1], in multi-project contexts there are different authority levels involved: technical, project management, and multi-project management (called organizational in [1]). Note, that in procurement contexts, these levels exist both, within the procurer process as well as within the supplier process. The technical authority is concerned with the features of the product, in particular, whether they meet user expectations and how they can be realized. The project management authority has to ensure feasibility of the project within the given time and cost constraints. The multi-project management authority has to ensure that the projects together achieve the company's goals and vision. Typically, project management and multi-

project management are involved as reviewers, while the technical authorities drive the detailing of the requirements in the different views (which is the design of the requirements). Reviews and consistency responsibilities support the sense-making and negotiation process between the different authority levels. The reviewer, on the one hand, gains insight into the issues important to the author, on the other hand, s/he can bring in her/his own issues. In a similar way, for ensuring consistency, the authors of different documents have to talk to each other and negotiate any differences. Of course, people also use other ways for sense-making and negotiation, e.g., through moderated group sessions. Responsibilities in the context of such a session could be captured also in the document details tables.

3. The Workshop Concept

As part of our approach, we recommend to create the information model described in Section 2 together with the stakeholders in a two-day workshop. This is important in multi-project contexts, since typically, the stakeholders cannot afford to stay away from their everyday work longer than two days. A general scheme that can be used for a two-day workshop is the following:

Preparation
- Identification and basic description of the typical roles in the project (as input to the moderator of the workshop)
- Preliminary identification of problems with the current process (as input to the moderator of the workshop).

Day One
- Introduction of participants and their expectations towards the workshop
- Introduction of RE terminology and basics through the moderator
- Collection of problems with the as-is RE process
- Derivation of a first, basic as-is document matrix (who designs requirements on which level)
- Teamwork: Discussion of document matrix (groups with a maximum of 10 members).

Day Two
- Presentation of the teamwork results and consolidation as an improved basis for the to-be information model

- Teamwork: Determination of the consistency and review responsibilities; determination of the change responsibilities
- Wrap-up and determination of the next steps to ensure that the to-be information model will be incorporated in the company's every day life.

There are several ways to perform the preparation step: the company itself collects the issues in brainstorming sessions, the company fills in some questionnaires, the moderator interviews persons in the company or reviews existing requirements documents. This input is important for the moderator to understand the as-is process, but it is also important to stimulate discussions about the process during the workshop.

The first day focuses on characterization of the current process and its problems. During these discussions, the notion of the information model is gradually developed to help focus the discussions and to identify improvement potential. The first day is more focused on the question of who designs which requirements. This is captured in the document matrix, as this is the base for all the other sub-models of the information model.

During the second day, the stakeholders define the to-be information model. This includes the definition of further responsibilities for reviews and consistency checks. These responsibilities are detailed in the document details and role details table. In addition, the change process is defined to ensure effective requirements management within one and across projects. Therefore, the second day is more focused on the question of who has to understand which requirements (sense-making) and which parties have to negotiate the requirements.

Of course, depending on the culture and the size and diversity of the stakeholder group, the stakeholders might not be able to discuss their problems openly. Then, two days are too short to really create a common understanding. In this case the preparation phase must be extended.

4. The Case Study

The notion of the information model and the workshop concept evolved during several process improvement projects at Fraunhofer IESE. In the following, we describe the details of one workshop we conducted with 20 participants of Nokia Smart Traffic Products (STP). First, the context at Nokia and the workshop preparation steps are presented. This is followed by a description of the developed information model and an explanation of the requirements documents, the improvement issues, and the solution devised in the workshop.

4.1 Nokia Context

The context at Nokia can be sketched as follows: There are customer projects that develop innovative, customer-specific products. Within these projects, technological and user issues have to be negotiated. The main focus of these projects is customer satisfaction.

Nokia STP uses platform projects to develop assets that are reusable in several projects. It is going into the direction of product lines [8]. Ideally, all the general features are developed as reusable assets. However, in reality, sometimes customer projects need to start developing such general features before the platform project can take over. The goal of the platform project is effort and cost reduction through reuse. To get a maximum benefit from this reuse, it is important to make sure that the platform project is synchronized with all customer projects.

During customer projects and platform projects the stakeholders involved on the supplier and procurer side are:
- Marketing
- Sales
- System design
- Software design
- Project management
- Multi-project management (also called program manager, where one program comprises a set of products).

4.2 Workshop Preparation

For preparation purposes, Nokia sent typical documents used in the RE process to the moderator. Before the workshop, the Nokia participants filled in a questionnaire (see [7]). We asked the participants to fill in the questionnaire for several reasons. First, we wanted to gather information about their current situation and problems. Second, the questionnaire should make the participants sensitive for the topics addressed in the workshop. Third, as we asked them to fill in the questionnaire in groups (sales, marketing, development), filling in the questionnaire triggered initial discussions in the group about their current processes and problems. Filling in the questionnaire in groups requires a certain maturity of the participants, as the group discussions can dominate the individual opinions. Thus, these opinions might not surface in the questionnaire. Therefore, one has to trade-off this risk

of loosing individual opinions against the benefit of the initial group discussions. As the Nokia participants already had some experience with process improvement, we trusted their ability to give room to individual opinions, even if contradictory to the group majority. The evaluation of the questionnaire revealed details about the RE process, stakeholders, and basic problems.

Another input to the workshop was a matrix, created by the Nokia workshop participants, which shows which stakeholder role creates or uses which requirements documents. The reason for such a matrix is twofold: First, this matrix can be seen as an initial step towards the information model, as documents and stakeholders are related. Second, the creation of such a matrix at a company creates a common ground: It gives each stakeholder a good overview on who is involved in the RE processes, especially in multi-project environments. Additionally, each stakeholder gets an overview of the involved requirements documents. Often, members of the customer projects are not aware of all documents and stakeholders of the platform development and vice versa.

4.3 A Basic As-Is Information Model

The first workshop day revealed that technical design decisions have to be made with regard to the following views:

- Marketing: general customer needs and innovative technologies tackled
- User: detailed consequences for the user, namely the usage of the product
- System: behavior and quality constraints of the system (HW, mechanical parts and SW)
- Detailed System: details of the functionality and the constraints (as far as needed to distribute responsibilities between hardware, software and mechanics).
- Software: behavior and quality constraints of the software

Figure 2 shows the basic document matrix that emerged during the first workshop day. We only distinguished three audiences: Customer, Customer Projects at Nokia STP and the Platform Project at Nokia STP. The figure describes the documents on the various levels of technical detail:

- The offer captures the product characteristics on the marketing level for the customer. The product marketing specification (PMS) captures the product characteristics identified by the market strategy as input to product development in customer projects. The platform PMS (PF-PMS) captures the roadmap for the platform development.

	Audience: Customer	Audience:Nokia Customer Project	Audience:Nokia Platform Project
Marketing View	offer / KAM	PMS / PM	PF-PMS / PF-PM
User View	UC / PM		PF-UC / PF-PM
High-level System View	Pflichtenheft / PD		
Low-level SystemView			PF-Sys-Spec / PF-Sys-TL
Software View		SW-Spec / SW-TL	PF-SW-Spec / PF-SW-TL

Figure 2. As-Is Document Matrix

- Use cases (UC and PF-UC) are used to capture the usage of the product and platform-product, respectively.
- A textual requirements document is used to capture the system behavior and quality constraints for the customer (called "Pflichtenheft" in German).
- The low-level specifications (Sys-Spec and PF-Sys-Spec) capture the system details for customer and platform system development. The low-level specification is not given to the customer.
- The software specifications (SW-Spec and PF-SW-Spec) capture the functionality and quality constraint of the software. This is also not given to the customer.

Figure 2 also shows the roles of the authors of the documents. The KAM is the key account manager, responsible for the the customer relationship. The PD is the product development manager, responsible for one single product to be developed in a customer development project. The PM is the product marketing manager, responsible for the marketing of a certain product and its features. PF is the abbreviation for platform development. The Sys-TL is the system teamleader, i.e., s/he leads the development of the system, including software, hardware, and mechanical parts. The SW-TL is the teamleader of the software development team. In addition (not shown in the figure) the role PPM (product program manager, responsible for a group of products) exists.

The customer project audience typically consists of different development roles, namely developer, tester, maintainer, and project manager. Each of these roles induces different quality requirements on the documents.

There are, of course, other technical roles involved such as hardware development, but in the workshop, we focused on software. Similarly, for the purpose of this workshop, it was not necessary to distinguish the different roles on the procurer side. This choice on the level of detail of the audience has to be made based on the company's major need for RE process improvement.

4.4 Elicited Areas of Improvement

The first workshop day ends with a group discussion about the information model. In the Nokia workshop, we built two moderated groups that discussed the information model. These discussions together with the information from the workshop preparation lead to a list of potential improvements for the RE process at Nokia. Altogether, Nokia already uses many good practices in their RE process. Still, the information model revealed a number of potential improvements:

1. The current RE process (handling of documents, information exchange) is more complex than necessary.
2. The RE processes and documents are not transparent for the different roles.
3. Not all documentation responsibilities, especially in the area of customer contact and quality assurance of the documents, are clearly defined.
4. The documents are not tailored to the information needs of the stakeholders. On the one hand, the documents contain unnecessary information. On the other hand, important information is scattered across several documents.
5. The documents do not follow a documentation standard. Templates are only used for parts of the documentation. The needed content (kind of information) for the documents is unclear. This leads to an incomplete set of requirements.
6. Change management procedures are installed for written change requests from the customer, but do not work well for internal change requests and customer change requests issued verbally to various team members.

4.5 To-Be Information Model and Solutions

First, we give an overview on how the information model helped to tackle the identified areas of improvement. This is followed by a more detailed description of the solutions.

4.5.1 Overview of solutions. Concerning the first area of improvement, an information model with explicit responsibilities and a focus on the most important documents as a kind of master document reduces the complexity of the RE process. In this information model, the information for requirements design (creation of certain RE documents), sense-making and negotiation (by reviews and consistency checks) as well as change procedures are defined.

The missing transparency was tackled by the explicit modeling of the documents, audiences, technical views, and responsibilities in the information model that is given to each team member.

The third area of improvement, the missing responsibilities, is directly improved by creating the information model. Defining responsibilities is an essential task during the creation of the information model.

The information model makes it easier to tailor the RE documents, as the audience and the technical level of the documents are clearly defined. Furthermore, the document descriptions (see Table 2) show which content a document should have. By having explicit reviewers, it is assured that this content is in the appropriate document.

The missing documentation standard is solved by using templates for the whole documents. The templates are not part of the information model, but the information model provides hints on which kinds of requirements should be addressed by the template.

The information model also tackles the change management procedures, as a change process definition is part of the information model.

4.5.2. The to-be information model. To get a first overview on the RE documents and responsibilities at Nokia STP, the as-is information model, described partly in Figure 2, evolved into a to-be information model with the main consistency relationships and roles that are responsible for these consistency relationships.

The document matrix: Figure 3 depicts the document matrix of the to-be information model that was created on the second workshop day. The document matrix shows that the "Pflichtenheft" served as a central document. It was agreed to use it as a kind of master document (e.g., it serves as an entry point for change requests). Several people at Nokia STP were not aware of the central role of the "Pflichtenheft". The consistency relationships give hints on which kinds of information should be included in the documents. Furthermore, the document matrix shows the importance of the integration of PF-development and customer projects. PF-development is very important

to synchronize the different customer projects and to save effort and time through reuse.

In addition to the consistency responsibilities in the document matrix, the details of the document and role responsibilities were captured in tables, and the change process was captured in a simple document flow diagram.
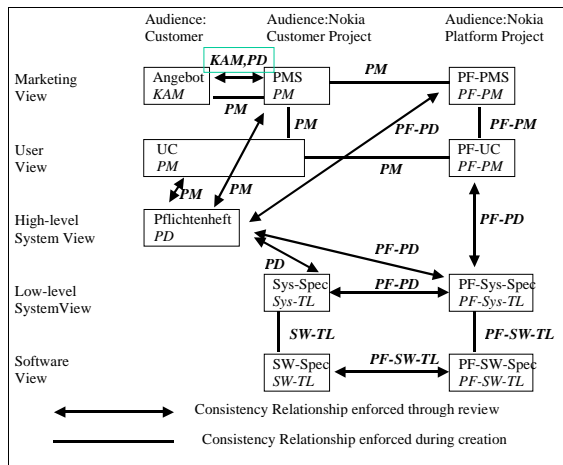

Figure 3. To-Be Document Matrix

The document details: The document details are expressed by a table that lists for each document:

- Its main contents
- The authors (the responsible person is underlined)
- The reviewers and their main concern during the review (the person who finally approves the document is underlined)
- Comments that highlight important considerations (e.g., what should be taken into account during creation/review/approval).

Table 1 shows an excerpt of the document details that was created during the second day. In the workshop, all the documents of the document matrix were described in the document details. The authors' column specifies the roles involved in the requirements design process, e.g., the TL and the PD are involved in the design of the "Pflichtenheft". The PD is underlined, which means s/he is responsible for the requirements design. The review column shows the roles involved in the review and consistency checking. The PPM and the PF-PD, for example, are involved in the review process. Both roles review the "Pflichtenheft" document with a multi-project view. As the review of the "Pflichtenheft" from the PF-PD is a consistency check, it is also shown in the document matrix. The review of the PPM is a review for approval and, therefore, it is not included in the document matrix.

The document details are important to get complete and consistent documents. Furthermore, the intertwining of the platform development and the customer development project is operationalized in documentation and review responsibilities.

The role details: The role details are expressed by a table that lists for each role the responsibilities the role has for the various documents in the information model.

Table 2. Role details

Role	Responsibility
KAM	Communication to the customer, in particular getting customer approval to the offer • the UCs • the "Pflichtenheft" • changes. This requires close communication with PM and PPM. The offer is created by the KAM.

Table 1. Document details

Document	Content	Authors (Responsible)	Review (Viewpoint) (Approvement)	Comments
"Pflichtenheft"	high-level system view Features, quality requirements, interfaces, architecture, additional internal requirements, test requirements	<u>PD</u> TLs, Supply Chain	<u>PPM</u> PM (consistency with PMS and UC) PF-PD (consistency with PF-Sys-Spec) Customer (approval, mediated through KAM)	Should be updated at each milestone After updates: review should be repeated

Table 2 shows an excerpt of the role details. The table summarizes the responsibilities of the KAM. The role view is important to inform a person taking the role about all responsibilities the role (e.g., approval of Use Cases) and about the requirements design activities s/he has to take care of (e.g., authoring of the offer).

The change process: Basically, there are two ways how change requests arrive at Nokia STP. First, written change requests are issued by the customer and, second, verbal change requests issued informally by the customer arrive at several points during a development project. The verbal change requests were much more problematic, as there was no common process for handling these kinds of change requests. The participants agreed upon the fact that verbal change requests cannot be avoided. In addition to the external change requests from the customer there are

- Internal change requests that are visible to the customer
- Internal change requests that are not visible to the customer

During the workshop, change processes were sketched for all kinds of change requests.

Change processes are part of the information model. Figure 4 shows an excerpt of the change process for customer change requests. As described before, the "Pflichtenheft" serves as the master document. So change requests affect the "Pflichtenheft" first and are then propagated to other documents. A change request from the customer arrives at any team member of the customer development project (marked as "X").

The workshop participants agreed that a dedicated contact person for change requests would be beneficial, but it would not be possible in their current projects. The change process was designed to handle this situation, i.e., the change request is entered by the team member "X" in a tool already used at Nokia. The change control board scrutinizes the change requests and gets information from various team members and experts. The review, approval and consistency responsibilities from the document and/or role details give valuable support in defining the change process, as these responsibilities show who has to be involved in the decision and negotiation processes. Once a decision is made, the customer is informed on whether the change request is accepted or not. The change control board approves the change request. The PD, as responsible author of the "Pflichtenheft" (see Table 1), informs all relevant stakeholders who need to know about the change to the "Pflichtenheft" and incorporates the change into the "Pflichtenheft". The PD, as responsible person for the consistency check between "Pflichtenheft" and Sys-Spec (see Figure 3), informs the system team about the change. The Sys-TL as responsible author of the Sys-Spec incorporates the change into the Sys-Spec and so on. From this description, one can see that the various responsibilities defined in the role details efficiently
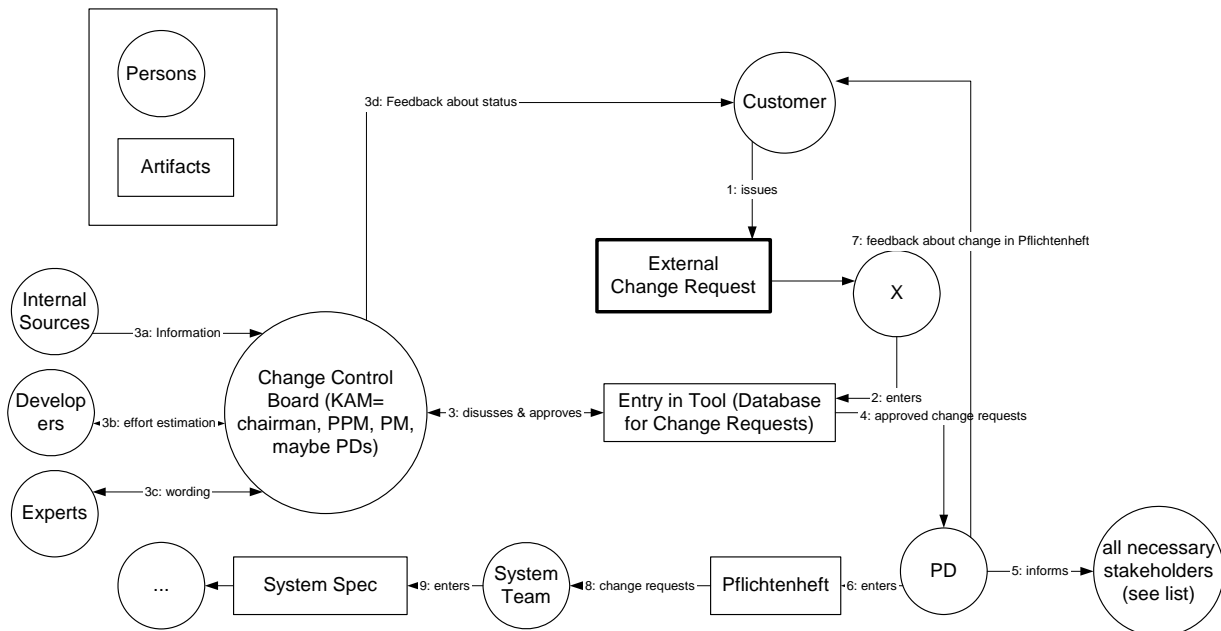

Figure 4. Change Process Flow

support the definition of the change process. Furthermore, the list of team members to be informed in case of a change to the "Pflichtenheft" (step five in Figure 4) can also be derived from the authoring and review responsibilities. The change process flow captures the documentation and negotiation activities in case of a change request.

5. Discussion

The case study described in the previous section showed that the approach is feasible: it was possible to create the information model in the two-day workshop with quite a lot of participants. All the participants were actively involved during the workshop. The feedback given to the moderators confirmed that the information model created the desired common understanding between stakeholder roles involved. In addition, we observed the following benefits:

- The focus on requirements design helped in finding improvements in the areas of completeness of documents and creation of templates for the RE documents.
- Eliciting the responsibilities in group work proved to be an efficient way of extending the information model with detailed review and consistency checking responsibilities. The focus on negotiation and sense-making helped in clarifying the responsibilities and handling of change.
- The information model is a succinct description of the documents involved. From the document matrix, it was easily possible to identify the central role of the "Pflichtenheft". The participants had not been aware of this before.
- Furthermore, the identification of the views is very important. It makes explicit that there are several equally important ways to define the system.
- For each role, the information model helps to make clear the responsibilities the role has with regard to the overall RE process. In the workshop, the role of the PPM was discussed several times. At first, it seemed that he had to approve each and every document. By carefully using review and co-authoring responsibilities and distributing his concerns to other roles, it was possible to drastically reduce his workload.
- The change process is essentially a cooperative decision process. This is captured in the explicit change process. Furthermore,

the explicit modeling of the change process supports the identification of all involved stakeholders who have to be informed or asked for information in case of a change.
- The information model supported communication between the members of multiple projects in the discussion of their RE processes. For example, the document matrix supported the discussion about the intertwining of platform development and customer development projects.
- The omission of time relationships in the document matrix (which document is created before another document) helped to avoid unnecessary discussions. The order of document creation differs from project to project. In this case study, it became obvious that the time information was not relevant to identify the potential improvements.

6. Conclusion

The information model is a means to characterize the RE process in a multi-project context. The document matrix captures the major information (in terms of documents) and their abstraction levels and audience. In addition, it captures responsibilities of different stakeholder roles in terms of authorship, review, approval, and change propagation. These responsibilities are detailed in the document details table, a role details table, and a change process diagram.

Such an information model can be elicited in a two-day workshop. This is the major advantage compared to traditional process models. In addition, it shifts the focus from individual activities emphasized in the process model to the overall picture of how requirements emerge and are communicated between different projects. Of course, the information model leaves more details open than a process model, e.g., it does not fix the point in time when a document is created. So, for instance in Figure 3, the offer could even be created after the "Pflichtenheft". While this seems strange for an individual project, this is very well possible in a multi-project context where the "Pflichtenheft" is taken from one customer project to another one and then the offer highlights important aspects for the new customer. Similarly, the Sys-Spec could be created before the PF-Sys-Spec, because a feature is first developed in a customer project. This flexibility of the information model should rather be viewed as a feature than a problem. Still, it is obvious that after a two-day workshop there is much to be done

before the new information model will be really applied in everyday work. Typically, one should start with a pilot project where as many documents and responsibilities as possible are worked out. Experiences during the pilot project should be captured and used to improve the information model (particularly, the details). Based on this understanding, further projects can be carried out. If at some point, a standard document and activity flow emerges, a full process model can be created.

We believe that the information model will also be useful in other multi-project contexts. In addition, we even recommend that individual projects at project start spend half-a-day to make their information model explicit. This seems to be a good way to quickly ensure a common understanding of the whole project team about the individual information needs and responsibilities.

Acknowledgements

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