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Framework for Validation of Economic, Socio-Technical and Technical Viewpoints

Work Package – WP 7

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1.02	Jönköping: update links to documents in Annex C	June 26th , 2006

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Executive Summary

This document is a report which is complementary to the Prototype Validation Framework[1] (HTML-Report[2]) which is part if this deliverable. So far, we have developed a framework to design and implement validation processes in MAPPER. We use this framework also as our common information space to exchange know-how, to discuss several aspects of several validation approaches and to decide how to validate the products-in-development in this project. On the one hand, WP7 develops and integrates several technologies. On the other hand, we define new methodologies and combine current useful methodologies to support the MAPPER use cases at CRF, Evatronix/advICo and Kongsberg Automotive (see MAPPER Description of Work, 2005) in their daily work. Validation takes a very important role in finding out whether technologies and methodologies we develop are really useful for our use case partners, what changes are required by our users after introducing these technologies and methodologies and how can we guarantee the quality of work in MAPPER. Development of the validation framework was mainly driven by the MAPPER objectives and the MAPPER approach to participative engineering:

- The MAPPER business driven approach to participative engineering is reflected in the business, scientific and techological results/objectives defined in the DoW. An essential task for the validation work package is to evaluate the contribution of MAPPER to the defined objectives.
- The results of the R&D work packages and their implementation in the MAPPER use cases aim at reaching the MAPPER objectives. In this context, validation has to provide feedback to WP 4, 5 and 6 in order to support continuous improvement.

In this report, first we show the different perspectives we have for the validation of MAPPER technologies and methodologies. Validation 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 MAPPER infrastructure and services is a key aspect. After showing relevant approaches from these perspectives we describe our Validation Framework. We point out the role of the framework in MAPPER and describe its objectives. We show what we are aiming at with the framework, plans for the future use of the framework in MAPPER, and how we utilise it for validation purposes. We show the architecture of the framework and describe briefly its components.

In a dedicated section we illustrate the use of the Validation Framework in MAPPER. This consists of two phases which are tightly interrelated to each other. The development phase is to develop the framework and visualise the validation approach for different stakeholders. The operation phase is the phase of validation of technologies- and methodologies-in-use. We conclude the report with the description of ongoing or finished validation actions.

[1] This is a model created with Metis 3.6.
[2] This is a HTML-report created automatically from the Metis model.

1 Introduction

The main purpose of this deliverable is to introduce the validation approach for the MAPPER project by defining the MAPPER validation framework. This framework includes and orchestrates approaches and methodologies from different fields and defines the validation actions to be performed.

Validation in MAPPER will cover 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 MAPPER infrastructure and services is a key aspect. The validation framework will include parallel validation activities for these viewpoints.

Main requirements that the validation framework will have to meet are:

- Allow for validation of the overall MAPPER objectives (business objectives, work practices, technology support)
- Include the different perspectives (economic, socio-technical, technical)
- 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, expert and users 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, national and European levels, across individual cases)

Development of the validation framework is based on an analysis of relevant existing approaches for each of the three validation perspectives. The results of this analysis and the selection of the MAPPER approach for each perspective are described in Section 2. Section 3 will introduce the validation framework, including terms and concepts, the validation framework prototype and the application of this framework. The overall validation process with actions planned, interpretation of results and connection to the dissemination work package are covered in Section 4. Some important documents related to the validation framework can be found in the Annex. These are validation terms and concepts, interview guide, scorecard info package, field study reports in Kongsberg Automotive and Evatronix.

2 Relevant Validation Approaches

In this section we are going to present our main approaches for validation in MAPPER. Our approaches can be described from three different but related perspectives:

- Economic perspective
- Socio-technical perspective
- Technical perspective

These three perspectives are based on different 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 MAPPER scope. Third, we tried to relate all perspectives and the result is a holistic validation framework (described in the Section 3, see also the prototype delivered) which is currently used, on the one hand, as a tool for communicating and collaborating within WP7, and on the other hand for analysing our validation scope and defining the criteria, methodologies and actions for validation.

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. Enterprises would like to know how to evaluate, improve and control the contribution of an IT-infrastructure to the business success. 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. This section provides an overview to BVIT approaches and introduces the selected approach for MAPPER.

2.1.1 Relevant Approaches

This section will present and briefly discuss different approaches for measuring BVIT. We selected four types of approaches and one typical representative for each of these approaches:

- 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)

Process-Oriented Approaches

In process-oriented approaches the BVIT is demonstrated through process improvements. These approaches answer the question of how value is added to the business. Traditional measures of productivity need to be expanded to capture the impacts of IT use. The organisational context and competitive position should be considered more in studies of business value.

Mooney et al. (1995) provide a framework that is a basis for process-oriented studies of BVIT. They propose a process view for three reasons: firstly to identify the value adding mechanisms of IT, secondly to develop an approach and a set of metrics for measuring the technology value and thirdly to enhance the understanding of the relationship between IT and organisations. Their framework incorporates:

- typology of business processes
- typology of potential impacts of IT on those processes
- framework for analysing the business value of IT created by its impacts on those processes

The focus of the approach is how the technology can improve management and operational processes. IT can have three effects on business processes:

- *Automational effects* which refer to the efficiency perspective of value deriving from the role of IT as a capital asset being substituted for labor.
- *Informational effects* which refer to the capacity of IT to collect, store, process, and disseminate information.
- *Transformational effects* which refer to the value deriving from the ability of IT to facilitate and support process innovation and transformation.

The business value impacts of each of these effects are associated with operational or management processes, as depicted in Figure 1.

	Dimensions of IT Business Value		
Business Processes	***Automational***	***Informational***	***Transformational***
Operational	Labor costs Reliability Throughput Inventory costs Efficiency	Utilization Wastage Operational flexibility Responsiveness Quality	Product and service innovation Cycle times Customer relationships
Management	Administrative expense Control Reporting Routinization	Effectiveness Decision quality Resource usage Empowerment Creativity	Competitive flexibility Competitive capability Organizational form

Figure 1 Potential IT Business Value Metrics (adopted from Mooney et al., 1995).

The framework does not include a methodology or an evaluation technique for business value assessment. Business value impacts of both an existing or planned IT system can be investigated with this approach.

Perceived Value Approaches

The information system (IS) success model by DeLone and McLean (1992) belongs to the perceived value approaches. This class of approaches bases BVIT evaluations on user perceptions rather than on financial indicators or measurements within technical systems. DeLone and McLean discuss the difficulty in defining IS success and conclude that different researchers address different aspects of success, making comparisons difficult and the prospect of building a cumulative tradition for IS research similarly elusive.

Their multidimensional model is based on theoretical and empirical IS research. Based on Shannon and Weaver (1949) and Mason (1978) the authors identified six major dimensions of IS success.

- *System quality:* Measures of the information processing system itself.
- *Information quality*: Measures of information system output. The focus is on the quality of the information that the system produces.
- *Use*: Recipient consumption of the output of an information system.
- *User satisfaction*: Recipient response to the use of the output of an information system. The measure of use is not very useful if the use of an information system is required. In that case the interaction can be measured in terms of user satisfaction. A key issue is whose satisfaction should be measured. Furthermore, it should be considered that user satisfaction is associated with user attitudes towards computer systems.
- *Individual impact*: The effect of information on the behavior of the recipient. Impact is related to performance, and so improving performance is an indicator that the information system has had a positive impact. But impact could also mean a better understanding of the decision context, improving the user's decision-making productivity, producing a change in user activity or changing the decision maker's perception of the importance or usefulness of the information

system.

- *Organisational impact*: The effect of information on organisational performance.

These six categories of IS success are used by DeLone and McLean to organise the IS research work (conceptual and empirical studies) that has been done on that field. Among others, they made the following observations in reviewing the IS research:

- IS research has a broad list of individual dependent variables. The choice of a success variable is often a function of the objective of the study, the organisational context, the research method, the level of analysis (individual, organisation, society) etc.
- There is a need for a significant reduction in the number of different dependent variable measures so that research results can be compared.
- There are not enough field study research attempts to measure the influence of the effort on organisational performance. DeLone and McLean discovered that many researchers tend to avoid organisational performance measures. The reason is the difficulty of isolating the effect of the IS effort from other effects which influence organisational performance.

The six success categories and the many specific measures within each of these categories clearly indicate that IS success is a multidimensional construct and that it should be measured as such. Figure 2 presents the IS success model which recognises success as a process construct, which must include both temporal and causal influences in determining IS success. Based on both process and causal considerations, these six dimensions are proposed to be interrelated rather than independent.

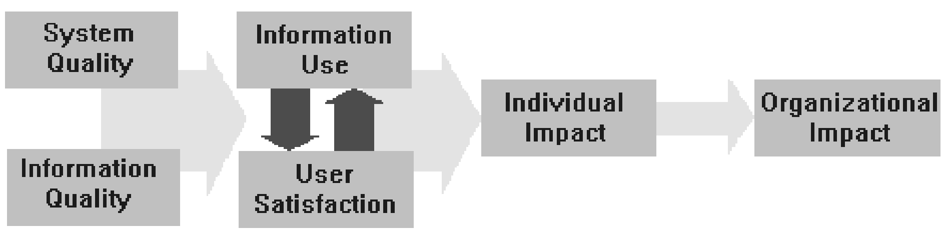


Figure 2 IS Success Model (adopted from DeLone and McLean, 1992).

The IS success model includes an explanation concerning the relation of these variables. An IS is created first, containing various features, which can be characterised as various degrees of system and information quality. Users experience these features by using the system and are either satisfied or dissatisfied. The use of the system and its information products then influences the individual user in the conduct of work, and these individual impacts collectively result in organisational impacts. DeLone and McLean point out that the model intends to incorporate and organise all of the previous research on this field, while at the same time it must be sufficiently simple. The categories and the structure of the model allow for an integration of most approaches from IS success research, as the model offers a rationale how the categories interact with and relate to these other approaches. That is the explanatory value of the model. Additionally, the model should also have a predictive value. The model is an attempt to reflect the interdependent process nature of IS success.

The main conclusion from DeLone and McLean is that IS success is a multidimensional and interdependent construct. It should be combined individual measures from the six IS success categories to create a comprehensive measurement instrument.

Project-Focused Approaches

Information economics by Parker and Benson (1988) is a method for project justification. It tries to regard the contribution of an IS in terms of business value and seeks to create a rational basis for summarising complex expressions of value. Representative stakeholders and risk factors influencing the delivery of the business value are identified. The method starts with financial and strategic objectives of the business. It adds technical dimensions of a project through project evaluation categories such as fit with technical architecture and vendor risk. Afterwards an evaluation scale for each category should be devised (e.g. if ROI is a project evaluation factor, an appropriate evaluation scale might run from 0 points for 0 to 5% ROI up to 5 points for over 15% ROI).

Before the framework is applied, the business and IS representatives of an enterprise must negotiate the importance of each evaluation criterion via a weighting factor, i.e. choices such as “the fact that a project enables a competitive response is more important than adherence to ROI targets” are made explicit. This leads to project prioritisation and generates an understanding of how IT is adding value to the business (see Figure 3).

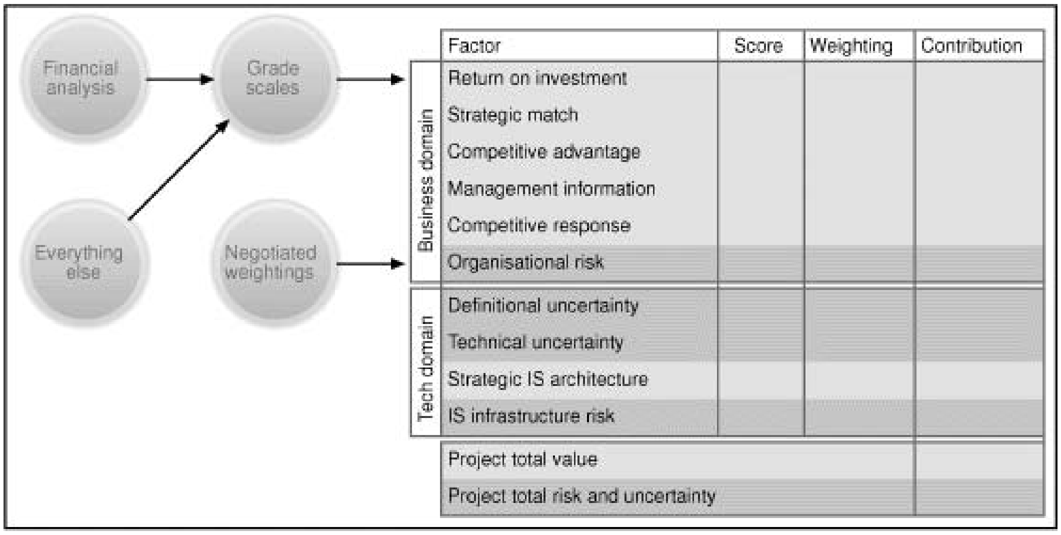


Figure 3 Information economics (adopted from Parker and Benson, 1988).

Figure 3 visualises the basic idea of Information Economics. The left-hand side indicates the development of grade scales based on financial and other aspects, and the negotiation of weights. The table on the right side shows the financial and strategic objectives (factor), the achieved score for each factor as a result of the measurement, the negotiated weighting and the overall contribution as a product of score and weighting.

Scorecard-Based Approaches

In the early 1990’s, Robert Kaplan and David Norton (Harvard Business School) developed a new approach to strategic management and named this system the “balanced scorecard” (1992, 1996). The balanced scorecard approach provides a clear prescription as to what enterprises should measure in order to base management decisions not only on financial aspects but balance them with other perspectives. This system was widely adapted in industry because it solved some of the weaknesses and vagueness of previous management approaches.

The balanced scorecard is a management system that allows enterprises to clarify their vision and strategy and translate them into action. This management system includes a measurement system providing feedback around both the internal business processes and external outcomes in order to continuously improve strategic performance and results.

Kaplan and Norton describe their balanced scorecard as follows (1992, 1996):

> *“The balanced scorecard retains traditional financial measures. But financial measures tell the story of past events, an adequate story for industrial age companies for which investments in long-term capabilities and customer relationships were not critical for success. These financial measures are inadequate, however, for guiding and evaluating the journey that information age companies must make to create future value through investment in customers, suppliers, employees, processes, technology, and innovation.”*

The balanced scorecard proposes that an organisation should be viewed from four perspectives:

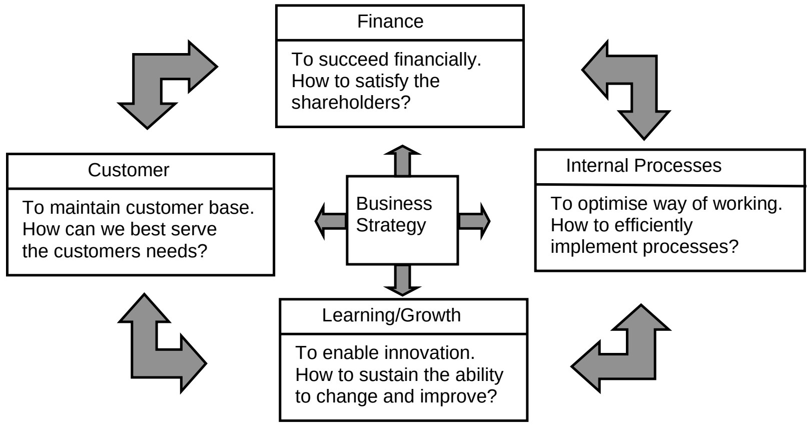


Figure 4 Perspectives of balanced scorecard.

- The financial perspective focusing on financial performance including risk assessment and cost-benefit data
- The business process perspective addressing the internal processes in an enterprise (value creation and support processes) and how well they contribute to fulfilling the enterprises' mission
- The learning and growth perspective covering knowledge as an important asset in a company with individual and corporate self-improvement
- The customer perspective focusing on customer satisfaction and performance of the enterprise in customer-related activities

For all four perspectives metrics have to be developed, data collected and analysed.

An approach close to the balanced scorecard concept is van der Zee B_{TRIPLE}E-Framework (van der Zee, 2002) for IT management and measurement, which is a dashboard of relevant performance indicators for IT. The framework consists of four levels:

- **B**usiness Value of IT: IT contributes to business objectives and to business strategy
- **E**ffectiveness of IT: IT effectively supports business processes, activities and employees
- **E**ffectiveness of IT supply: IT supply aligns with business requirements
- **E**fficiency of IT supply: If IT is supplied at minimum cost

As there is no single performance measure to determine the BVIT, multiple measures are needed to reflect different relationships at different levels. An aggregated approach should be applied to correlate IT cost with the performance of the organisation. The initial point of the framework is that the BVIT can only be derived from the improvement in performance of the organisation, as a result of the application of IT. BVIT is measurable on three related dimensions and its measuring is concerned with the relationship between the costs of IT and its contribution to the improvement of

- Financial performance
- Business performance
- Strategic performance

IT Costs

IT costs might be segmented to perform trend analysis and comparison with other companies

- by activity, e.g. development of new IT capabilities, maintenance of existing IT capabilities, operating IT capabilities, end-user computing support, planning and administration of IT etc.
- by resources, e.g. technology costs (hardware and software), personnel costs, costs of outside services etc.

Zee emphasises that analysis, benchmarking of the total percentage of revenue spent on IT or the measures of IT cost by activity or by resource have not been proven by research to be valid and reliable “value for money” indicators on their own. Nevertheless they provide an insight into IT cost patterns and may reveal abnormalities in trends. Finally, the IT costs and each of the three related dimensions are brought together.

Financial performance and IT costs
Financial performance can be measured by financial indicators such as profitability, productivity, earnings etc. In order to determine the value of IT, IT costs must be related to financial performance measures.

Business performance and IT costs
Business performance can be measured by non-financial indicators such as competitiveness, new product sales, product development lead times or customer satisfaction. The Balanced Scorecard concept can be applied. Furthermore the BVIT can be determined from an historical perspective (trends) or from an external comparative perspective (benchmarking). IT costs are related with multiple business measures to reflect the different activities and objectives of the business in a balanced way. Business performance measures are specific to sectors and depend on business priorities. Zee considers the improvement of business performance, determined by these measures, as an indicator of the business value of IT.

Strategic performance and IT costs
In this dimension, the contribution of IT in realising strategic goals is measured. Strategic performance can be measured by indicators that match specific management objectives. The concept of the Critical Success Factors (CSF) should be applied. Two approaches can be identified:

- CSF can be enhanced by distinguishing between “going concern” IT costs, IT infrastructure and IT research costs and the development costs of new IT capabilities for each CSF.
- Another approach looks at the value of IT assets: An IT asset balance sheet reflects the monetary value of investments in information, software and technology per CSF.

The BVIT within the $B_{TRIPLE}E$-Framework includes more than one dimension. However this framework is not a methodology for a holistic BVIT assessment because every dimension is only put into relation to the costs of IT. The framework provides indeed a wide dashboard of performance indicators for IT. But these indicators are only expressed in terms of organisational performance improvement at minimum cost.

2.1.2 Selected Approach

The previous section clearly shows a wide range of possibilities how to approach the validation in MAPPER from an economic perspective. All four types of approaches could potentially be tailored for and applied in MAPPER. However, a more detailed look shows differences between the approaches presented with respect to their suitability for MAPPER. We decided to use the balanced scorecard approach for MAPPER 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, 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, do not cover these aspects sufficiently. 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 for MAPPER 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 Bensons Information Economics – are usually applied in order to support decision making, whether a project should be started or not. Monitoring of the different aspects Parker and Benson propose could theoretically 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 are no longer considered for use in MAPPER. Two candidate approaches remain: scorecard-based and process-oriented. Decision making process for one of these approaches has to take into account that the overall MAPPER objectives have to be considered in all three use cases and that the effort for developing the approach must be accommodated in the MAPPER budget.

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. However, structuring the evaluation into automational, informational and transformational effects 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 indicators,
- 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 (definition of appropriate indicators) and
- the development and implementation efforts for scorecards are reasonable with respect to the available efforts in the work package addressing validation in MAPPER (WP7).

Furthermore, DeLone and McLean's list of relevant aspects and Mooney's et al. dimensions of BVIT can be used as inspiration when developing scorecards for the use cases. In this context, we also decided in favor of the original balanced scorecard approach from Kaplan and Norton and against van der Zee's $B_{TRIPLE}E$ method. $B_{TRIPLE}E$ is a very sophisticated, but at the same time very complex development requiring extensive efforts for both implementation and operation.

The next section will introduce in more detail how balanced scorecard is implemented in MAPPER.

2.1.3 Balanced Scorecard in MAPPER

Use Case Scorecard and MAPPER Scorecard

The Balanced Scorecard approach introduced in the previous section is considered as a suitable way to structure the economic objectives of MAPPER for the validation process and to implement a measurement system for this purpose. In this context, we have to distinguish between the scorecard for the overall MAPPER project (MAPPER Scorecard) and the scorecards for the individual use cases (Use Case Scorecard).

The Use Case Scorecards will have to reflect the objectives of the industrial enterprises involved in each use case and will implement a measurement system for these objectives. However, the overall MAPPER objectives also have to be represented in the individual use case scenarios, in order to make the Use Case Scorecards an instrument supporting both, the evaluation within the use cases and on the overall project level. The MAPPER Scorecard will focus only on the overall MAPPER objectives and use information from the individual Use Case Scorecards, aggregate and evaluate them.

The definition of sub-scorecards for top-level scorecards is also an element of Kaplan and Norton's original concept. They recommend the translation of strategic objectives into more operation-oriented objectives for strategic business units (SBU). But Kaplan and Norton do not explicitly describe the connection between goals and indicators in the top-level scorecard and on sub-scorecard level. They see the development process of the strategic objectives for the SBU as decisive step when connecting strategy for the company with strategy for the SBU.

We consider a more precise definition of the correspondences between MAPPER Scorecard and Use Case Scorecards as beneficial for the validation framework, as the use cases are no SBUs in the same organisation. The following table shows the principal cases of correspondences and how the cases will be treated. The main strategy behind this table is to include only those sub-goals from the Use Case Scorecards in the MAPPER Scorecard that have a clear inclusion relationship to the MAPPER objectives.

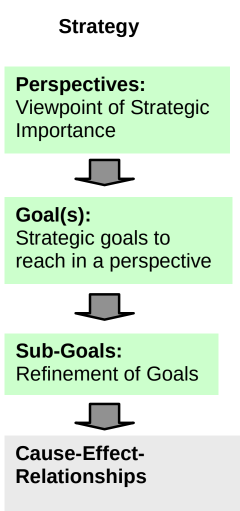
Correspondence Case	Integration Action
Identical objectives in MAPPER Scorecard and one or more Use Case Scorecards	Include the use case indicator in the MAPPER Scorecard for measuring the MAPPER objective
Use Case Scorecard goal is sub-goal to MAPPER business objective	Include sub-goal and indicator in the MAPPER Scorecard
Use case goal is contributing to measure scientific/technology objective	Include sub-goal and indicator in the MAPPER Scorecard
Use case goal is neither sub-goal of business objective nor contributing to scientific / technology objective	No inclusion of the objective

MAPPER Scorecard and Use Case Scorecards are included in the validation framework, which will be introduced in Section 3.

Developing the MAPPER Scorecard

The WP7 team supported the use cases in developing a balanced scorecard for each use case by arranging a one day scorecard workshop for each use case. These workshops produced an initial scorecard version, which forms the starting point for refinements and further development.

During the Use Case Scorecard workshops, the following steps were taken:



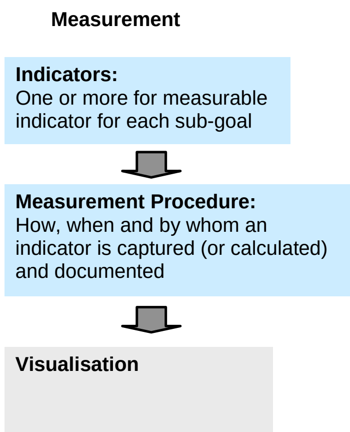
The first four development steps focused on capturing the business **strategy** of the organisation units participating on behalf of the use case partners in MAPPER and translating this business strategy into goals and sub-goals.

The first step was to evaluate, whether the *perspectives* proposed by the initial Balanced Scorecard approach (i.e. financial, internal business process, learning and growth, customer) are valid and appropriate for the enterprise in question or whether they should be changed. A starting point for identifying relevant perspectives was the business strategy or mission statement. If such an explicit strategy definition did not exist for the enterprise, the main objectives and challenges for the enterprise were discussed. The result of this step was an initial agreement on perspectives to consider in the Use Case Scorecard.

For each perspective, *strategic goals* have to be defined and preferably quantified, as quantifying them helps to reduce the vagueness in strategic goals. Identifying strategic goals was again based on the business strategy and also included the overall MAPPER objectives. If possible, just one strategic goal for each perspective was defined.

The defined strategic goals were in a next step broken down in *sub-goals*. Guiding question when defining the sub-goals was “What do we have to do in order to achieve our strategic goals?”. Again, the overall MAPPER objectives were helpful in defining the sub-goals. The objective was to define not more than 5 – 7 sub-goals per goal.

The last step related to strategic aspects was the identification of *cause-effect-relationships*. There might be strategic goals which cannot be achieved at the same time because they have conflicting elements. It is important to understand these conflicts or cause-effect relations between goals. During the first scorecard workshop, cause-effect relationships were not included in order to allow for reflection and discussion of the goals and sub-goals developed before continuing.



After having covered the strategic aspects, focus will shifted on **measurement** issues:

For each sub-goal defined in the different perspectives, a way had to be found how to measure the current situation with respect to this goal. For this purpose, *indicators* had to be defined contributing to capture the status with respect to the sub-goal. When defining indicators, one had to have in mind that there must be a practical way to capture these indicators. In this context, existing controlling systems or indicators (e.g. from quality management) were inspected and checked for possibilities to reuse information.

For each indicator identified, the *measurement* or recording procedure was defined. Again, the feasibility of implementing a measurement approach was considered carefully.

A measurement procedure typically includes

- The way of measuring an indicator
- The point in time and interval for measuring
- The responsible role or person performing the measurement
- How to document the measured results

Furthermore, the baseline or reference value had to be defined. This could preferably be based on historical data, i.e. records or documents from the past allowing to derive the indicator.

The last step in this measurement context, the *visualisation* of the indicator development over time, was not discussed in the first scorecard workshop. Visualisation, interpretation of the measurements and defining counter measures for certain developments will be subject of later steps in the validation work package.

Validation Process

Based on the development process described in the previous section, a use case scorecard for each use case was developed. Current activities in the use cases aim at implementing the balanced scorecard, which basically includes two steps:

- To determine the baseline values for the different indicators. For those indicators where historical information is available, this information will be evaluated in order to determine the state “before MAPPER”.
- To implement the measurement process. For each indicator, the process how to capture this indicator, which was developed in the scorecard workshop, has to be put in place.

As soon as the measurement process is implemented, all indicators will be captured continuously. Continuously means in this context that either whenever a change in the indicator occurs this is captured or after a pre-defined time interval (e.g. weekly) the indicator is captured.

Besides the interpretation of the indicators values on use case level, which is part of the use case work packages, a propagation of relevant indicator values for the MAPPER scorecard level and interpretation on this level is necessary. The initial time interval for this propagation will be 3-monthly, starting three months after the roll-out of the first MAPPER infrastructure version to the use cases. The use cases are asked to provide the indicator values monthly to WP7, where the integration into the MAPPER scorecard will be done. Interpretation of the results will be based on the baseline values and lead to preliminary results and feedback to the use cases and if adequate the WP 4, 5 and 6.

2.2 Socio-Technical Perspective

MAPPER will enable fast and flexible manufacturing by providing methodology, infrastructure and reusable services for participative engineering in networked manufacturing enterprises (DoW). Participatory engineering deals with the processes which link communities to the technological interventions which affect them. Examples of sustainable linkages abound in many sectors including agriculture, irrigation, material processing, hydropower, water and sanitation (McGahey, 1999). Participatory engineering 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 and even of customers in design, manufacturing and decision-making processes. Actors involved in design, development and manufacturing processes have an important role, on the one hand, because they use MAPPER technologies and apply MAPPER methodologies developed, 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 make use of MAPPER methodologies for participative engineering, how they improvise in order to overcome difficulties during their (cooperative) work, how they deal with incontingencies and coordinate their work etc. Socio-technical perspective focus on understanding work practices that are supposed to be supported by MAPPER technologies and methodologies, and on evaluation of the usage of MAPPER technologies and validation of the use of MAPPER methodologies.

In this section we first describe relevant approaches for the socio-technical perspective of our validation framework. Second, we will choose some of the approaches that are relevant for MAPPER and illustrate their use and necessity in validation activities in this work package.

2.2.1 Relevant Approaches

Ethnography

The socio-technical perspective in the validation processes of MAPPER is very crucial. Technologies and methodologies we develop in this project will be used in WP1, 2 and 3. Users of these work packages will carry out their daily work by using these technologies and methodologies. Not only single-user-to-single-computer interactions but also cooperative design activities will occur, which are bound up in a social situation. “The turn to the social has encouraged the use and incorporation of techniques, methods, and theories from, for example, anthropology, sociology, and social psychology. An important strand of this research has utilized *participant-observational field studies* (ethnographies). Ethnographic studies focus on building up an understanding of work or activity as it occurs, *in situ*.” (Martin and Sommerville, 2004, p.60). Besides participative observations, *in-depth open interviews* with significant actors and *document analysis* are essential parts of ethnographic field studies. Field studies have the goal to identify work-related issues explained in the Validation Framework:

- The complexity of the work, with respect to two dimensions:
  - People’s flexibility in ordering work processes and adapting them situationally to the exigencies as they unfold.
  - People’s need for getting an overview of the work process and the status of work – the usefulness of different kinds of overviews.
- Collaboration needs and practices in the team:
  - How are different media used and combined?
  - Strategies of aligning work across boundaries.
  - How are cultural differences between professions and/or organisations dealt with?
- The larger context of the work:
  - How do actors position their role and tasks in relation to others?
  - What is their view of the context of project and enterprise?
- Key tools and artifacts in use:
  - The diversity of software tools and infrastructures – For what purposes are tools and infrastuctures used?
  - The role of standard descriptions and procedures – How are they used?
  - The evolution of artifacts (Cluts, 2003)
    - How do artifacts evolve? How are they created?
    - How are artifacts shared?

        - How are artifacts given meaning?
        - How is the perceived use or credibility of artifacts determined?
        - How are the relationships among actors affected by the use of technology?
        - How do actors appropriate technology artifacts over time?
        - How are promises and mutual commitments made?
    - The use of the physical space for making work visible, sharing etc. and the role of physical artifacts.
    - The role of redundancy.

In the CSCW (Computer Supported Cooperative Work) and HCI (Human Computer Interaction) there are several ethnomethodological, ethnographic, conversational analytic and interaction analytic studies of work and technology (among others Bowers and Martin 1999, Cluts 2003, Eveland 1993, Forsythe 1999, Herper 2000, Hughes and Randall 1992, Jordan 1993, Karasti 2001, Kensing 1998a, Nardi and Miller 1990). Their main goal is to describe and analyse work practices as they unfold. They focus on the everyday accomplishment of work activities involving technologies, computer systems, artifacts, instruments, pens, paper etc. The socially produced order of work, the achievement, maintenance and repair of this order are relevant issues for these studies.

There are some other concepts based on ethnography:

- *Autoethnography or personal ethnography* (Crawford, 1996) is "the creation of an ethnography focused on the self. The author is both informant and investigator." (Cunningham & Jones, 2005, p.2) The investigator creates an ethnographic description and analyses his/her own behaviour. He/she tries to develop an objective understanding of the behaviours and work context under consideration.
- *Rapid ethnography or quick and dirty ethnography* are modified versions of classic ethnographic techniques (Hughes et al., 1995). They accommodate commercial and educational circumstances, allowing practitioners and students to understand more quickly and more directly from potential end-users.

In ethnography-based studies it is very important that critical and unexpected things that occur can be observed and documented. The context and the reaction of actors to these contingencies are important factors to consider for systems design and for the validation of systems. Unfortunately ethnographers cannot be present the whole time of investigations of use case partners. It is a commonplace practice to use a "*self-reporting diary study* to assist with such ethnographic blind-spots". "The subjective information obtained from the diaries can give a valuable, alternative perspective to external, somewhat more objective investigator one. In writing the entries, a participant can be given the opportunity to reflect on their experience, without the pressure or influences they might feel when being observed" (Cunningham & Jones, 2005, p.2). Most diary studies are paper-based. There are also some *interactive computer-based technologies* applied to help the informants in keeping diaries like Mobile Probes (Hulkko et al., 2004) or Experience Clip (Isomursu et al., 2004).

The *Cultural Probe* method can be used to engage participants during the data capture phase (Gaver et al., 1999). A cultural probe consists of materials created and used to provoke and question informants over time. Participants deliver items from the probe in their own time and on their own terms. Probes can consist of several types of materials like texts, images, drawings, postcards, maps, photo albums, media diaries etc.

Patterns of Cooperative Interaction

Martin and Sommerville introduced patterns of cooperative interaction “as ways of highlighting regularities in the organisation of work, activity, and interaction among personnel taking part, and with, through and around artifacts.” (2004, p.66). Authors identified and described ten patterns presented with a vignette which is a front page summary including a textual description of the pattern and of the social practices[3].

- *Artifact as an audit trail* is concerned with the way in which an artifact can serve as a stratified record of work. It focuses on how amendments and attachments to the artifact, such as comments, date stamps, post-it notes, other documents and so forth, are accountable to the personnel within a setting. In a way the artifact serves as a means of coordination between actors allowing them to locate who has done what work and therefore assisting in remedying problems and so forth.
- *Multiple representations of information* is concerned with how people make use of multiple representations of information when performing their work. This is evident particularly in critical real-time work like work in control rooms.
- *Public artifact* is concerned with the use of a public artifact (e.g. a large display monitor, notice board) which serves as a shared object which provides a group of actors with some form of overall perspective on their activity. This promotes collaboration of various kinds allowing actors to visualise how their work fits into an overall perspective, to assist and monitor in one another’s work.
- *Accounting for an unseen artifact* is concerned with the manner in which one actor can make available (or not) details of a local artifact like a computer system and their interaction with it when involved in communicating with another actor.
- *Working with interruptions* focuses on the nature of interruptions in the workplace. It deals with situations where interruptions emanate from various sources where the timing of interruptions is largely outwit the control of the personnel.
- *Collaboration in small groups* is concerned with the manner in which small collocated groups carrying out various activities collaborate. It draws attention to the way in which collaboration is facilitated by seating arrangements and various artifacts.
- *Receptionist as a hub* is concerned with the nature of the role and the activities carried out by the reception in different organisations.
- *Doing a walkabout* is concerned with the activity of doing a walkabout for different actors in different organisations. Doing a walkabout may be a directed or undirected activity in which a worker wanders around a site or areas of a site as a way of gathering information about what is going on, what others are doing or to find out the actual situation at locations on the shop floor or to keep in touch.
- *Overlapping responsibilities* is concerned with the explicit interdependence of roles amongst tightly coupled groups of actors in safety critical control room settings.
- *Assistance through experience* is concerned with effects of prescribed career trajectory amongst tightly coupled groups of actors in safety critical control room settings. The career trajectory prescribes that actors progress through roles with increasing complexity and responsibility.

2.2.2 Selected Approach

For user grounding and laying the ground of future validations and evaluations of MAPPER technologies and methodologies, both at the initial stages of design and development and at later stages of the use assessment in the industrial pilots the socio-technical perspective uses ethnographic workplace studies, in-depth open interviews and document analysis as the main methodology for validation. These studies take place as field visits to CRF, Evatronix/advICo and Kongsberg Automotive (see Validation Actions in Section 4). Field visits will provide as a result:

- 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.
- Scenarios of use for MAPPER tools and services.
- Criteria for useful services that build on the MAPPER concepts – model-based approaches, participatory engineering methodology, configurability, transparency and security.
- Theory-based deepened concepts.

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[3] http://www.comp.lancs.ac.uk/computing/research/cseg/projects/pointer/patterns.html

- Report of modelling processes.

Autoethnography or personal ethnography will be used partly in some specific settings which is still to be identified and integrated into the pilots. Rapid ethnography or quick and dirty ethnography will not be applied in MAPPER because they narrow the “wide angle research lens” of standard ethnographic approaches (Millen, 2000). Unfortunately ethnographers (i.e. researchers from Trento) cannot participate and observe users (CRF, Evatronix/advICo and Kongsberg Automotive) the whole time during the pilots. Therefore diaries will be used by users themselves for self-reporting without using interactive computer-based technologies for this purpose. Optionally cultural probes will be considered for data capturing in the industrial pilots.

Furthermore, ethnographic studies of modellers interviewing users will be carried out. Modelling activities and their results in the three use cases will be compared. As said in the kick-off meeting of MAPPER: “Models are important knowledge sources, but it is the modelling that has the greatest value to users!”. However, how to quantify and objectify the value of modelling experience is still an open question. Observation of modelling session will provide data about the following dimensions:

- The work which took place as preliminary to the modelling process will be captured. Different stakeholders will be interviewed to find out what they did to prepare the modelling session. E.g. researchers who are facilitators of modelling processes prepare an agenda and issues to talk and to clarify during the modelling session. Users identify documents which might be relevant for the next modelling process and provide some examples of these to the modellers. They also prepare a set of material that they might need during the modelling sessions. Modellers study work processes of users in order to be familiar with their users’ work settings and objectives. This information will be investigated through structured interviews and observing training sessions that took place prior to modelling sessions.
- Practical means by which the process of participative engineering takes place in modelling sessions will be investigated. These include the use of several tools to support the process of modelling: METIS as modelling tool; presentation slides (prepared in MS PowerPoint) to communicate ideas, current processes and issues to discuss; open issue lists created in MS Word or MS Excel.
- Problems encountered by final users in modelling sessions will be observed. Are users able to think in four dimensions of POP* approach? Are they able to present their problems in terms of present and wanted situations?
- Issues about the collaboration between coordinator, modelling expert and coach will be investigated. How do they coordinate their work in the modelling sessions? How is home work distributed from a modelling session to another?
- The coaching of modelling situation is another issue for investigation. How is the POP* approach used? Or how is the SGAMSIDOER approach or other approaches used?
- The management of model files is a challenging task and contains interesting questions like how and when they circulate, whether there are inscriptions used to circulate the models (printouts, screenshots, slides), or whether there are documents presenting the results of modelling sessions.

The main result of the observation of modelling sessions will be:

- scenarios of supportive techniques for modellers in modelling sessions
- criteria regarding final user participation in modelling sessions
- suggestions for a refinement of a common modelling approach as MAPPER methodology (connected to WP4).

Additionally WP7 will try to identify some of the patterns of cooperative interactions in work practices improved by new technologies and methodologies (Martin 2004). These patterns will be used to analyse the findings and to come up with change requests and feedback to WP4, 5 and 6:

- In order to find out how artifacts facilitate work within a collaborative environment the pattern *artifact as an audit trail* will be applied. This will provide an enhanced accountable record of work promoting better coordination amongst users. This will also promote auditability of work and recoverability. For example in case of failures annotations may provide valuable process information.
- The use settings in MAPPER are very complex. Complex activities need to be broken down into more manageable tasks. This will be provided by *multiple representations of information*. The possibility to have different views to the same activities supports different aspects of the

activity. When these are available to a small collocated group this allows concurrency in work practices. Different members can work on different parts of an activity simultaneously and collaborate in solving more complex tasks. The redundancy in the information and also the group can be useful in ensuring the dependability of the system.

- *Accounting for an unseen artifact* will be used in MAPPER in the sense that the work can be done more visible to members of a group. This will help collaborate from different locations and organisations.
- Interruptions are a routine and necessary part of individual and collaborative work. The pattern *working with interruptions* will be applied in areas where promoting teamwork amongst personnel as they are managed and dealt with in a collaborative manner is an important issue. This is also connected to the sharing of knowledge and skills.
- *Collaboration in small groups* is a necessity in design and manufacturing. Collaboration promotes teamwork. This allows for group knowledge and expertise to be shared. Monitoring and checking can occur as the work is produced. Collaboration in small groups promotes tighter coordination between actors dealing with interrelated tasks and makes it more likely that activities will be dealt within a consistent way.
- *Doing a walkabout* is a crucial part of everyday activity for many actors. This can serve as the best way of finding out what is actually going on now and can be seen to be provoked by or augment, for example, computer-based information. The seeing-things-for-yourself and the face-to-face interaction seem to be important components of this type of activity. The activity itself serves as the context within which ad hoc collaboration of various kinds and the sharing of knowledge, expertise and so on can take place.
- *Overlapping responsibilities* serves as part of explicit design for dependability in safety critical socio-technical systems. For example, it ensures that the system can function with varying size of a group as individuals may carry out more than one role or allocate themselves to required areas of the activity. Furthermore, the knowledge and experience actors have of one another's roles aid in binding the separate stages or tasks together. This also builds redundancy into the system and provides for cooperation, supervision, advice, sharing of knowledge and so forth as part of the normal group activity. The group can fluidly respond to the various changes in circumstance that characterise control work as it passes from standardised routine (i.e. activity that can be carried out quite programmatically, where decisions are straightforward and time pressure is normal) to exception or crisis handling (dealing with failures, complexity, ambiguity, multiple contingencies and under more extreme time pressure).
- *Assistance through experience* is considered to have a number of benefits for a socio-technical system in terms of dependability. For example, it ensures that those in more responsible roles have knowledge and experience of the activities that feed into their work, or that must be coordinated to achieve their work.

For analysis of our ethnography-based investigations we will apply some key concepts from the CSCW research (Heath and Luff 1993, Pycock and Bowers 1996, Randall and Roucefield 1995, Scaifeet al. 2002, Shapiro 2005):

- *Coordinative artifacts* are used to manage the complexity of coordinating and integrating cooperative activities (Schmidt and Wagner, 2004). They are identified with a unique identifier, have usually a standard format. There are authentication procedures connected to coordinative artifacts. They have also specific functions, like interfacing distributed activities for instance by means of templates and standards, anticipating and prescribing actions like todo-lists and workflows, keeping track of past actions by using records, identifying or classifying objects etc.
- *Ordering systems* are based upon the combination of specialised coordinative practices and coordinative artifacts (Schmidt and Wagner, 2004). They help manage interdependencies that transcend local interactions. They provide interoperability among hundreds of artifacts/documents. They assist in identifying and validating individual artifacts and versions of artifacts, in maintaining a practical degree of consistency across the local activities as constituted by division of labour and specialisation, over time etc. They keep track of and providing access to the vast and perpetually changing collection of representational artifacts. They document that actors, including external partners and authorities, meet agreed-to or statutory deadlines.
- Collaboration involves producing successive objectifications of the work and interacting with them in a variety of ways, inspecting them, comparing them, assessing them etc. That is, the

conspicuous display of *representational artifacts* can be seen as the fundamental means of making the not-yet-existing and in-the-process-of-becoming field of work immediately visible, at-hand, tangible. They make the invisible visible, the ephemeral immutable, the intangible tangible. They enable exploring and evaluating options. They help specifying, closing options and making them public.

- Cooperative work involves articulating – to distribute work, align tasks, explain, clarify misunderstandings, identify errors and so forth. *Articulation work* is work to make work work – activities undertaken to ensure the articulation of activities within the cooperative arrangement. It is a kind of meta activity. It may involve specific tasks, such as scheduling, moderating a meeting, coordinating, project management etc.
- *Peripheral awareness* has been identified as a crucial element of co-located work. It means being aware of what others in the same location are doing and to pick up clues that are relevant for one's own work without having to interrupt that work. For example, to systematically monitor each other's actions, so that colleagues can be informed of any relevant, but potentially unnoticed problems. Awareness is not the product of passively acquired information but is a characterisation of some highly active and highly skilled practices. Competent practitioners are able to align and integrate their activities because they know the setting, they are not acting in abstract space but in an material environment which is infinitely rich in cues.
- For distributed work the notion of *workspace awareness* has been developed. This includes awareness of people and how they interact with the workspace, rather than just awareness of the workspace itself. Second, workspace awareness is limited to events happening in the workspace – inside the temporal and physical bounds of the task that the group is carrying out. Workspace awareness is used in cooperative work in several ways:
    - Management of coupling: Assists people in noticing and managing transitions between individual and shared work.
    - Simplification of communication: Allows people to the use of the workspace and artifacts as conversational props, including mechanisms of deixis, demonstrations, and visual evidence.
    - Coordination of action: Assists people in planning and executing low-level work - space actions to mesh seamlessly with others.
    - Anticipation: Allows people to predict others' actions and activity at several time scales.
    - Assistance: Assists people in understanding the context where help is to be provided.
- *Knowledge sharing* is not a CSCW concept. People share knowledge through articulation work, by maintaining and supporting workspace awareness and all kinds of shared coordinative and representational artifacts. Knowledge sharing is supported by *boundary management*. In most cooperative arrangements there are physical, social, organisational, professional or cultural boundaries. An important issue then is how to identify those boundaries to successfully manage them. Boundary management may include:
    - Standardisation of practices across boundaries
    - Visualisation – finding the appropriate form of representing problems for different purposes so that they can be easily read and understood by others
    - Fostering membership – supporting mutual engagement and building a shared repertoire of communal resources (routines, sensibilities, artifacts, vocabulary, styles etc.)

To sum up, there are differences between our validation perspectives: Economical and technical validation perspectives will say what MAPPER objectives that have been reached are and to what extent they have been reached. Socio-technical perspective can tell why MAPPER objectives have been matched or not. It can tell it since economical and technical validation results can be traced back to what actually happened on the field and during modelling sessions. So obtained information provides guidelines for MAPPER methodology and technology refinements and improvements.

2.3 Technical Perspective

The technical perspective validation is primarily handled by a MAPPER partner with strong focus on usability of software. This focus therefore permeates this section.

2.3.1 The Importance of Usability of ICT Systems

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 commercial benefits of usable systems are:

- Reduced development time and costs
- Increased sales and revenues
- Decreased training and support costs
- Increased productivity
- Reduced maintenance costs

Landauer (1995) has estimated that the cost of lost productivity due to low usability can be up to 720**%**. He estimates that productivity within the service sector would rise 4% - 9% annually if every software program was designed for usability (Landauer, 1995). It has been shown that office actors "futz"[4] with their machines an average of 5.1 hours each week, costing American businesses $100 billion annually in lost productivity. Almost one-fifth of the actors' time is spent waiting for programs to run or for help to arrive, with double-checking printouts for accuracy and format following as a close second.

The usability engineering approach to solving this problem 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-centered design returns between $2 and $100 according to Pressman (Pressman 1992).

Developing, implementing and maintaining a usability engineering approach which meets the requirements of complex ICT projects, dynamic development and user organisations has proven to be an extremely challenging and on-going task that continues to stretch the abilities of research and commercial communities. In addition to the complexity of individual ICT projects, the high rate of evolution of ICT continually draws researchers, practitioners and users into exciting but unknown and unpredictable contexts for new applications and ways of working.

[4] A recent term initiated in the United States of America for non-productive time spent at a computer or ITC system in order to fix a problem or learn a solution rather than actually directly achieving the goal task.

Usability engineering involves different activities among them:

- Role and task analysis
- Focus groups
- Interviews
- Questionnaires
- Heuristic evaluation
- Observations
- Usability testing

All these have different implications in when in the project life they are usable and in their time usage requirements.

2.3.2 Selected Approach

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 the MAPPER project two aspects of use are central to the validation of the technologies developed:

- Collaboration support
- Organisational learning support

Seen from a user-centered perspective, the validation of the support for these aspects cannot be done solely based upon the top-down concepts introduced by the MAPPER project team, but should be subject also to bottom-up input from the different users in order to incorporate measures that they think are important for such validation. For this early assessment with a small number of actors, we chose to use phone interviews, since these can 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 (CRF, Evatronix/advICo, Kongberg Automotive) 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.

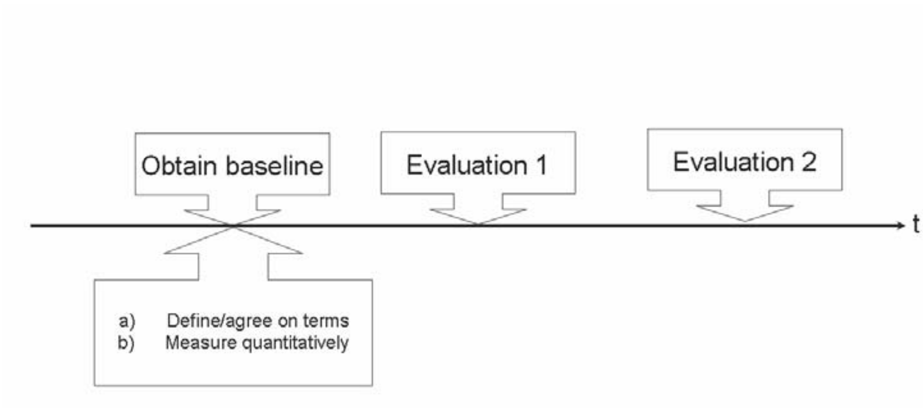


Figure 5 Approach taken for MAPPER validation.

From each use-case owner a couple of representatives were interviewed over telephone with questions about what they would consider the best ways of measuring the effects of using the MAPPER tools for organisational learning and collaboration support.

The questions were deliberately broad culminating in the important elicitation of which way they would suggest measurability of the aspects.

For the *collaboration* aspect they were:

- In which degree do you agree with the following statement? “It is important to measure the effects the MAPPER tools have on collaboration.”

- Describe a typical collaboration scenario.
- What does “collaboration” mean to you?
- In which situations are you supposed to collaborate?
- With whom do you collaborate?
- How do you collaborate with them?
- How often do you collaborate? What is the usual setting that triggers a collaboration activity?
- What does the collaboration result in?
- What characterises “good collaboration”?
- What aspect of collaboration should be measured, and how should it be measured?

For the *organisational learning* aspect they were similarly:

- In which degree do you agree with the following statement? “It is important to measure the organisational learning effects of the MAPPER tools.”
- Describe a typical learning scenario involving your work.
- What does “learning” mean to you?
- In which situations is your organisation supposed to learn by using tools?
- How do you actually learn within the organisation using tools?
- What should organisational learning result in?
- What characterises “good organisational learning”?
- How can organisational learning be measured?

We then modelled the input from the measurable parameter suggestions from these interviews into our validation framework where overlapping and similar suggestions became apparent. The most applicable of these were then used as suggestions to the technology builders to incorporate into their tools as basic monitoring systems for collaboration and organisational learning support. Those are:

- Primary measures (N)
    - N of entries in Bank of Ideas
    - N of members in Bank of Ideas
    - N of entries for different roles
    - N of TRMS task invocations
    - N of deviations
- Access rates (A)
    - Total knowledge base access rate
    - POI access rate

3 Validation Framework

This section contains the Validation Framework. First, terms and concepts that the framework is based on are described. Examples given for each validation perspective illustrate the use of these terms for validation. Second, we present the framework in detail. This section is complementary to the model prototype of the Validation Framework (HTML-Report).

3.1 Terms and Concepts

The first step in developing the validation framework is to agree on a way to express the validation framework and its content. Besides the modelling tool and the visual language used, it is important to define terms and concepts the validation framework is based on. These definitions can also be interpreted as meta-model for the validation framework consisting of constructs and relations that will be used in it. This section will provide definitions and examples for the concepts and terms used.[5]

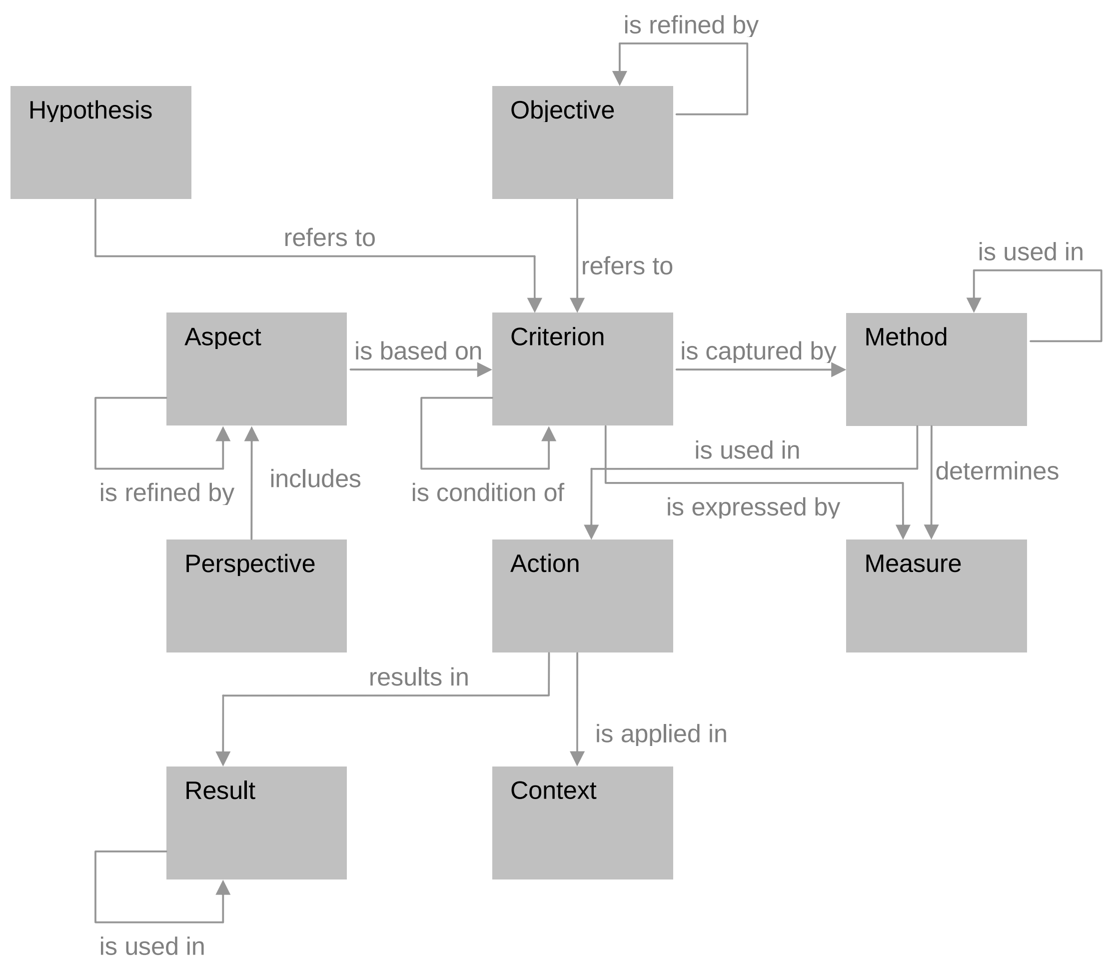


Figure 6 Validation terms and concepts.

Figure 6 gives on overview to the different concepts of the meta-model and their relationships: 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 captured by using an appropriate method, which is used in a validation action that leads to a result. An action is applied in a

[5] For more detail see the Annex A – Terms and Concepts.

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.

3.2 Examples

Terms and concepts introduced in the previous section are used in the prototype of the validation framework (HTML-Report) which is expressed in a METIS model (see the next section). In order to illustrate how terms and concepts can be applied in the context of the three validation perspectives, we will show here one example for each perspective.

Example 1: Economic Perspective for POI at KA

The first example is taken from the economic perspective and concerns the validation aspect of resource use when developing new products within a Process of Innovation (POI) at Kongsberg Automotive. The main criterion for this aspect is the average length of POI projects, which can be captured by measuring the POI length, which is expressed in working days. The objective in this context is to reduce cycle time by reducing the POI time. The validation action performed in order to perform the measuring is continuous documentation of POI projects in the context of the KA Use Case. This leads to a statistic on POI length.

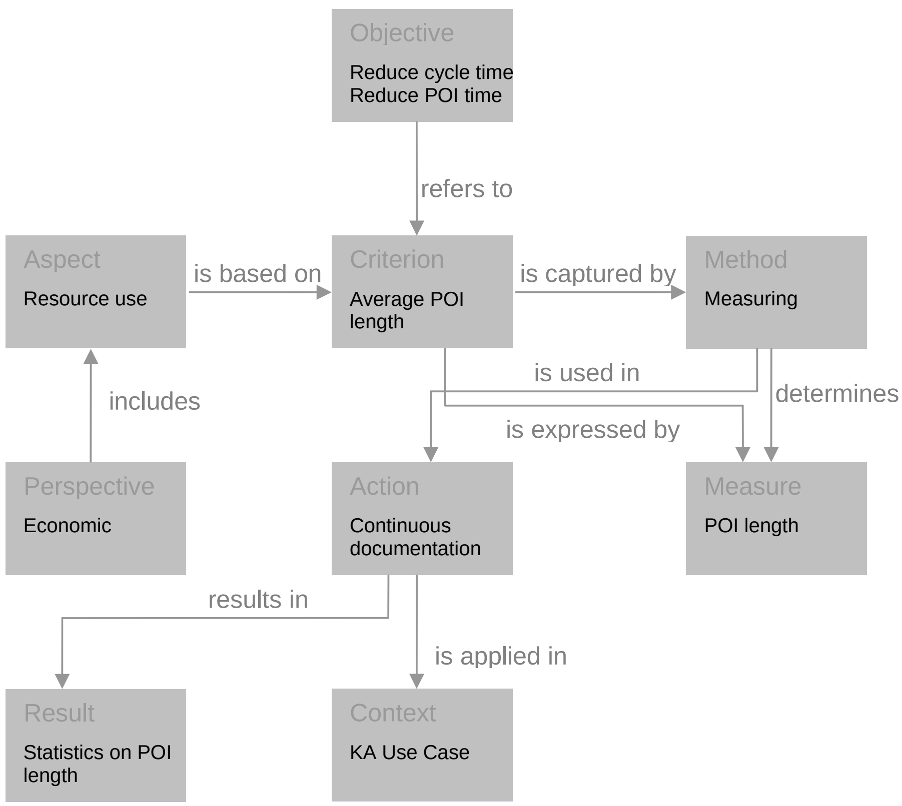


Figure 7 Example from economic perspective.

Example 2: Socio-Technical Perspective at KA

The example for the socio-technical perspective is related to collaboration support in MAPPER and covers the validation aspect of work practices with focus on ordering systems. Ordering systems help to manage interdependencies between large amount of documents or artifacts based on the combination of specialised practices and coordinative artifacts. One important criterion in this context is identification of objects, which is related to the objectives of improvement of work practices. The current practice with respect to identifying objects can be captured by a video supported observation of work. This method is applied during field studies in the KA Use Case and leads to a field study report.

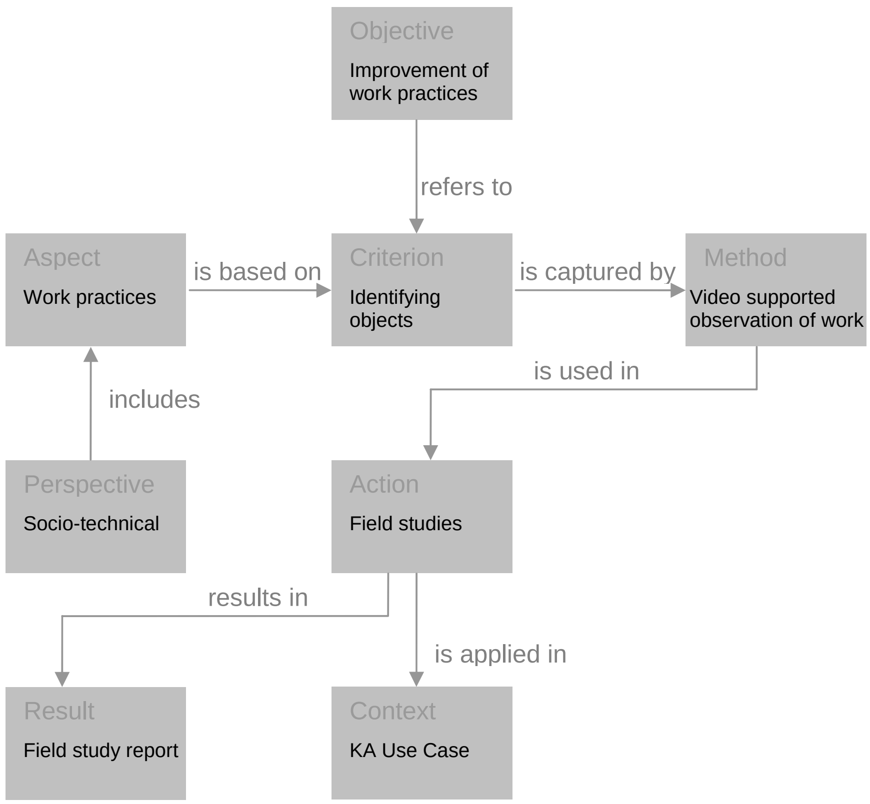


Figure 8 Example from socio-technical perspective.

Example 3: Technical Perspective at CRF

For the aspect usability we need among others the criterion efficiency of use with the objective to achieve a high efficiency. Potential methods to capture efficiency of use are interviews with users and logging the most significant actions the user is performing. These methods are used in different validation actions like interviews and a field study in the context of CRF Use Case. The actions result in different measures for the criterion, which are also related to the methods: the perceived efficiency resulting from the interview and completion time for the key actions derived from the evaluation of the logs. The measures in turn form the basis for results, which in this example are a field study report summarising the observations and statistics about the completion time for key actions.

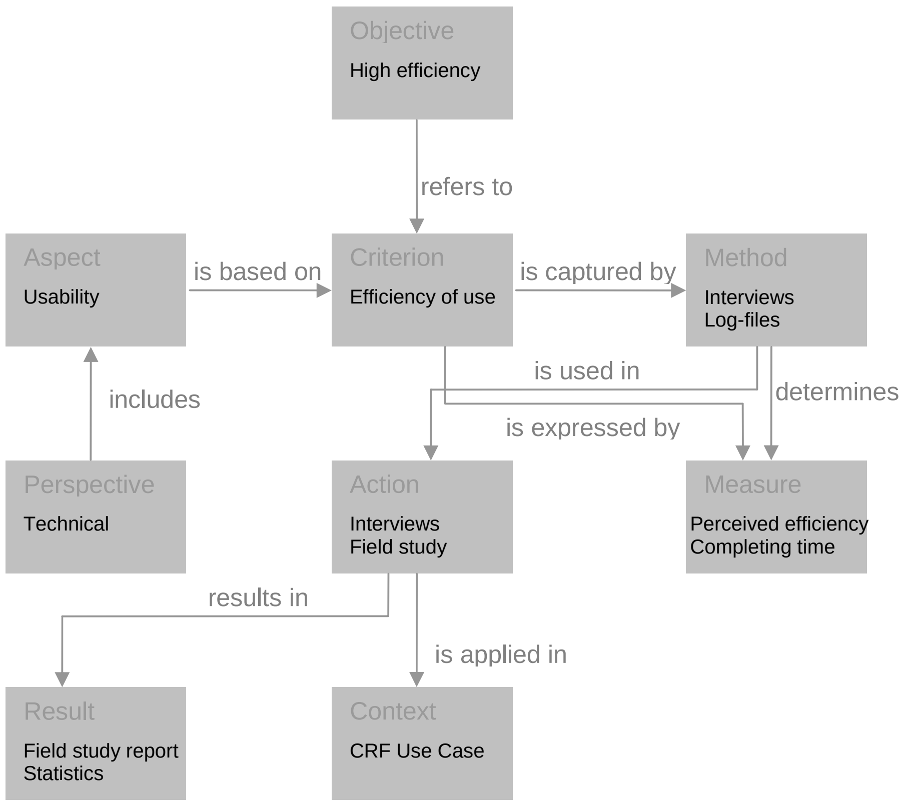


Figure 9 Example from technical perspective.

3.3 Framework

The validation framework consists of instances of the terms and concepts and their interrelationships (Figure 10).

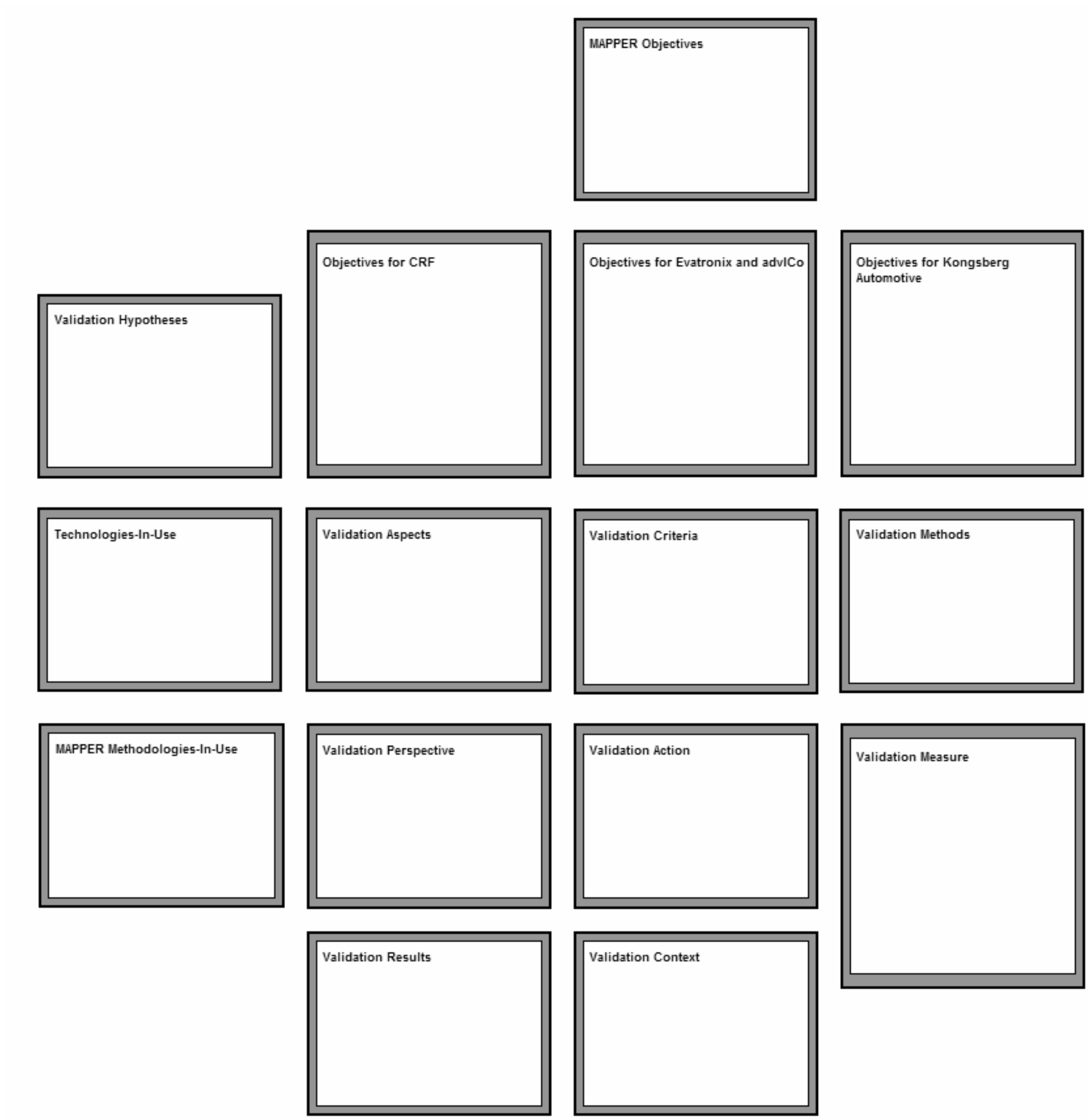


Figure 10 The Validation Framework (Version 1.0) developed in WP7.

The boxes in Figure 10 are container objects created as a Metis model which again include several constructs. These are instances of the terms and concepts we introduced in the previous sections. Some terms are more detailed here. For instance, the instances of objectives are manifold: MAPPER Objectives, Objectives for CRF, Objectives for Evatronix/advICo and Objectives for Kongsberg Automotive. We also added MAPPER Technologies-In-Use and MAPPER Methodologies-In-Use as additional containers to make a linking to other validation constructs possible.

3.3.1 MAPPER Objectives

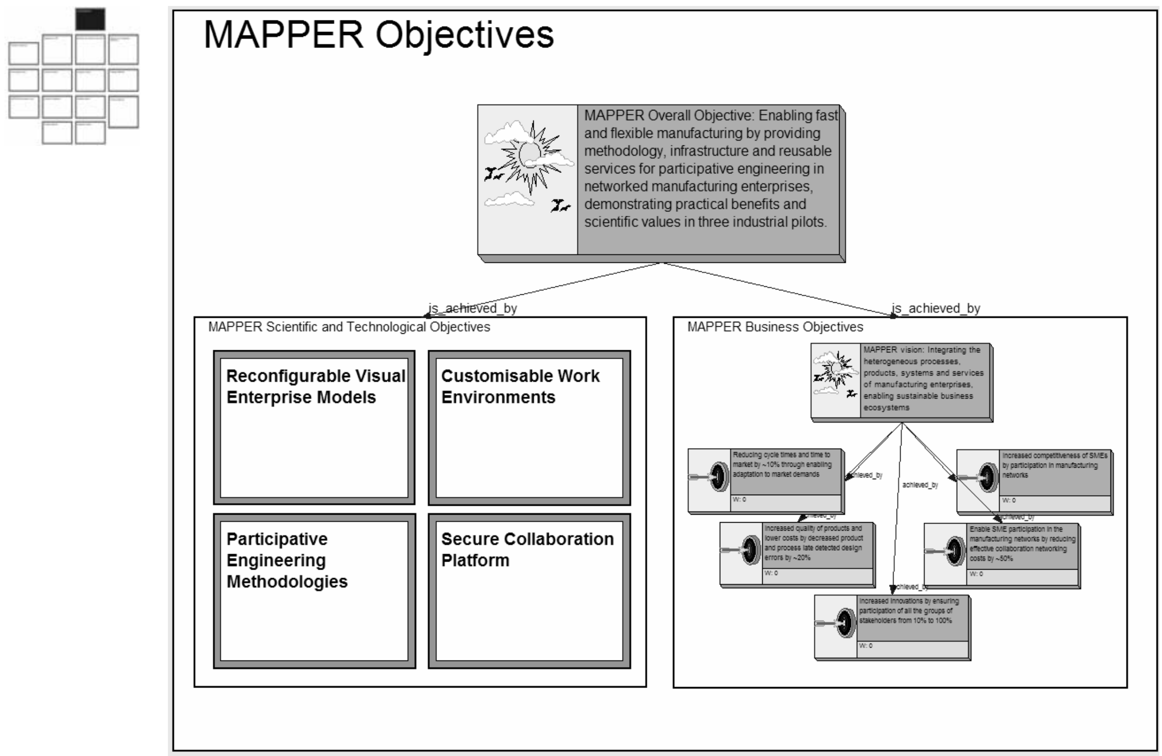
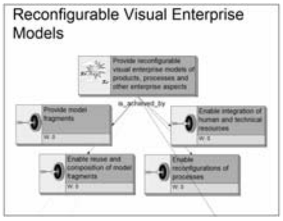


Figure 11 MAPPER Objectives as part of the Validation Framework.

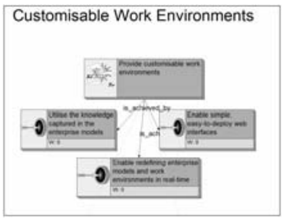
The **MAPPER overall objective** is achieved on the one hand by MAPPER scientific and technological objectives and on the other hand by MAPPER business objectives. These are mainly taken from the MAPPER Description of Work (2005, p.4f).

MAPPER business objectives have the vision of integrating the heterogeneous processes, products, systems and services of manufacturing enterprises, enabling sustainable business ecosystems. To achieve this cycle times and time to market must be reduced by ~10% through enabling adaptation to market demands, the quality of products and lower costs need to be increased by decreased product and process late detected design errors by ~20%, innovations must be increased by ensuring participation of all the groups of stakeholders from 10% to 100%, SME participation in the manufacturing networks must be enabled by reducing effective collaboration networking costs by ~50% and the competitiveness of SMEs must be increased by participation in manufacturing networks.

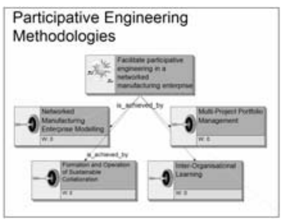
MAPPER scientific and technological objectives contain several factors:



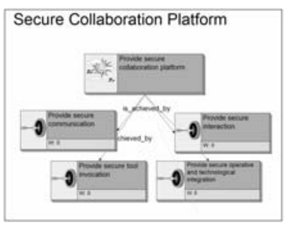
Reconfigurable visual enterprise models are models of products, processes or other enterprise aspects. They provide model fragments, enable integration of human and technical resources, reuse and composition of model fragments, and reconfigurations of processes.



Customisable work environments utilise the knowledge captured in the enterprise models, enable simple, easy-to-deploy web interfaces and redefining enterprise models and work environments in real-time.



Participative engineering in a networked manufacturing enterprise can be achieved by four different methodologies: networked manufacturing enterprise modelling, formation and operation of sustainable collaboration, inter-organisational learning, multi-project portfolio management.



Secure collaboration platform provides secure communication and interaction, secure tool invocation and secure operative and technological integration.

Figure 12 MAPPER scientific and technological objectives as part of the Validation Framework.

The MAPPER general objectives are related to the objectives of the industrial partners. In the following subsections we will present the objectives for each of the MAPPER use cases.

3.3.2 Objectives for the Use Case at CRF

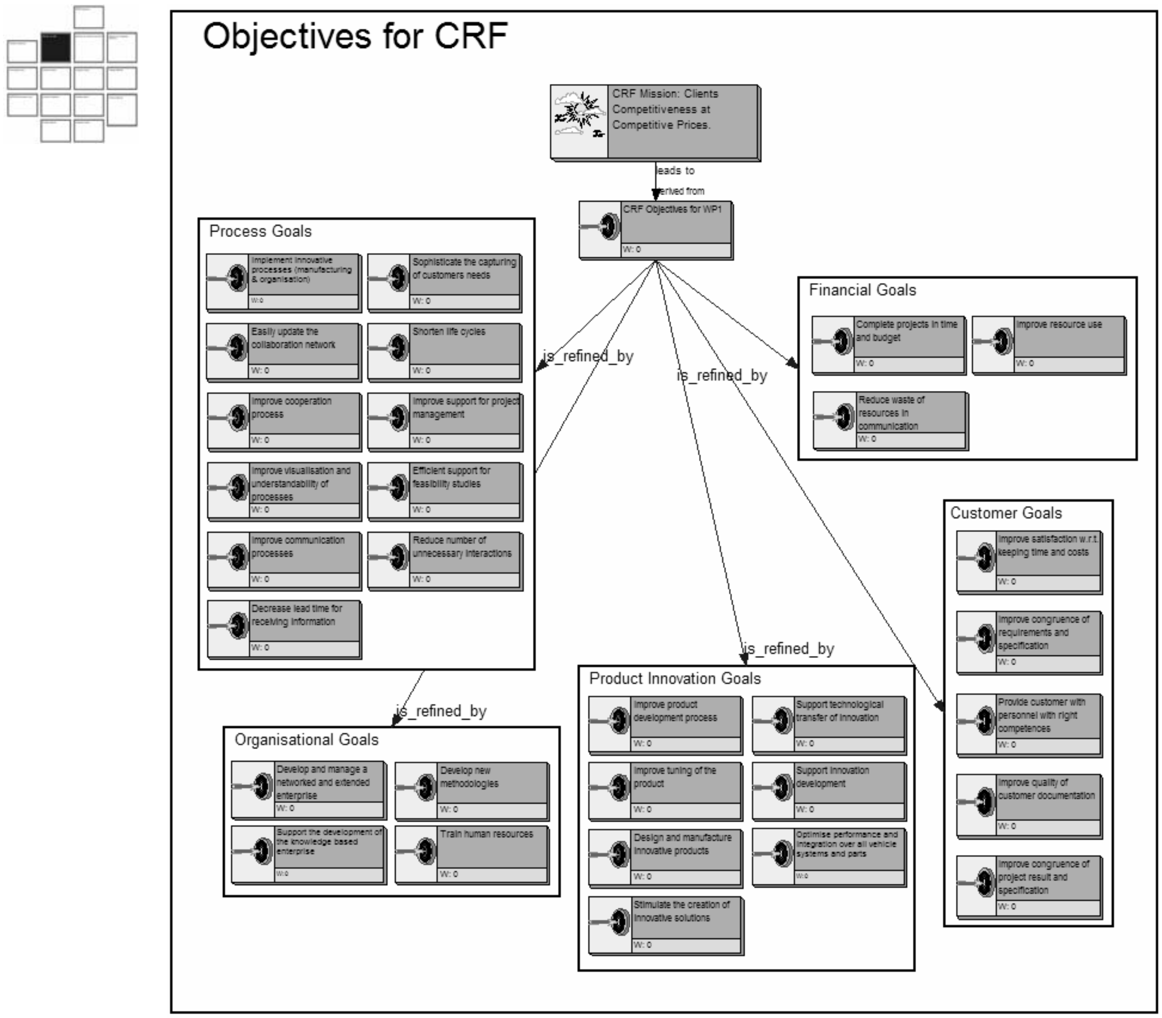


Figure 13 CRF Objectives as part of the Validation Framework.

Objectives for the use case at CRF are refined by several categories of goals:

- *Process goals* refer partly to improvement of several processes like visualisation and understandability of processes, cooperation, communication, support for project management and capturing of customers needs. They also refer to the implementation of innovative processes in manufacturing and organisation, to easily update of the collaboration network, to short life cycles and lead time for receiving information, to the reduction of unnecessary interactions and to support for feasibility studies. *Organisation goals* are concerned with organisational issues like development and management of a networked, extended and knowledge-based enterprise, development of new methodologies and training of human resources.
- *Product innovation goals* are related to improvement of and support for innovation processes like product development process, product tuning, design and manufacturing of innovative products, stimulation of the creation of innovative solutions, technological transfer of innovation, performance optimisation and systems integration over all vehicles.
- *Customer goals* are customer-related. CRF wants to satisfy their customers with respect to keeping time and costs, with services provided by skilled personnel, with better documentation and congruence of requirements, specifications and project results.
- Finally, *financial goals* contain issues about optimisation of time, budget and resource use.

3.3.3 Objectives for the Use Case at Evatronix and advICo

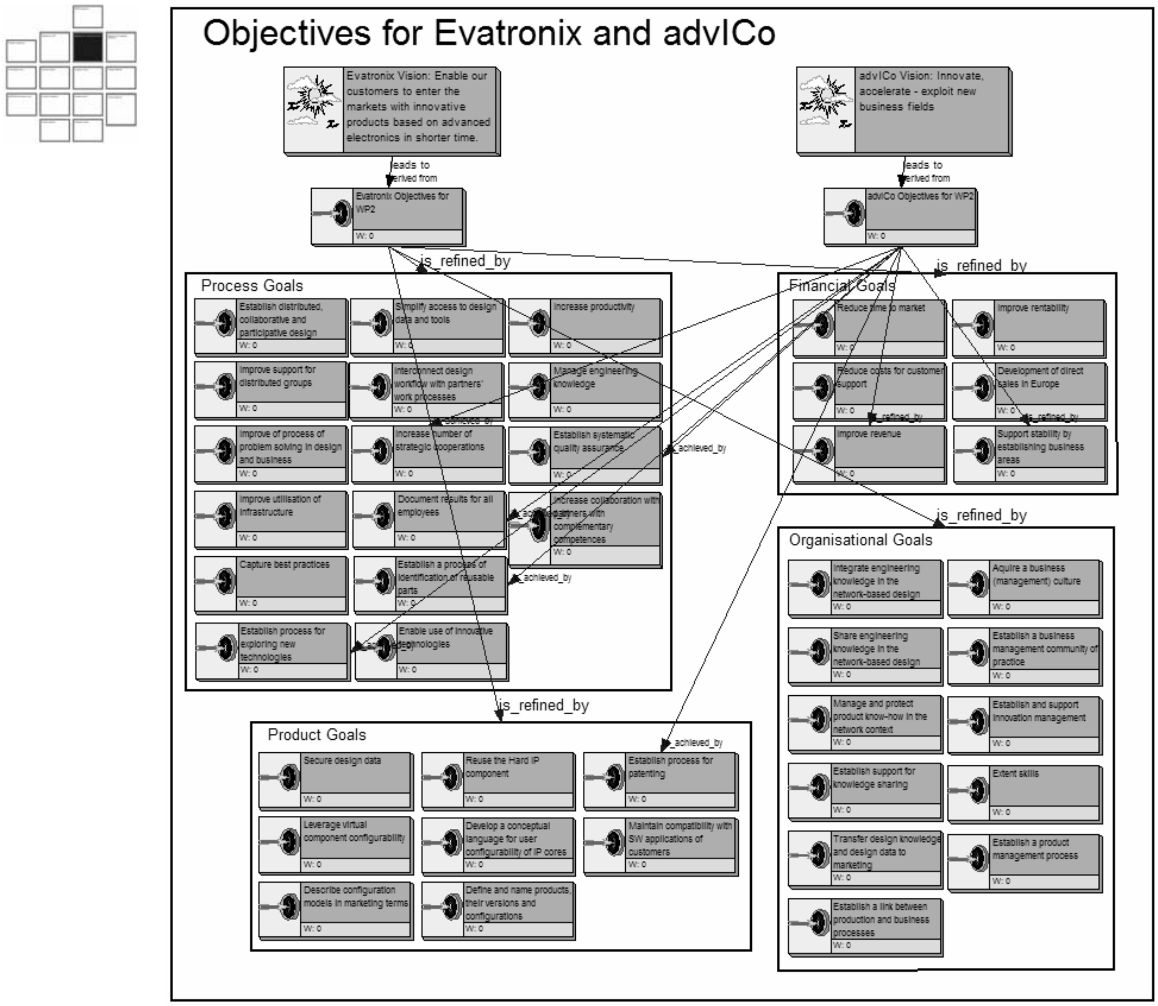


Figure 14 Evatronix and advICO Objectives as part of the Validation Framework.

Evatronix and advICo are cooperating partners and have similar objectives for their use case which are refined by process, product, organisational and financial goals.

- *Process goals* address establishing distributed, collaborative, participative design, processes for exploring new technologies and for identification of reusable parts as well as systematic quality assurance. Furthermore, the improvement of support for distributed groups, problem solving in design and business, utilisation of infrastructure, use of innovative technologies, capturing best practices, increasing productivity, management of engineering knowledge e.g. by documenting results for all employees. Cooperation with partners is very important for both companies. Through simplifying access to design data and tools and interconnecting design workflow with partner's work processes they want to increase the number of strategic cooperations and collaborations with partners with complementary competences.
- Configurability is very important with respect to their *products*, especially leveraging virtual component configurability and describing configuration models in marketing terms are very complex processes and are not established yet. They want to develop a conceptual language for user configurability of IP cores and name their products, their versions and configurations properly. Design data must be secured and the hard IP components must be reused. One of the further product goals is to establish processes for patenting.
- One of the most important *organisational goals* of Evatronix is establishment of a business culture and a business management community of practice. Integrate and share engineering knowledge in the network-based design are related to knowledge sharing. Not only there is a

need for support but also in transferring design knowledge and data to the marketing. The precondition for this is the existence of a link between production and business processes. The protection and management of shared knowledge are crucial and needs clearly defined and established management of products in development.
- In addition, there are some *financial goals* set: Reduce time to market, reduce costs for customer support, improve revenue and rentability, development of direct sales in Europe.

3.3.4 Objectives for the Use Case at Kongsberg Automotive

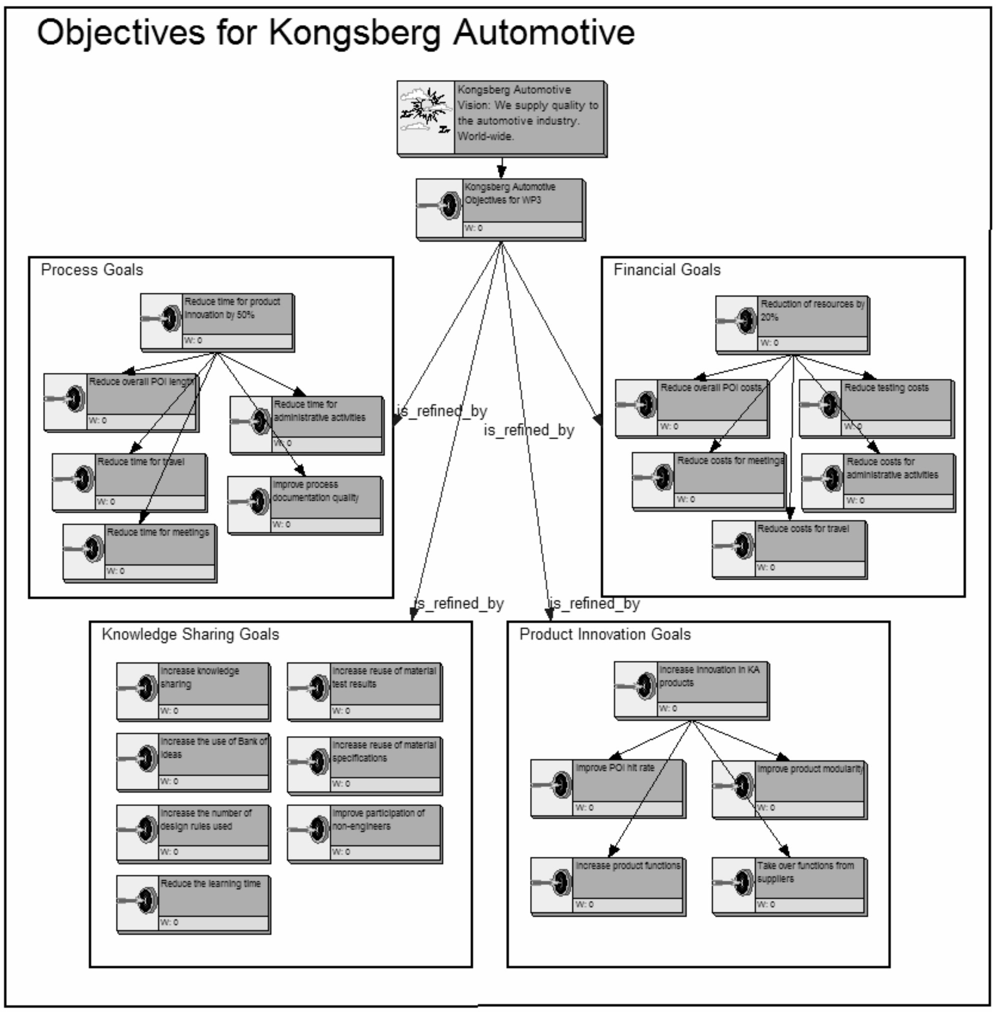


Figure 15 Kongsberg Automotive Objectives as part of the Validation Framework.

Objectives for the use case at Kongsberg Automotive are grouped as process, knowledge sharing, product innovation and financial goals.

- The main *process goal* is to reduce time for product innovation by 50%. This includes reducing overall Process of Innovation (POI) length, time for travel and meetings, time for administrative activities and improving the quality of the process documentation.
- Improved sharing of knowledge shall contribute significantly to reduction of lead time and resources needed. Bank of Ideas shall be created and the use of this repository shall increase. One focus in this context is on encouraging all stakeholders. Furthermore, *knowledge sharing goals* focus on the reuse of material specifications and test results. It is a necessity to increase the number of design rules used. Unfortunately the participation of non-engineers is not satisfactory and needs to be improved. Additionally, the time that is needed for new team members to understand the way of working, product and organisation structure must be reduced which again would contribute to POI. *Product innovation gaols* focus on increasing

innovation in KA products by improving the POI hit rate[6], by increasing product modularity and functions and by taking over functions from suppliers.

- Finally, *financial goals* are mainly concerned with the reduction of resources by 20%. To achieve this, overall POI costs, testing costs, costs for travelling and meetings and costs for administrative activities must be reduced.

3.3.5 Relation between MAPPER Objectives and Objectives of Use Cases

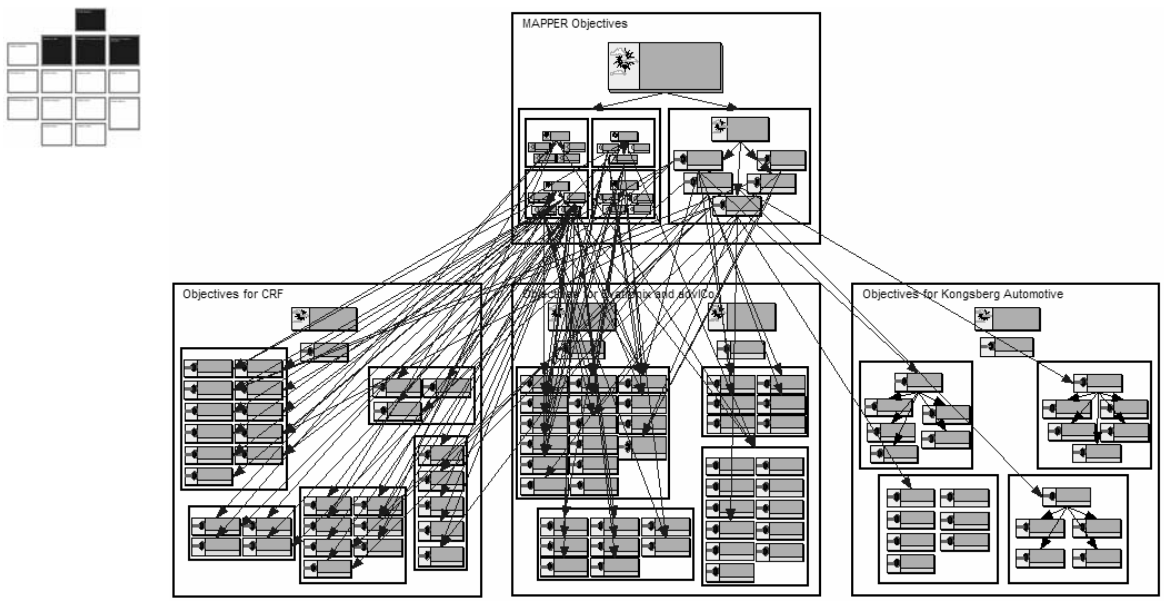


Figure 16 Relations between MAPPER objectives and use case objectives.

The MAPPER overall objectives and the objectives of the use cases are related to each other. We don't want to validate improvements or changes in CRF, Evatronix/advICo and Kongsberg Automotive that are not addressed either by MAPPER or by our users themselves. The following model fragment shows the density of these relations.

[6] The POI hit rate is defined by the percentage of development from POI resulting in actual products.

3.3.6 Validation Criteria

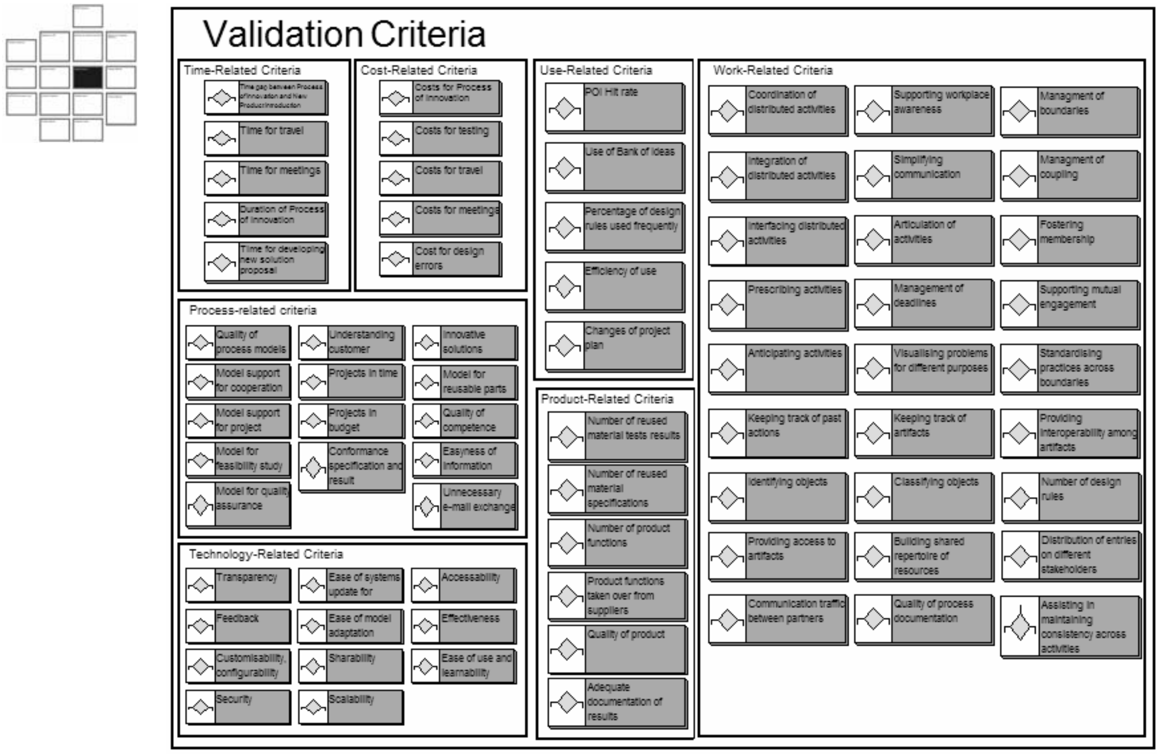


Figure 17 Validation Criteria as part of the Validation Framework.

The core of our validation processes is the **validation criteria**. The criteria are structured content dependent.

- *Time-related criteria* is concerned with time-related issues like time gap between POI and New Product Introduction, time for travel and meetings, duration of POI and time for developing new solution proposal.
- Costs are the content of *cost-related criteria*: costs for POI, for design errors, for testing, travelling and meetings. Our hypothesis is the reduction of resource consumption in all these areas.
- With *use-related criteria* we want to validate the POI hit rate and the use of the Bank of Ideas, the percentage of design rules used frequently, the efficiency of use and changes of project plans.
- *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 by providing support for workplace awareness, articulation of work and maintenance of consistency across activities. Keeping track of past actions as well as achieving and maintaining a high quality of process documentation are important for knowledge management in the enterprise. There is a set of artifact-related criteria: Identifying and classifying objects, providing access to and keeping track of artifacts by building a shared repertoire of resources, providing interoperability among artifacts. Management of boundaries and coupling, fostering membership and supporting mutual engagement are related to the concept of boundaries which can be supported by standardising work practices across boundaries. Furthermore, management of deadlines and visualisation of problems for different purposes belong to the work-related criteria.
- Additionally, we identified *process-related criteria*: quality of process models, model support for cooperation and project management, model for feasibility study, quality assurance and reusable parts, understanding customer requirements, projects in time and budget, conformance specification and result, innovative solutions, quality of competence information,

easiness of information supply, unnecessary e-mail exchange.

- We separated *product-related criteria* to focus on product functions and qualities. These vary from number of reused material specifications and test results, to product functions taken over from suppliers and adequate documentation of results.
- Finally, we have *technology-related criteria* dealing with transparency, feedback, customisability, configurability, security, easiness of systems update for partner integration, easiness of model adaptation, sharability and accessability, scalability, effectiveness, ease of use and learnability.

3.3.7 Validation Aspects

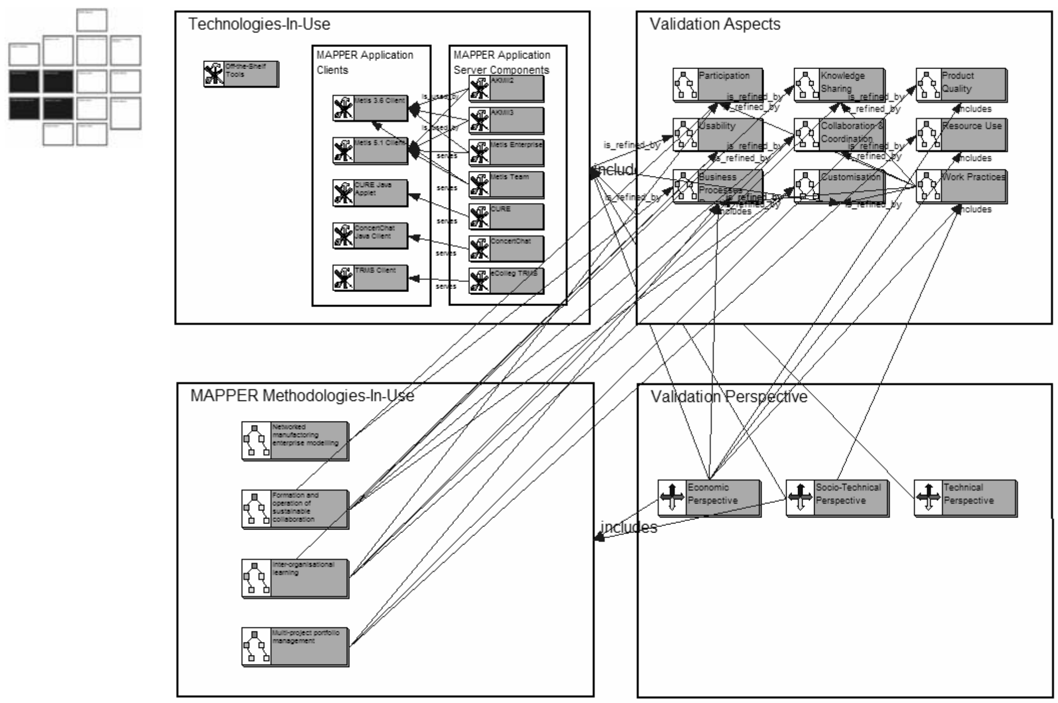


Figure 18 Validation Aspects as part of the Validation Framework.

Validation aspects are related to validation criteria, perspectives, technologies- and methodologies-in-use. Work practices are refined by participation, knowledge sharing, collaboration, coordination, business process duration and customisation aspects, and are included in economic and socio-technical perspectives. Technologies-in-use including off-the-shelf tools, MAPPER application clients and server components are refined by the aspect usability which is based on use-related criteria.

3.3.8 Validation Methods

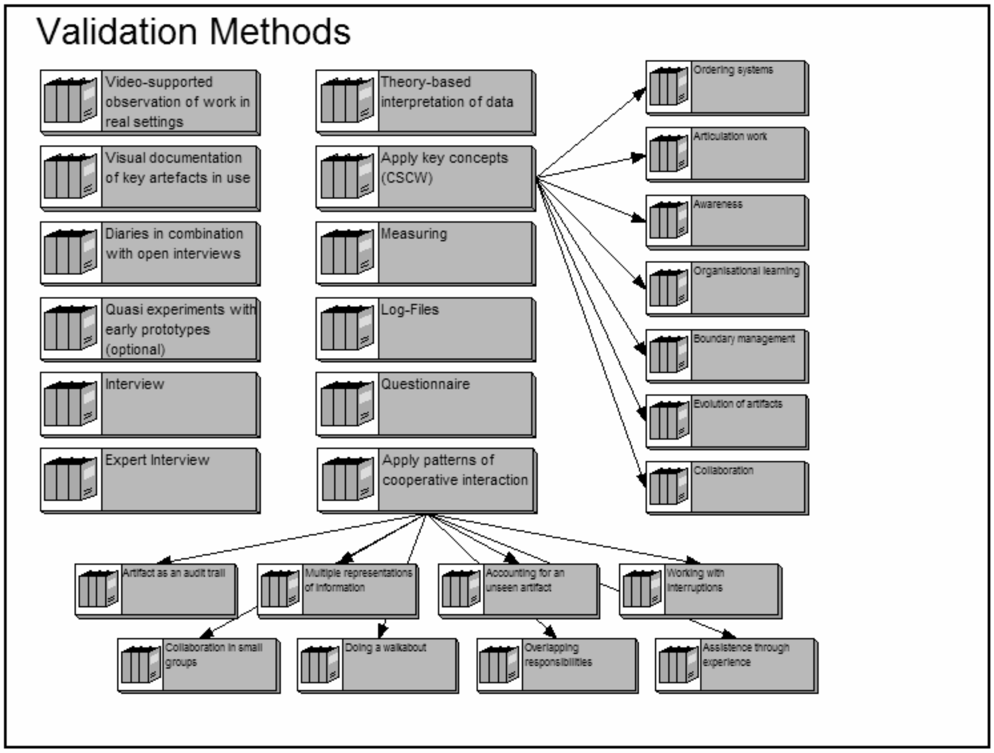


Figure 19 Validation Methods as part of the Validation Framework.

Our **validation methods** are of different types: Some of them are used for field studies like video-supported observation of work in real settings, visual documentation of key artifacts in use, diaries in combination with open interviews, quasi experiments with early prototypes (optional), (expert) interviews. Some are needed for gathering quantitative data like measuring, log-files, interviews and questionnaires. To analyse our findings we will interpret our data theory and concept-based by using concepts like ordering systems, articulation work, awareness, organisational learning, boundary management, evolution of artifacts, collaboration as well as by applying patterns of cooperative interaction.

3.3.9 Validation Measures

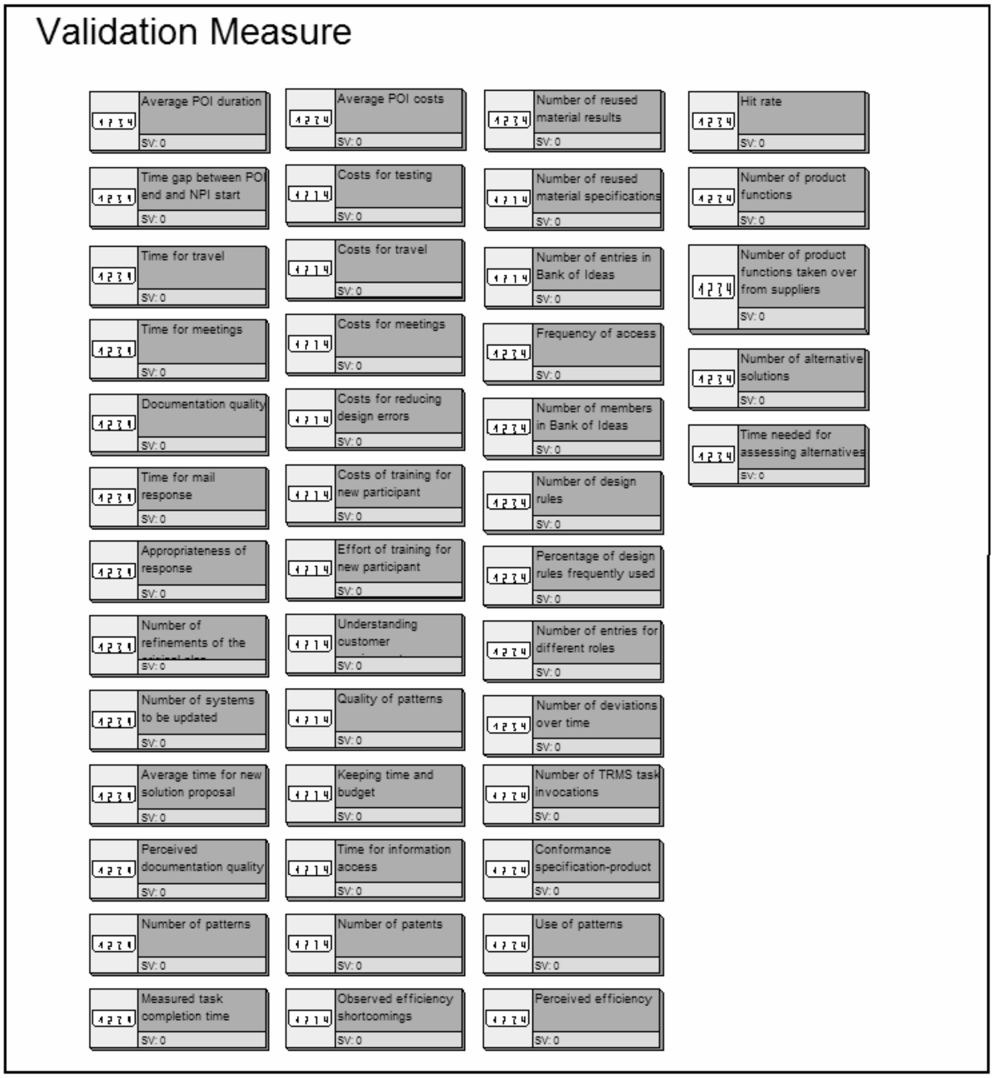


Figure 20 Validation Measures as part of the Validation Framework.

We use several indicators for measuring. Our **validation measures** are used by some methods like measuring or log-files. They are needed to express some criteria mainly connected to the economic perspective. The following model fragment shows the measures we consider in MAPPER.

3.3.10 Validation Actions

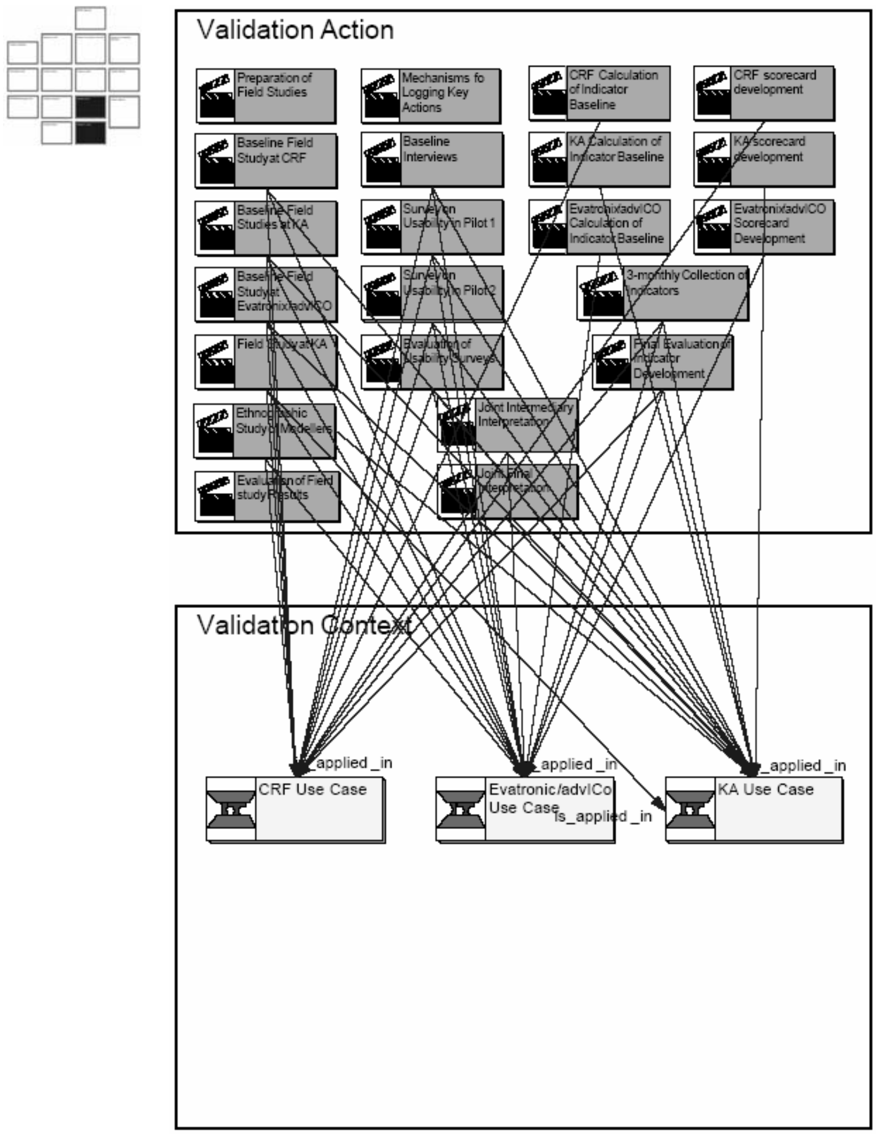


Figure 21 Validation Actions and Validation Contexts.

Our **validation actions** are imbedded in the validation context of MAPPER. There are baseline validation actions that aim at capturing the state of validation criteria before the MAPPER technology and methodology are implemented. The baseline is an important reference point for evaluating the effects of MAPPER. It is followed by intermediary validation actions which aim at capturing the state of criteria during the use case execution in order to be able to give feedback to WP4, 5 and 6. Typical points in time for these actions are several weeks after installation of new pilot versions. After final validation actions with the aim at capturing the state of criteria close to completion of the project, there are interpretation actions to integrate the results of intermediary or final validation from the single perspectives and interprets them jointly. Interpretation actions complement the interpretations in the single perspectives, which are performed after validation actions.

There are three strands of activities in validation actions:

- One strand is running *field studies*. We studied our users before they introduced MAPPER technologies and methodologies (Baseline Field Studies). We also studied modellers working together with our users to model their enterprise or their requirements (Ethnographic Study of Modellers). We will continue with our investigations after the Pilot 1 (Pilot 1 Field Studies) and after introducing and using MAPPER methodologies and technologies (Field Studies on Methodologies-In-Use, Field Studies on Technologies-in-Use).
- The second strand is the *investigation of usability* of MAPPER technologies. There are several stages of usability studies during the whole project (Baseline, Pilot 1, Pilot 2 and Pilot 3 Usability Investigations).
- The last strand is based on *Balanced Scorecard* development. After having finished the baseline scorecard workshops (CRF, KA and Evatronix/advIco Scorecard Baseline) we continue with further development of scorecards in all use case partners (CRF, KA and Evatronix/advICo Scorecard Development). There will be intermediary scorecard measuring on a three-monthly base (3-monthly Intermediary Scorecard Measuring) before the final evaluation (Final Scorecard Evaluation).

3.3.11 Validation Results

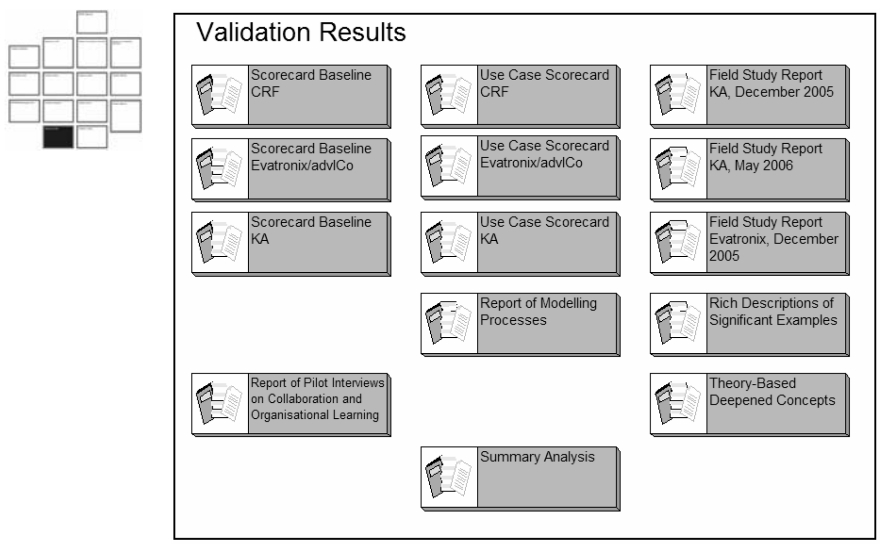


Figure 22 Validation Results as part of the Validation Framework.

Our validation actions result in several reports: Scorecard investigations and development, field studies, pilot interviews on collaboration and organisational learning will be reported separately. Based on our methods we will provide additional rich descriptions of significant examples of work practices what we will analyse and discuss by applying theory-based deepened concepts. Finally, we will summarise all findings, analysis and results in a final validation report.

3.3.12 Relationships in the Validation Framework

The following figure of the full validation framework shows a birds-eye view of the complex relationships from the MAPPER Objectives on the top through the densely linked Validation Criteria in the middle and down to the Validation Results at the bottom. We include it here not for detailed inspection which of course would require using the interactive zooming features, but rather for giving an intuitive view of the overall model coherence. The model represents the objectives and mechanisms for validating the MAPPER approach for the three industrial sites, and does in our experience constitute a fertile basis for inter-project and extra-project discussions and explanations of our work.

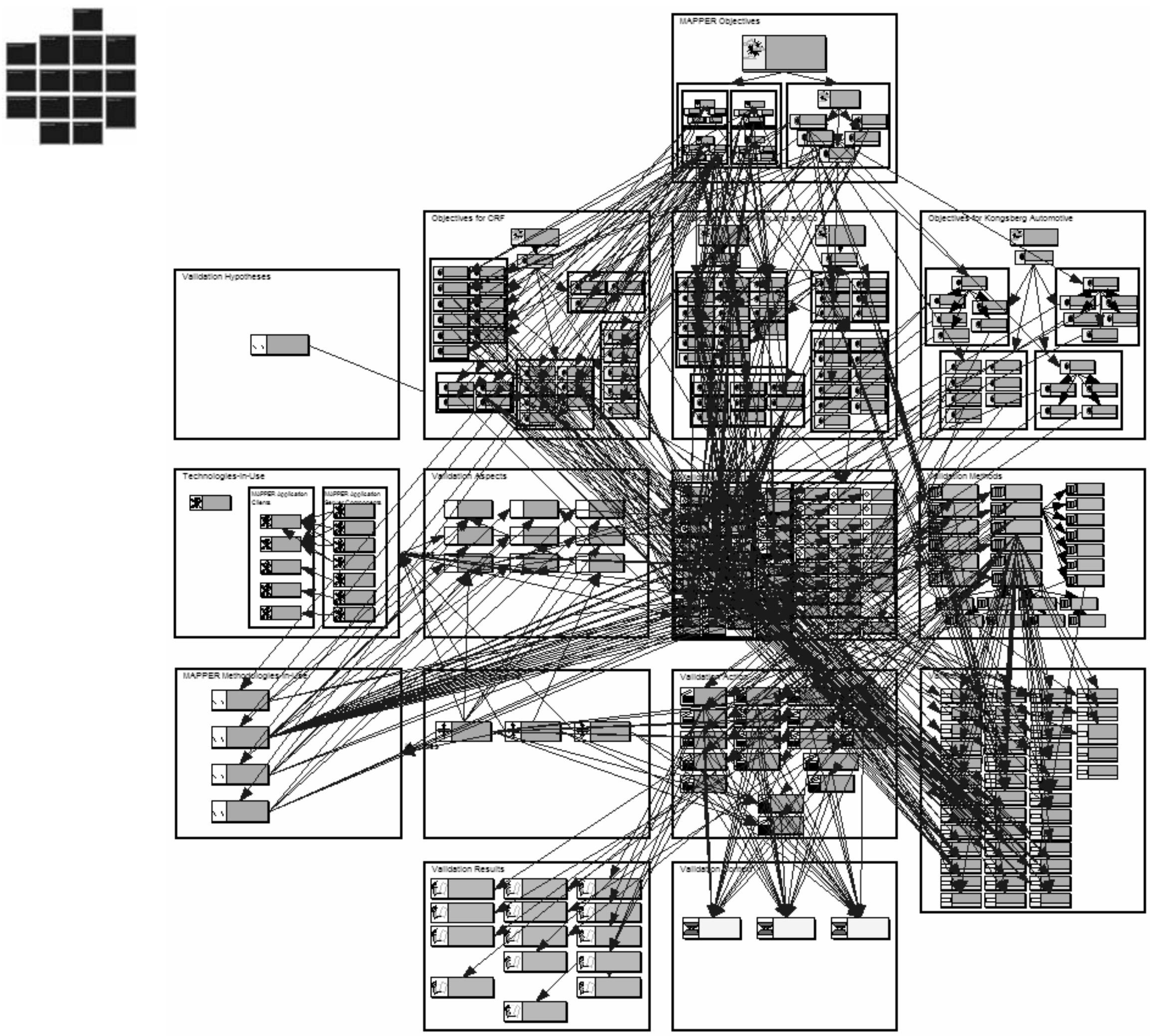


Figure 23 A birds-eye view of the total MAPPER Validation Framework.

3.4 Use of the Framework

In this section we will briefly describe how we plan to use our validation framework in MAPPER. There are two phases we identified so far: the development phase and the operation phase. With this deliverable (which includes the validation prototype) we have almost passed the development phase which is followed by the operation phase.

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 validation perspectives. We discussed several issues connected to the quality of validation. We had to identify areas that can 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 WP7 by using the framework itself as a common artifact. Additionally, we had regular telephone conferences to discuss the open issues and make a decision regarding methodologies to use for validation. The result is our validation framework containing differing approaches including methods, concepts, criteria, aspects etc. to validation in MAPPER.

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 described in the MAPPER Description of Work (2005). Then, we gathered the objectives of 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 is effortable in this project.

Just from the beginning of this Work Package, we decided to create a METIS model of our validation framework. The idea was to 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 WP members who accessed the model and participated in telephone conferences to discuss the differences and commonalities of the three perspectives.

The framework as a model has some additional functions in MAPPER: So far we have used the framework as a common artifact of the validation team to coordinate our different activities. This is something that we want to continue with during the whole project. We used the model as a visualisation tool to communicate our validation approach with different stakeholders. Furthermore, we want to use the model to coordinate the documentation of all validation activities.

Operation Phase

The operation phase starts in June 2006 with the first pilot in Kongsberg Automotive. We will use the validation framework to document our investigations, to analyse our findings and as a support for organising and structuring validation results and documents.

4 Validation Actions

The main purpose of this Section is to describe how the different validation perspectives are interlinked within the overall validation process in MAPPER. Section 4.1 will list the validation actions performed and planned, Section 4.2 the planned process for interpretation of results and 4.3 the connection to dissemination activities in WP8.

4.1 Actions

In addition to the different strands of validation activities included in the validation framework (see section 3.3), we also can differentiate between different types of activities. The validation activities performed in work package 7 can be divided into 5 basic types of actions:

- *Implementation* of the validation approach in the use cases includes all preparation steps for subsequent validation actions. Examples are the development of balanced scorecards, preparation of field studies or implementation of logging mechanisms in the MAPPER infrastructure
- *Baseline validation* aims at capturing the state of validation criteria before the MAPPER infrastructure, methodology or other results of MAPPER are implemented. The baseline is an important reference point for evaluating the effects of MAPPER
- *Intermediary validation* actions aim at capturing the state of criteria during the use case execution in order to be able to give feedback to the MAPPER engineering team and the methodology development. Typical points in time for these actions are several weeks after installation of new pilot versions
- *Final validation* actions are aiming at capturing the state of criteria close to completion of the project
- *Interpretation* actions integrate the results of (intermediary or final) validation from the single perspectives and interprets them jointly. Interpretation actions complement the interpretations in the single perspectives, which are performed after validation actions.

The intention of introducing these different types is to better illustrate the time line of the MAPPER validation approach: implementation and baseline actions in each perspective are followed by intermediary and final validation actions. Interpretation actions are required after every (intermediary or final) validation action.

The following table summarises the already performed and planned validation actions. The actions are also contained in the validation framework (see Section 3.3).

Type of Action	Validation Perspective	Action	Date (*performed* or planned)
Implementation	Economic	Use case scorecard development for KA (WP3)	*February 2006 (V1)* *March 2006 (V2)*
		Use case scorecard development for Evatronix and advICO (WP2)	*March 2006*
		Use case scorecard development for CRF (WP1)	*May 2006*
	Socio-technical	Preparation of field studies	*October 2005*
	Technical	Mechanisms for logging of key actions in the MAPPER infrastructure	June 2006
Baseline	Economic	Calculation of indicator values based on historical data at KA (WP3)	*May 2006*
		Calculation of indicator values based on historical data for WP2	June 2006
		Calculation of indicator values based on	August 2006

		historical data at CRF (WP3)	
	Socio-Technical	Field studies at KA	*November 2005 (1st)* *January 2006 (2nd)*
		Field study at Evatronix	*November 2005*
		Field study at CRF	*January 2006*
	Technical	Baseline interviews with 2 representatives of each use case and one representative of each technology provider about collaboration and learning	*March to May 2006*
Intermediary validation	Economic	3-monthly collection of the use case scorecard indicators and interpretation on MAPPER scorecard level	From September 2006
	Socio-Technical	Pilot 1 field study at KA (WP3)	November 2006
		Ethnographic study of modellers	February 2006
	Technical	Survey on usability after pilot 1 installation	October 2006
		Survey on usability after pilot 2 installation	March 2007
Final Validation	Economic	Evaluation of indicator development on use case and MAPPER scorecard level	November 2007
	Socio-Technical	Evaluation of field study results	November 2007
	Technical	Evaluation of results from usability surveys	November 2007
Interpretation	All	Joint intermediary interpretation of results from all validation perspectives	January 2007
		Joint final interpretation of results from all validation perspectives	November 2007

Table 24 Validation actions.

4.2 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 is necessary in order to get the complete picture with respect to validation. In this context, we intend 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 are supported by the validation framework as all relations between objectives, aspects, criteria and measures necessary are included.

The *objective-based strategy* starts from the economic and scientific/technical objectives of MAPPER and the related objectives in the use cases. For each MAPPER objective, the related validation aspects are identified and validation results with regards to these aspects are in a first step summarised separately for each perspective. In a second step, the results from different perspectives for each aspect are compared, related to each other and interpreted.

Examples of selected aspects to investigate in this context include:

- 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 correspondencies 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 concerning

the related methodology)?

- 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 will at least help to verify consistency between the perspectives or to discover contradictions. We of course expect new findings and insights on inter-perspective relationships.

The *criteria-based strategy* uses as main instrument that several criteria are related to more than one perspective and that there are criteria captured by different measures. These criteria will be identified quite easily in the validation framework. 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) will again help to identify contradictions, verify consistency and discover interesting questions for future investigation.

4.3 Connection to WP8 Dissemination

The primary and quite obvious connection between dissemination and validation is that most dissemination events (workshops, fairs, congresses) and actions (mailings, newsletters, web-site) can be used to collect feedback from the target groups, which can be used in validation. Within MAPPER, our strategy is to use dissemination events for validation in regional, national and on European level. This is reflected in the joint event plan of WP7 Validation and WP8 Dissemination (see Annex D).

The validation aspects represented in Section 4.1 and most parts of the validation framework aim at validation in the use cases and on basis of the use case experiences and achievements. In a use case driven project, this validation area has to have the highest priority. The achieved results will even be important for the extension of the validation from the use case level to regional, national or European level, as they can contribute to projections on this larger scale.

Validation on regional, national and European level will primarily be based on expert interviews and feedback from events with industrial participation. We consider the MAPPER Industrial User Group (MIUG) as important source for feedback, recommendations, criticism and future potential of the model adapted approach for participatory engineering including the technologies, methodologies and developed services. The MIUG will be established and managed by the work package addressing exploitation and dissemination (WP8). However, MIUG meetings on national and European level will be intensively supported by the validation work package in terms of contents to be presented, questionnaires or interview guides for collecting feedback and active participation in collecting validation information from the participants.

Other sources for valuable input are fairs or conferences with industrial participation. MAPPER related presentations and tool demonstrations can be used to initiate discussions or start a dialogue about the MAPPER approach. An example is the 4. International Workshop on Challenges in Collaborative Engineering (CCE 06, Prague, Czech Republic, April 2006). During this workshop, a panel discussion with industrial participants about industrial practices in collaborative engineering was arranged and a special MAPPER session with tool demonstration was offered.

First expert interviews are planned for early 2008 and will include in this first stage renowned industry experts from the use case partners’ home countries. In these interviews, dissemination of results will be the side effect as the experts of course will receive detailed information about the MAPPER approach and first results.

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Annex A – Terms and Concepts

Validation Objective

Definition

An objective is the expression of the desired future development of a criterion. A validation objective may be divided into more detailed objectives.

Examples

Reduce time to market by 20%, improve learnability, improve cooperative thinking and remembering.

Relations

- Objective "refers to" criterion, e.g. product goals refer to product-related criteria.
- Objective "is refined by" objective, e.g. enable SME participation in the manufacturing networks by reducing effective collaboration networking costs by ~50% is refined by easily update the collaboration network.

Validation Criterion

Definition

A validation criterion is a standard upon which a decision or judgment can be based. Standard means there is a defined and accepted way to express the state of the criterion (one or more measures) and to record the state of the criterion (one or more methods).

Examples

Cost for design errors, ease of use and learnability, management of boundaries.

Relations

- Criterion "is condition of" criterion, e.g. ease of systems update for partner integration is condition of building shared repertoire of resources.
- Criterion "is captured by" method, e.g. technology-related criteria is captured by video-supported observation of work in real settings.
- Criterion "is expressed by" measure, e.g. the criterion 'project is in budget' is expressed by keeping time and budget.

Validation Aspect

Definition

A validation aspect is what we want to investigate during validation. A validation aspect may be divided into more detailed aspects. One or more criteria may contribute to investigate an aspect.

Examples

Collaboration, usability, work practices.

Relations

- Aspect "is refined by" aspect, e.g. collaboration is refined by usability of collaboration services.
- Aspect "is based on" criterion, e.g. resource use is based on cost-related criteria, on POI hit rate and on product-related criteria.

Validation Hypothesis

Definition

A hypothesis is a provisional idea with respect to the future development of a criterion whose merit needs evaluation.

Examples

Resource consumption in POI will be reduced by using the MAPPER infrastructure.

Relations:

- Hypothesis "refers to" criterion, e.g. the hypothesis 'resource consumption will be reduced' refers to cost-related criteria.

Validation Perspective

Definition

Validation perspective is a collection of validation aspects, which are relevant for a specific viewpoint.

Examples

Socio-technical perspective, economic perspective, technical perspective.

Relations

- Perspective “includes” aspect, e.g. the economic perspective includes the business process duration.

Validation Method

Definition

Method is the defined and accepted process of determining the state of a criterion including the necessary instruments and the way of expressing the results.

Examples

Measuring, diaries in combination with open interviews, interviews.

Relations

- Method “is used in” action, e.g. diaries in combination with open interviews are used in the baseline usability investigation.
- Method “determines” measure, e.g. measuring determines the number of reused material results.
- Method “is used in” method, e.g. interviews are used in video-supported observations of work in real settings.

Validation Action

Definition

A validation action is the specialisation of a method and the use of this specialisation in a context.

Example

Field studies on methodologies-in-use, 3-monthly intermediary scorecard measuring.

Relations

- Action “is applied in” context, e.g. KA scorecard development is applied in KA use case.
- Action “results in” result, e.g. ethnographic study of modellers results in report of modelling processes.

Validation Measure

Definition

A measure is a means to express the state of a criterion as determined in an action by applying a method.

Examples

Hit rate, number of systems to be updated, number of patents.

Validation Result

Definition

A result is a document or model containing the results of validation actions.

Examples

Field study report, Use Case Scorecard CRF.

Relations

- Result “is used in” result, e.g. rich descriptions of significant examples are used in the summary analysis.

Validation Context

Definition

The context defines the setting for an action, i.e. which actor at what time uses which instruments, e.g. services of the MAPPER infrastructure, to perform which task.

Annex B – Interview Guide

Interview guide for use case owners about collaboration and learning

These are the questions which were asked in the 45 minute long phone interview with the use case owners (Kongsberg, Evatronix et.al.).

1. *Interview no*: _______

2. *Interviewer*: ____

3. *Date*: ____

Introduction: *In the next 45 minutes we will ask you some questions about what you will consider the best ways of measuring the effects of using the MAPPER tools for organisational learning and collaboration support. These two areas are of major interest in the MAPPER consortium. This interview is conducted to ensure that we measure those aspects in a way that you believe to be significant.*

Based on your and other MAPPER participants input, we will be able to construct a better qualitative measure of the effects of using MAPPER.

4. Is it OK by you that we quote your views to the other participants in the project in order to get a better overall picture of what is important?

YES / NO

About you

5. *Name*:____

6. *Position*: ____

7. *Company*: ____

8. *Your work experience*: ____________________________

9. *Your role in use case elicitation:* ____

Collaboration

We will start by asking you some broad questions about collaboration.

10. In which degree do you agree with the following statement?: "It is important to measure the effects the MAPPER tools have on collaboration?"

o	o	o	o	o
Strongly agree	*Agree*	*Don't know*	*Disagree*	*Strongly disagree*

- *a) In case you agree or disagree then please explain why:*

- 11. *Describe a typical collaboration scenario.*
- 12. *What does "collaboration" mean to you?*
- 13. *In which situations are you supposed to collaborate?*
- 14. *With whom do you collaborate?*
- 15. *How do you collaborate with them?*
- 16. *How often do you collaborate? What is the usual setting that triggers a collaboration activity?*
- 17. *What does the collaboration result in?* (Describe the artefact that is the result of a cooperative work.)

- 18. *What characterises "good collaboration"?*
- 19. *What aspect of collaboration should be measured, and how should it be measured?*

Attribute	*Measured by*	*When*

Organisational Learning

By 'organisational learning' we mean how the organisation adapts to changing conditions.

20. In which degree do you agree with the following statement?:

It is important to measure the organisational learning effects of the MAPPER tools.

o	o	o	o	o
Strongly agree	Agree	Don't know	Disagree	Strongly disagree

- 21. *Describe a typical learning scenario involving your work.*
- 22. *What does 'learning' mean to you?*
- 23. *In which situations are your organization supposed to learn by using the tools?*
- 24. *How do you actually learn within the organisation using tools?*
- 25. *What should organisational learning result in?*
- 26. *What characterises 'good organisational learning'?*
- 27. How can organisational learning be measured? (measurability)

Attribute	*Measured by*	*When*

- 28. *Is there anything we did not ask, which you think that we should have asked?*
- 29. *Was conducting this interview a useful approach to you?*

Thank you for your time and effort!

Annex C

The following documents are closely related to Deliverable 3:

Scorecard Info Package

- BSC Introduction (pdf)
- WP3 Scorecard (pdf)
- Kaplan and Norton 1992 (pdf)
- Kaplan and Norton 1996 (pdf)

Field Study Report KA, December 2005

Field Study Report KA, May 2006

Field Study Report Evatronix, December 2005

The above documents are contained in the file D3.zip, which also contains this document as PDF and MS-Word file, and the validation framework as METIS file and HTML report. In order to make the above hyperlinks work, we recommend extracting all contents from D3.zip into the same directory and browse the MS-Word file.

Annex D

WP7 Validation: Event Plan

The table below summarises events planned within MAPPER's validation work package. All events are described with the tentative date, the planned content of the event, the target group or expected audience, the venue, and association with other major events. We distinguish between internal events with only participants from the MAPPER project, and external events aiming at target groups outside MAPPER. Most activities proposed will at the same time be dissemination activities. Thus, those events are closely connected to work package 8.

Tentative Date[7]	**Contents**	**Target Group / Audience**	**Venue**	**Assoc. with Major Event**
MAPPER –internal events				
M10	• Validation framework and implementation in use cases • Exchange of experience between use case partners	All use cases partners; all partners participating in WP 7	Vienna	MAPPER consortium meeting
M21	• Presentation of validation results • Draw joint conclusions with respect to impact on industry sector	All use cases partners; all partners participating in WP 7	To be decided	MAPPER workshop 2007
Events with external participation				
19./20. April 2006	• MAPPER objectives and approach	Industry and Research Community	Prague, Czech republic	CCE06
M10	• Introduction of validation framework and how implemented in use cases • Presentation of predicted economic, social and technical impacts • Discussion with MIUG and feedback	MIUG	Tentatively: Gothenburg, Sweden	MIUG meeting (joint activity with WP8)
November 2006	Workshop: • Present MAPPER approach and experience • Presentation of predicted economic, social and technical impacts • Discussion and feedback	Sub-contractors and producers from automotive and electronic industries	Jönköping (Sweden)	Elmia Subcontractor Fair (joint activity with WP8)
November 2006	Exhibit on Evatronix booth • Present MAPPER approach and expected impact • Discuss with visitors	Producers, suppliers, consultant to electronic industries	Munich (Germany)	Electronica Fair (joint activity with WP8)

[7] "M" is indicating MAPPER project month

April 2007	• Present MAPPER approach and experience • Presentation of predicted economic, social and technical impacts • Discussion and feedback	Automotive and Electronic Industries	Not yet announced	INCOSE
Autumn 2007	• Present MAPPER approach and experience • Presentation of predicted economic, social and technical impacts • Discussion and feedback	Athena partners and invited conference participants	Not yet announced	Athena conference
M22	• Evaluate whether the finding from the validation phase are supported and shared by the MIUG	MIUG	To be decided	MIUG meeting (joint activity with WP8)
M27	• Capture the experts expectations w.r.t. impacts of MAPPER on automotive industries • Evaluate whether the findings from the validation phase are supported and accepted by the experts	Experts from automotive industry	at the experts site (tentatively: Italy, Germany)	Expert Interviews: Automotive OEM
M27	• Capture the experts expectations w.r.t. impacts of MAPPER on electronics industries • Evaluate whether the finding from the validation phase are supported and accepted by the experts	Experts from electronics industry	at the experts site (tentatively: Poland, Portugal, Germany)	Expert Interviews: Electronics
M27	• Capture the experts expectations w.r.t. impacts of MAPPER on automotive supplier and SME • Evaluate whether the finding from the validation phase are supported and accepted by the experts	Experts from automotive suppliers with SME focus	at the experts site (tentatively: Sweden, Norway)	Expert Interviews: Automotive Supplier

