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2008

Orchestrating Economic, Socio-Technical and Technical Validation Using Visual Modelling

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ORCHESTRATING ECONOMIC, SOCIO-TECHNICAL AND TECHNICAL VALIDATION USING VISUAL MODELLING

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The paper presents an approach for orchestrating validation of project results from different perspectives by using visual modelling techniques. The context for the paper is the FP6 project MAPPER. Validation in MAPPER covers economic, socio-technical and technical viewpoints. The economic viewpoint mainly focuses on business value and coherence with business drivers like reduced lifecycle time or increased flexibility. Sustainable collaboration for joint value creation of various units in a networked organisation is the main aspect of the socio-technical viewpoint. From a technical point of view, usability of IT-infrastructure and services is a key aspect. The MAPPER Validation Framework includes and orchestrates approaches and methodologies from these three viewpoints and defines the validation actions to be performed. The main contributions of the paper to research in the field are (1) the structure of the MAPPER Validation Framework integrating different validation perspectives, (2) experiences from using a visual modelling environment for framework development and (3) experiences from orchestrating different validation perspectives.

1 INTRODUCTION

The paper presents an approach for orchestrating validation of project results from different perspectives by using visual modelling techniques. The aim of validation is to ensure that the project results meet the project objectives. The context for the paper is the FP6 project Model-based Adaptive Product and Process Engineering (MAPPER). Based on the requirements from three industrial use cases, the project develops methodologies and technologies for collaborative product engineering. Examples for project results are customisable workplaces, a secure collaboration platform, a methodology for networked enterprise modelling, or a methodology for sustainable collaboration. In addition to features, effects and impacts of these methodologies and technologies, validation of the project's business and scientific/technological objectives has to include the overall project level and the use case level. The three use cases include in total four industrial partners from automotive manufacturing, automotive supplier and electronics industries, all of them with specific aims to be validated. Validation on the overall project level has to focus on the project objectives, which will be introduced in section 2.

The validation requires different perspectives covering separate but at the same time coordinated aspects: the economic, socio-technical and technical perspective. The economic perspective mainly focuses on business value and coherence with business drivers like reduced lifecycle time or increased flexibility. Sustainable collaboration for joint value creation of various units in a networked organisation is the main aspect of the socio-technical perspective. From a technical perspective, usability of MAPPER infrastructure and services is a key aspect. As the main instrument for establishing these perspectives in an iterative validation process and enabling means of analysis of validation results from these perspectives, a validation framework was developed, which is supposed to:

- Allow for validation of project objectives (business objectives, work practices, technology)
- Provide a guideline for evaluation in the use cases
- Allow for different validation methods (e.g. analytic evaluation, measurement, qualitative evaluation of technologies-in-use based on fieldwork, interviews and surveys)
- Provide guidelines for interpretation of the validation results (e.g. relevant indicators or metrics, theory-based concepts)
- Include different validation levels (regional, industry-sector, across individual cases)

As different methods will be used during validation, an approach for coordinating the application of these methods, aligning validation activities and interpreting the results had to be developed. This "orchestration" of validation is based on the validation framework (Campagnolo et al, 2006) presented in this paper. The development of the validation framework was based on the project objectives and an analysis of existing approaches for each of the three validation perspectives. The results of this analysis and the selection of the project's approach for each perspective are described in Section 2. Section 3 introduces important terms and concepts including the meta-model for the validation framework. Section 4 focuses on the framework as such, followed by a description of the use of the framework in section 5. Section 6 discusses experiences. Section 7 describes plans for future work.

2 VALIDATION PERSPECTIVES

As in many research and development projects, the objectives of MAPPER are quite diverse and include business and scientific/technological objectives, as illustrated in table 1. Visual enterprise models build up the main technology in this project. Especially their configurability by users who are mainly engineers and carrying out design processes is one of the main goals. Users need customisable and secure collaborative work environments in order to reduce cycle times and time to market, to increase the quality of their products and innovations by increasing the participation of the stakeholders.

Scientific/Technical Objectives	*Business Objectives*
O1 Reconfigurable visual enterprise models	B1 Reducing cycle times and time to market
O2 Participative engineering methodologies	B2 Increased quality of products and lower costs
O3 Customisable work environments	B3 Increased innovations by increased stakeholder participation
O4 Secure collaboration platform	B4 Enable SME participation
O5 Validation in use cases	B5 Increased competitiveness of SMEs
O6 Continuous exploitation of results	

Table 1: MAPPER project objectives (MAPPER DoW, 2005).

Early in the project, it was decided to use different validation perspectives in order to cover all objectives sufficiently: (1) economic perspective, (2) socio-technical perspective and (3) technical perspective. These three perspectives are based on different validation approaches; use different theories, concepts and methodologies. We first analysed the state of the art of validation concepts and methodologies. Then we selected those concepts and methods that were relevant and useful for the project's scope. Thirdly, we related all perspectives and the result in a holistic validation framework (described in the Section 4).

Why do we need three different perspectives? First of all, the four industrial partners do have different objectives. Some are financial, others are organisational and work-related. Validation of these different objectives cannot be done by one approach. They differ in nature, quality and quantity. MAPPER developed technologies and methodologies to facilitate the achievement of these objectives. Second, the main focus of the project is on model-based collaboration support for distributed groups to increase participation of all stakeholders in design and production processes. For validation of the achievement of these goals we have to define some indicators for capturing the change in organisations in terms of numbers. Additionally, we have to look on work practices, which are changed and hopefully improved. For that we need to capture the work before and after using MAPPER solutions. To find out whether the new technologies provided are usable and easy to handle, we need to study the user perception of the application of these technologies. So, we have three different views to the same results, which preferably complement each other and offer us an overview across these perspectives.

How can we achieve the added value of having three different perspectives? We apply different methods, like balance scorecards, ethnographic field studies and surveys for capturing the data. We study these data first from one perspective, which is different in each perspective due to theories and concepts behind these perspectives. Then, we put all results together and try to find out gaps and inconsistencies among them. We can try to find the reasons for these deviations and try to modify our validation methodology. As researchers, we are interested to systemise a validation process in IT projects where different user groups are involved. We also are interested to find ways of composing the results of complementary validation perspectives to create a holistic framework for validation purposes.

2.1 Economic Perspective

Increasing expenditures on IT-infrastructure have been accompanied by a growing demand to measure the business value of investments in information technology. Numerous research activities from business administration, national economy, computer science and other areas have addressed this area during the last two decades as the "business value of information technology" (BVIT). BVIT can be defined as measures that evaluate how IT-related changes and investments contribute over time to business performance, competitiveness, innovation and economic growth. Approaches aiming at measuring BVIT are considered as an interesting contribution to the economic perspective in MAPPER. We investigated four types of approaches and one typical representative for each of them:

- Process-oriented approaches, like IT Business Value Metrics (Mooney et al., 1995)
- Perceived value approaches, like IS Success Model (DeLone and McLean, 1992)
- Project-focused approaches, like Information Economics (Parker and Benson, 1988)
- Scorecard-based approaches, like B_{TRIPLE}E-Framework (van der Zee, 2002)

All four types of approaches could potentially be tailored for and applied in the project. However, a more detailed look shows differences between the approaches presented with respect to their suitability. We decided to use the balanced scorecard approach in combination with indicators and aspects from perceived value and process-oriented approaches, which is based on the following reasons.

As stated in the introduction and illustrated in table 1, the validation approach has to include business value and coherence with business drivers like reduced lifecycle time or increased flexibility. These business drivers are measurable criteria reflected in controlling systems of many companies. Perceived value approaches, like DeLone and McLean's approach (1992), do not cover these aspects sufficiently, as they focus on user perception and not on measuring quantitative criteria, which is required for confirming reduced cycle times or increased number of innovations. DeLone and McLean provide on the other hand a long list of potential aspects to be investigated, which can be used as inspiration when defining criteria to be measured.

Furthermore, the validation approach should support the monitoring of BVIT and relevant performance indicators during the whole project, i.e. capturing of performance indicator only one time without considering their development over time is not appropriate. This requirement is difficult to meet with project-centric approaches: These approaches aim at evaluating the business value of a project for a company or organisation and – in case of Parkers and Benson's Information Economics (1988) – are usually applied in order to support decision making, e.g. whether a project should be started or not. Parker and Benson recommend a number of aspect to be evaluated, but – due to the purpose of supporting decision making rather than long term monitoring – these criteria are evaluated only once. Monitoring of the different aspects that Parker and Benson propose theoretically could be implemented, but would require a combination with a project controlling approach.

Due to the reasons presented above, perceived value approaches and project-centric approaches were no longer considered for use in the project, as we need measurement, not perceived value and continuous monitoring, not one-time evaluation. Two candidate approaches remained: scorecard-based and process-oriented. Process-oriented approaches are by nature quite specific for the individual company, as you have to understand the business processes, potential business impact and potential IT impact before starting the actual analysis of BVIT. This makes the approaches quite expensive in terms of efforts that have to be invested. Furthermore, a common approach for use in all four use cases is required, why a company-specific approach is not suitable. However, structuring the evaluation into automational, informational and transformational effects as proposed by Mooney et al. could be used when identifying suitable criteria for the MAPPER validation.

The scorecard-based approach meets all requirements discussed in this section:

- Measurement of business drivers can be accommodated in a scorecard by including the respective measurable criteria (see section 3 for a discussion of terms and concepts).
- Scorecards form an important part of management systems, which include monitoring of performance as main element
- The overall objectives can be accommodated in the same way as business drivers
- The development and implementation efforts for scorecards are reasonable with respect to the available efforts in the work package addressing validation in MAPPER

2.2 Socio-Technical Perspective

One of the important objectives of MAPPER is to enable fast and flexible manufacturing by providing methodology, infrastructure and reusable services for participative engineering in networked manufacturing enterprises (MAPPER DoW, 2005). Participative engineering deals with processes, which link communities to technological interventions, which affect them. It is an approach to the assessment, design and development of manufacturing and engineering products that places a premium on the active involvement of different collaborating enterprises in design, manufacturing and decision-making processes. Actors involved have an important role, on the one hand, because they use technologies and apply methodologies developed in MAPPER, on the other hand, because they participate in design and decision-making processes. Therefore it is crucial to know how these actors work with MAPPER technologies in their daily work, how they apply MAPPER methodologies for participative engineering, how they improvise in order to overcome difficulties during their (cooperative) work, how they deal with unexpected situations, how they coordinate their work etc. The socio-technical perspective focuses on these issues, especially on understanding work practices that have to be supported by MAPPER solutions.

Having work practices as the main focus of socio-technical perspective, it is very important to establish user grounding and laying the ground of future validations and evaluations of MAPPER solutions. This should happen not only at the initial stages of design and development but also at later stages of the use assessment in the industrial pilots. The main methodology applied in this perspective was ethnographic workplace studies including in-depth open interviews, participatory observations and document analysis (Blomberg et al., 1993; Boedker et al., 1991; Hughes et al., 1992; Jordan, 1993). Open interviews are semi- or non-structured interviews with key persons from user groups. A list of themes and questions guide the interview where as interviewers are free to improvise and change the focus of the interview depending on the interview partner. Open interviews are very useful to discover issues, which are not obvious for the interviewers so far. Observing users during their work, especially in situations where they cooperate, coordinate, communicate or use technologies feeds us with qualitative data that we need to analyse and complement with the information from the interviews. Of course, we complete the study with analysing artefacts users created, used and exchanged during their work practices.

In MAPPER, these studies took place as field visits to three industrial use sites. These field visits were scheduled at the beginning and at the end of the project. They provided several results: Field study reports consisting of rich descriptions of work practices that help technology teams to better understand the details and intricacies of the work to be modelled. These were then communicated with engineering teams in terms of user requirements related to work practices. The result was a list of scenarios of use for MAPPER technologies and methodologies. On the other hand, we were able to create criteria for useful services that build on the MAPPER concepts like configurability, transparency and security in model-based approaches or participatory engineering methodology, which we were able to create based on the material gathered in field studies. These theory-based deepened concepts were used to analyse cooperation situations and work settings observed in order to specify (electronic) environments to support users.

Neither auto-ethnography (Cunningham and Jones, 2005) or personal ethnography (Crawford, 1996) nor rapid ethnography or quick and dirty ethnography could be used because they would narrow the “wide angle research lens” of standard ethnographic approaches (Millen, 2000). Unfortunately ethnographers could not participate and observe users the whole time during the 2-3 pilot phases at each use site. An idea was to use diaries for self-reporting without using interactive computer-based technologies, which was difficult to design without knowing the details of work changed by MAPPER solutions. Optionally cultural probes (Gaver et al., 1999) have been considered for data capturing in the industrial pilots and used in several workshops with users from all sites.

2.3 Technical Perspective

The technical perspective of validation has been primarily handled with a strong focus on usability of software. Over the past 30 years, productivity growth in the seven richest nations has fallen from an average of 4.5% a year in the 1960s to a rate of 1.5% in recent years. The slowdown has hit the biggest information technology spenders: Service-sector industries, especially in the U.S. (Gibbs, 1997). Landauer (1995) has shown that a company's investment in information technology does not increase the company's margin of profit and that this is due to the general low usability of user products: The average software program has 40 design flaws that impair employees' ability to use it. The usability engineering approach aims to solve this problem. It is threefold:

- To apply general knowledge of usability issues throughout the whole product development cycle. This knowledge is made available through the scientific literature, general principles, heuristics and guidelines. For example, IBM gained a 400% increase in online sales and an 84% decrease in help button usage after redesigning their web site according to usability principles (Tedeschi, 1999).
- To implement methods and procedures that ensure quality and traceability in the requirement, design and evaluate stages of the product development life cycle. The implementation of usability engineering techniques has demonstrated a reduction in the product development cycle by 33% - 50% (Bosert, 1991).
- To ensure that procedures and methods are user-centred in the sense that the appropriate characteristics of users, tasks and user environments are taken into consideration during product development. Every $1 invested in user-centred design returns between $2 and $100 (Pressman 1992).

Creating successful systems and applications to be used in a variety of settings and different cultures is not possible without giving attention to the different users of the systems and their various views upon what constitutes successful use. In MAPPER two aspects of use are central to the validation of the technologies developed: collaboration support and organisational learning support.

Validation of these aspects has to include aspects introduced by the project team measures that the end users consider important for such validation. For the early assessment with a small number of actors, we chose to use phone interviews, since these could be done fast and with little resource usage, while still giving valuable input for the process. We conducted interviews with the different use-case owners as well as with the technology builders, in order to agree upon and obtain a baseline for later validation and ensure that we measure those aspects in ways that were meaningful to the users.

3 TERMS AND CONCEPTS

The first step in developing the Validation Framework was to agree on a way to express the framework and its content. Besides the modelling tool and the visual language used, it was important to define the terms and concepts. These definitions were then expressed as the meta-model for the Validation Framework consisting of constructs and relations that were used in the visual modelling.

Figure 1 gives an overview of the different terms, concepts and their relationships (shown as directed arrows) in the meta-model: A validation *perspective* includes different validation *aspects* that are based on *criteria*. *Objectives* and *hypotheses* refer to validation *criteria*. A *criterion* is expressed by a *measure* and is captured by using an appropriate *method*, which is used in a validation *action* that leads to a *result*. An *action* is applied in a *context*. An objective may be *refined by* another objective, an aspect by another aspect. A criterion can be *a condition of* another criterion. A method can *be used in* another method, a result in another result.

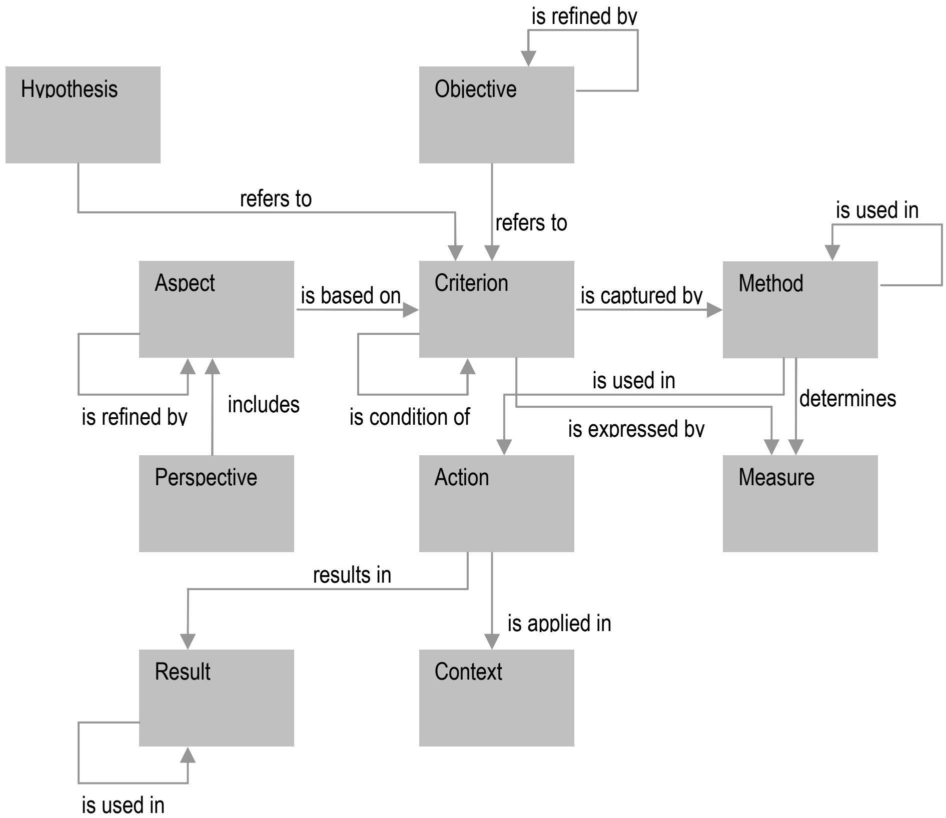

Figure 1 Meta-model of the MAPPER Validation Framework.

An example illustrating how terms and concepts are applied is taken from the economic perspective and concerns the validation aspect of *resource use* when developing new products at one of the use case partners. The main criterion for this aspect is the average length of the innovation process, which can be captured by measuring the process length, expressed in working days. The objective in this context is to reduce cycle time by reducing the process time. The validation action performed in order to achieve the measuring is continuous documentation of innovation projects in the context of the use case in question. This leads to a statistics on process length.

4 THE MAPPER VALIDATION FRAMEWORK

The MAPPER Validation Framework is represented as a visual model with instances of concepts and relationships according to the specified meta-model (see

Figure 1). Concepts are represented as containers that aggregate all model elements, which are instances of the respective concept. For some concepts, additional containers are used to group the modelling elements. For instance, the container representing *objectives* is organised into the categories: MAPPER Objectives, Objectives for Use Case 1, Objectives for Use Case 2 and Objectives for Use Case 3. We also added MAPPER Technologies-In-Use and MAPPER Methodologies-In-Use as additional containers to make a linking to other validation constructs possible. As the validation framework model represents the objectives and mechanisms for validating the MAPPER approach for the three industrial sites, it does in our experience constitute a fertile basis for inter-project and extra-project discussions and explanations of our work.

The validation criteria are the most important elements of the validation framework. This is not only clearly visible when considering the meta-model introduced in the previous chapter, but also makes sense intuitively: all validation efforts, independently of their nature, have to aim at validating well-defined criteria. For the three validation perspectives, different validation criteria were defined, which were grouped according to different content areas. The most important criteria groups are:

- *Time-related criteria* is concerned with time-related issues like time for travel and meetings, duration of innovation processes and time for developing new solution proposal.
- Costs are the content of *cost-related criteria*: costs for innovation processes, for design errors, for testing, travelling and meetings.
- With *use-related criteria* aspects shall be validated, like the percentage of design rules used frequently, the efficiency of use, changes of project plans or the use of the "Bank of Ideas".
- *Work-related criteria* are concerned with issues connected to work practices. Some of them focus on aspects around activities carried out: coordinating, integrating, interfacing, prescribing and anticipating distributed activities, simplifying and decreasing communication between partners, articulation of work and maintenance of consistency across activities. There is a set of artefact-related criteria: Identifying and classifying objects, providing access to and keeping track of artefacts, providing interoperability among artefacts. Management of boundaries and coupling, fostering membership and supporting mutual engagement are related to the concept of boundaries.
- Additionally, we identified *process-related criteria*: quality of process models, model support for cooperation, understanding customer requirements, conformance specification and result, innovative solutions, quality of competence information, easiness of information supply.
- *Product-related criteria* focus on product functions and qualities. These vary from number of reused specifications and test results, to product functions taken over from suppliers.
- Finally, we have *technology-related criteria* dealing with transparency, feedback, customisability, configurability, easiness of model adaptation, sharability and accessibility, scalability, effectiveness, ease of use and learnability.

5 USE OF THE VALIDATION FRAMEWORK

In this section we will briefly describe how we used our validation framework in MAPPER. We identified two phases where the framework should be used: development phase and operation phase.

5.1 Development Phase

The main goal of the development phase was to develop a validation framework that hosts concepts, criteria and methods from the economic, socio-technical and technical perspectives. We discussed several issues connected to the quality of validation. We had to identify areas that could be investigated by using qualitative and/or quantitative methods. It was a challenge to choose among these methods with respect to appropriateness for gathering information of different types. For instance, economic perspective works with measurable criteria. Socio-technical approach does not measure because the issues investigated from this perspective are not measurable. Fortunately, we managed to overcome this difficulty mainly by exchanging know-how and experience in the validation work package by using the framework itself as a common artefact.

The second challenge was to reduce validation actions due to our limited resources in the project. We rationalised our validation actions by reducing the validation objectives. This was achieved by applying our framework once again: First, we considered the MAPPER objectives (see Table 1) described in the MAPPER Description of Work (MAPPER DoW, 2005). Then, we gathered the objectives of each of the use case partners by means of scorecard workshops and field studies. By creating relationships between these two different types of objectives, we managed to identify which objectives of our users are relevant for MAPPER and which are not. Hence, we could define our focus of validation that was feasible in this project.

At the start-up of the validation related activities, we decided to create a visual model of our validation framework. The decision was based on the assumption that visual modelling in the selected modelling environment would be most flexible in visualising objectives, concepts and methods regarding validation. This model-based framework made it possible to make different approaches visible to all members of the work package who discussed differences and commonalities of the three perspectives. The visual model of the framework was first used as a common artefact shared by the validation team and later by the entire project. We used the model as a visualisation tool to communicate our validation approach with different stakeholders.

5.2 Operation Phase

In the operation phase, we used the MAPPER Validation Framework to document our investigations, to analyse our findings and as a support for organising and structuring validation results and documents. We had to adapt the framework during this phase: Validation actions were modified because some new validation actions were carried out like ethnographic studies of modellers at al use cases or additional field visits were arranged to some user sites. New validation results were provided.

Furthermore, the validation framework will be used for interpretation of results. In addition to the interpretation of validation results within the three different validation perspectives, a joint interpretation of the economic, socio-technical and technical perspective was necessary in order to get the complete picture with respect to validation. In this context, we intended to use two strategies for integration of results, discovery of new insights and identification of possible inconsistencies: objective-based and criteria-based interpretation. Both strategies were supported by the MAPPER Validation Framework as all relations between objectives, aspects, criteria and measures necessary are included.

The *objective-based strategy* used the economic and scientific/technical objectives of MAPPER and the related objectives of the use cases as input. For each MAPPER objective, the related validation aspects were identified. Validation results with regards to these aspects were in a first step summarised separately for each perspective. In a second step, the results from different perspectives for each aspect were compared, related to each other and interpreted. To illustrate how to investigate validation aspects some examples of such aspects are given here:

- Are the results from field studies (socio-technical perspective) with respect to technologies-in-use and the results from the technical perspective regarding usability of the same technologies compatible? What are explanations for possible differences?
- The economic perspective includes indicators for improvement of internal processes based on model adaptation. Are there correspondences between the results of methodologies-in-use from the field studies and development of the indicators in the economic perspective (like improvement of indicators and at the same time positive impressions of the users)?
- Do the results gathered with respect to stakeholder involvement correlate in all three perspectives?
- Knowledge sharing includes technical, economic and socio-technical aspects. Do the results in this context create a sound picture?

This procedure helped to verify consistency between the perspectives and to discover contradictions.

The *criteria-based strategy* was based on the fact that several criteria were related to more than one perspective and that there were criteria captured by different measures. These criteria were identified quite easily in the validation framework. By comparing the different measures for the criteria and the state of the criteria captured in the different perspectives (or the different interpretations of the same state from the viewpoint of different perspectives) we were then able to identify contradictions, verify consistency and discover interesting questions for future investigation.

6 EXPERIENCES

Development and use of validation framework led to various experiences summarised in this section.

Experiences from visual model development

The process of developing the visual model of the validation framework as such showed similarities to challenges of visual modelling in an enterprise modelling context. Main prerequisites for a successful model development were an adequate modelling process, role distribution, knowledge about the modelling tool, and effective repository services providing access to and sharing of models. The modelling process had to start with an agreement between the different participants on the purpose of the model, the intended users, and about the aspects, concepts and relations to capture within the model. This led to the meta-model defining the visual modelling language to be used (see

Figure 1).

Important roles to be assigned were a modelling facilitator and a tool expert. The modelling *facilitator* was responsible for choosing the modelling language, for moderating the discussion, capturing and structuring of ideas, as well as for assisting in the model development. The *tool expert* was responsible for drawing the model into a computerised tool, in order not to distract the *modelling participants* from the main purpose of the modelling activity, i.e. to develop a validation framework and capture and visualise it as a model. The *domain experts* for the different validation perspectives were basically the modelling participants and contributed the knowledge about their area of work.

Experiences from orchestrating different validation perspectives

The different validation perspectives of MAPPER are interdisciplinary and thus it is not surprising that we experienced some well-known problems of interdisciplinary work: different values, different priorities, different methods and acceptance of validity and soundness of methods, theories and approaches exist. There was a need for a common language, which in this project is represented by the visual model of the validation framework. This common language has organised and structured the validation activities, made the actions transparent to all and showed the dependencies between different elements.

Three perspectives are complementary to each other. They cover different aspects of the validation by considering different factors/values of validation. The orchestration of the results can result in an integrated view, e.g. if ethnographic material can be used to explain some results derived from economic perspective. However, to achieve this, a dense exchange has to take place between the representatives of the different perspectives.

Ethnography-based studies, especially about work practices, deliver narrative explanations and descriptions of phenomenon in work environments, which are multilayered, complex and difficult to represent in models. In case of orchestrating different validation perspectives, the richness of findings of ethnography-based studies needs to be tuned down to keep a balance between the different perspectives. This is actually a problem. One way to avoid this is to achieve a common understanding of models and modelling in the workgroup. If we consider models as so called entry points enabling an overview of the whole setting and highlighting if necessary, then we can create a space for more textual and narrative validation data, which can be linked to the model.

Results of each perspective are in different formats, e.g. in economic perspective we get measured values, in socio-technical perspective narrative descriptions of impacts of technology and methodology used, in technical perspective we get descriptions of use resulting in technical requirements, whereas socio-technical and technical perspectives are similar in form, but completely different in semantics. There are still some questions that we have to answer: How can we homogenise these results? What is a common result? Actions are partly redundant and there are overlaps between perspectives. How can we merge or orchestrate these results?

Orchestrating the results of different perspectives was not an easy task. There were some problems: In the economic validation, end users evaluated the MAPPER solutions introduced. They saw the usage of these solutions from their perspective and were of course influenced by their tacit knowledge about their work environment. In socio-technical perspective, researchers captured and analysed the usefulness and positive impact of new MAPPER technologies and methodologies on work practices. They were more critical about the results achieved and saw mainly gaps and inconsistencies in the systems delivered, especially in relation to work practices and user requirements. In some cases, there were completely different views of users and researchers to the impacts of MAPPER solutions introduced, which made a composition and relation between the results of different perspectives very difficult.

Usage aspects of the visual model development

One has to make sure that models are accessible for users. Everything that makes the deployment of and access to models difficult hinders the acceptance of models as work tools, instruments to arrange and communicate work. Browsing models with a usual web browser is for instance one way to solve this problem. On the other hand, models are complex artefacts, their modification necessitates according systems and tools. Even if users have the right tools for modelling, they need to know more than just using those tools. Modelling is a process with its own components, semantics, rules and notations. The most visual modelling languages are based on standards like UML, SysML, BPMN, BPEL, domain-specific modelling languages or OWL for the semantic web; they are different in nature; they are based on different approaches to modelling; and these all adds to the complexity of visual modelling. To understand visual models and to create them by using visual modelling languages require modelling know-how and experiences and therefore cannot be taken for granted.

Through visualisation and annotation, the visual model supports on the one hand articulation work between different perspectives, i.e. different communities of practice. On the other hand, it highlights the differences in approaches and methods applied, which calls for more articulation and negotiation between people involved. Visualisation helps to communicate our validation aspects, methods, actions, etc. also with outsiders like users or project officers. We can make use of visualisation qualities in many ways. We can easily modify the arrangement of elements or highlight specific aspects without modifying the semantic the model is based on. Views we create help us to focus only on certain aspects for a certain period of time.

7 SUMMARY AND FUTURE WORK

The paper presents an approach for orchestrating validation of project results from different perspectives by using a validation framework developed with visual modelling techniques. The framework includes and orchestrates approaches and methodologies from economic, socio-technical and technical viewpoints and defines the validation actions to be performed. The main contributions to research in the field are (1) the structure of the MAPPER Validation Framework integrating different validation perspectives, (2) experiences from using a visual modelling environment for framework development and (3) experiences from orchestrating different validation perspectives.

Future work will focus on three main lines of work:

- The application of the framework in another project context for evaluation and enhancement.
- Investigate in more detail, how to interrelate different methods of different perspectives to a common methodology (if this is possible). The work will aim at finding out whether this migration or merge makes sense or not.

- By including the Validation Framework in an enhanced modelling environment (e.g. utilising the Configurable Visual Workplace technology), we would be able to increase the usefulness of the framework for all stakeholders in a project.

Furthermore, we plan to investigate what experiences from mixed method design can be used for improving our approach. Mixed-methods design (Tashakkori and Teddue, 2003) means using quantitative and qualitative methods for different but coordinated purposes within the same project.

Acknowledgements

The authors wish to thank their co-workers when developing the MAPPER validation framework: Gian Marco Campagnolo, Gianni Jacucci, Odd-Wiking Rahlff and Ina Wagner. Furthermore, acknowledgements to the three anonymous reviewers of the paper for valuable comments.

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