Modelling Cooperative Work: 
Chances and Risks of Structuring

Thomas Herrmann, Marcel Hoffmann, Gabriele Kunau, Kai-Uwe Loser 
Informatics & Society, University of Dortmund, Germany
{herrmann, hoffmann, kunau, loser}@iug.cs.uni-dortmund.de

Abstract. We found evidence in several cases that semi-structured modelling methods are quite helpful to model cooperative work. How can our positive findings with modelling be related to those publications which emphasize a sceptical view on representing work with models and list a number of problems, risks and inappropriateness with respect to the explicit representation of cooperative work? In this paper we evaluate the chances and risks of modelling based on three case studies. Various arguments about impacts of modelling are assigned to a framework differentiating the following three levels: A) perceiving and reflecting of structure, B) explicating, articulating and negotiating structures and C) contributing to the developing of structures. Within this framework we discuss possible chances and risks from literature and from our case studies. We argue that improved methods, notations and tools can help to reduce or even avoid the risks and use the chances for cooperative work.

1 Introduction

We found evidence in several cases that semi-structured modelling methods are quite helpful to model cooperative work [10]. This semi-structured method avoids the equalization of modelling and formalization (e.g. [3], referring to [15]). However there remain some central questions: How can our positive findings with modelling be related to those parts of the literature which emphasize a sceptical view on representing work with models (e.g.[14]) and list a number of problems, risks and inappropriateness with respect to the explicit representation of cooperative work. And furthermore, if the answer about the usefulness of explicit representations is not just “yes” or “no”, what are the criteria according to which we can compare the benefits with the risks and costs of developing explicit models of cooperative work – and how relate these criteria to the literature as well as to empirical case studies.

To answer these questions in this paper, we start with a framework (fig. 1) which differentiates between three levels of structuring. The three levels are helpful to assign the different orientations of the arguments on explicit representation of cooperative work which are given in the discourse:
A. Individual mental models are developed in interaction with the perception of the structure of parts of the reality (such as work processes, organizational units)
B. Mental models are made explicit and structure is developed in interrelation with the method of representation and by combining the viewpoints of different individuals
C. Implicitly and explicitly represented structures are reproduced or reformulated in practice and, on the other hand, guide and constrain practice, too. Purposefully attempting to shape reality with recourse to an explicit model gives rise to special chances and risks.
According to this framework, structuring and modelling are highly interrelated. We use the term “structure” to refer to the mesh of relations between the elements of a system and between the properties of these elements.

Ad A) The activity “structuring” is already taking place when a vague mental model of a system emerges, since the structure of an entity can only be relevant in interrelation to an observer. From the viewpoint of the general systems theory, every system has structure which determines its borders, unity and identity. In the Seventies and Eighties, system theorists such as Maturana [13] or Luhmann [12] supported the constructivist approach by emphasizing that any structure is always the result of an interrelationship between an observer and an observed system. The supposition that every type of system is structured is also supported by Giddens’ structuration theory [7], which is widely adopted by CSCW researchers.

Human actors build theories about the systems [1] which we call mental models of the system’s structure. However, also in the case of these mental models, too, Bannon’s [2] question of “what can, in principle, be captured in any model of the work process” has to be applied. In the special case of cooperative work it might be an appropriate assumption that the overall structure of the cooperation is not replicated in any of the individual participants’ mental models. This concern can be related to Suchman’s ([19], ref. in [17] p.323) statement that the procedural structure of organizational activities is the product of the orderly work of the office rather than the reflection of some enduring structure found behind the work. According to this, the overall structure of a cooperative work process is only present in the work itself or - in other words - human action cannot be described by “plans” that are separated from the action itself [21]. Consequently, the issue of whether mental models can represent a relatively permanent reflection of the structure of cooperative work is questionable.

We will have to study these problems in the light of our case studies by analysing whether modelling contributes to an higher transparency of the overall organization of cooperative work and how far workers can be supported to continuously reflect on their
own practice. These potential benefits can only occur in the context of the next level when models are made explicit.

Ad B) Schmidt and Bannon [16] claim that cooperation needs articulation work which supports the coordination of cooperation. Articulation work can be facilitated by explicit models of work and it can help to create such models. Thus it becomes obvious that it might be sensible and supportive to make mental models of the structure of cooperation processes explicit. However, explicit models share certain characteristics which give reason for sceptical considerations:

- Explicit models are more permanent compared with the potentially more ephemeral mental models.
- Explicit models are more standardized and generalized. They have therefore a greater distance to real work. Thus, it might be the case that the problems of work are ignored in procedural expressions modelling its structure ([17] p. 320, ref. to [20]). It is argued that the greater distance to the ongoing work, the more stereotyped are the models [23]. However, it can also be stated that the problems of stereotyping and idealizing disappear if the appropriate tacit background assumptions can be meshed with the models [17].
- Explicit models are the result of a political process: different individual perspectives are merged; certain aspects are sorted out. The developing of explicit models is always combined with selection and this is guided by interests [23]. Since there are different interests involved and related to representations, some actors might want to push their personal beliefs into the model. Others might want to keep their working practice a secret for varying reasons: it might be “… valuable that members of an organization know their own work in ways that others positioned differently in the organization do not” ([23], p 56).

The problems with making models explicit heavily depends on the question whether the models are developed within the modelled system or whether they stem from outside ([23], [4]). The potential problems with explicit models do not provide sufficient reasons for totally neglecting the potential benefits of explicit work representations. Schmidt [17], who values the work of Suchman, states that her investigations do not provide sufficient insight in how standard procedures defined as pre-defined stipulations are applied in routine daily work. Thus, it is sensible to ask the question of under which circumstances it might be an advantage to develop explicit models. They might help to disclose the influence of different interests and they can serve as a basis for negotiation. Therefore we are investigating in our case studies the question of how far the models support dealing with conflicts, participation or continuous changing of work presentations in mind.

The success of or problems with explicit models depends also on the modelling method being used: mainly the type of notation [8]. We are especially interested in graphical notations. Explicit models provide structure on two levels: the structure of the modelled reality and the structure of the representation itself. If the modelling method allows the modeller to consciously leave parts of the modelled reality unconsidered and to make this decision transparent in the model itself, we call the modelling method semi-structured. All in all we agree with Suchman [23] that the work of modelling has itself to be reflected on.
Ad C) Generally, the development of explicit models pursues a certain purpose which also reflects the interests of the participants being involved. Explicit models are often used to anticipate how the modelled system or process can be improved and to model the improved constellation. With the model of the improved “to-be”-situation, managers and system designers try to shape and to change the structure of reality. The activities of these attempts as well as all unintended influences on the reality’s structure have to be assigned to level C. The intentional attempts to reshape structure mainly serve the following purposes:

- Guiding activities: Explicit representations are often developed with the aim of controlling human activity, especially the coordination of cooperative work [23]. However, it has to be taken into consideration that plans can be seen as a resource for situated action, but do not in any strong sense determine its course [21]. If this statement can also be applied to the role of explicit representations, it is questionable whether they can be used appropriately to guide human activities. To overcome this problem, Bannon and Schmidt [14] propose the differentiation between models as maps or scripts. While scripts describe exactly how a work procedure has to be carried out, maps only provide orientations if needed. Modelling methods should support this differentiation. Furthermore, it is stated that the guidance of human activity should never rely completely on explicit representation but should always be accompanied by a channel for informal communication ([16] ref. to [14]).

- Designing technology: the designers of CSCW systems in particular try to build models of how cooperative work will be conducted with their system. The question arises [16]: “How can designers unravel the essential functions of the cooperative work relations to be supported as opposed to ephemeral or accidental cooperative work practices that may be observed”? The answer to this question leads to a more general and permanent model of a certain situation of cooperative work. However, all the problems with an explicit model, such as interest oriented selectivity or generalization, have a considerable impact on the technical system which is designed in accordance with this model. This impact is even more relevant if the system is used to control human activities as in the case of most workflow management systems.

It is obvious that the problems with guiding human activities by explicit models are clearly intensified if technology is used to enforce this guidance. In the first two case studies, we did not investigate such enforcement strategies but used models to make people aware of the potentials and limits of using structure or shaping the structure of their work and cooperation. However, technology can be very helpful in this context if it reflects the heavy constraints of work processes without giving up the possibilities for flexibility (e.g. Freeflow, [6]), or if it is used to provide data which can help to complete the explicit models.

To understand the relevance and the impact of these problems, we analysed in our case studies the impact of explicit models on the coordination of activities, on quality, on the enactment of designed solutions and on organizational change and its anticipation.

In the following sections we introduce three case studies which are our basis to evaluate the chances and risks of modelling (Section 2). Sections 3, 4 and 5 describe the results of this evaluation on the three levels of our framework by referring to different criteria as shown in fig. 2.
2 Case Studies

2.1 Case: Developing new business processes in a university library

A new software-system for their work on the acquisition and cataloguing of books was to be introduced in two departments of a university library. Since there was a fundamental difference between the current organizational practice and the type of processes being required by the new technology, we were asked to help the group to redesign the work processes. The traditional practice in the library was to start with the acquisition and to do the cataloguing afterwards. Now, with the availability of software system based catalogues, the simplification of the cataloguing reduces the required qualification for most of the new books. With the new system, it can be done in the early steps of the process and guarantees a high quality of data. Another reason to introduce this new system was the seamless integration into the software-platforms of the other departments. However, the software system provided more functions than needed and was not sufficiently adaptable to the situation in the library.

The project with the library developed a diagrammatic representation of the future practice (Figure 3). The complex structure of interrelated activities for performing the acquisition and cataloguing of media was represented. These tasks were supposed to be supported by the new software system. Therefore it was necessary to develop a picture of the activities with respect to the system’s functionality. In parts there was a clear relation between tasks in the diagram and forms in the system. The scope of this project was the tasks of the involved groups doing the acquisition and cataloguing and the goal was to show how the software is employed for these tasks.

At first, the main focus was the standard procedure for common books, but most of the special cases were also integrated later. There were six practitioners from the two groups participating in the meetings. We used the modelling method SeeMe [10] [11] to represent the process. The diagrams were represented on pin boards first and then transferred and aesthetically improved using presentation software.

2.2 Case: Web Interface for Ordering Business Cards

The Medienzentrum Duisburg (MZD) offers services and products associated with digital printing. Amongst other things they print business cards for insurance companies. In order to improve the efficiency of the process of ordering and printing business cards for major customers the MZD is developing a web interface. The customer will be able to place orders using the web interface without the need for contacting a sales person. Software automatically generates the files needed for production from the information the customer
enters through the web interface. We helped one of the responsible managers on the sales team to model the work processes as they were without the web interface and how they might be using the web interface. The people at the MZD had not yet systematically identified the processes that would be affected by the usage of the web interface. They knew that changes would be necessary but they did not exactly know where and how. The diagrams helped to identify those parts of the current working process that had to be reorganized. Furthermore, the representation of the future work processes with the web interface was used to discuss alternative options for the organization. The goal was to ensure that the new process will be as efficient as possible without missing necessary steps. Therefore the scope of the diagrams is the production of business cards starting with the order placed by the customer, then the printing, and ending with the delivery of the cards as well as the invoice (Figure 4 shows the diagram representing the future working processes). We included only those activities, persons and entities in the representation that were either affected by the introduction of the web interface or that had to be included in order to create a coherent model. The modelling language SeeMe [10] [11] with its editor was used to create the diagrams. An extensive visit to the production site was the beginning of the work on the external representation. The responsible manager showed us around and explained the working processes as they were. She also demonstrated a prototype version of the web interface and explained how she intended to use it. Afterwards we – the researchers – drew up first versions of the two process diagrams which we then discussed and modified together with the manager. This manager, who had been trained in the usage of SeeMe before, was the only one who participated in the whole process of creating the diagrams. We did, however, meet and talk to some other employees during our visit of the production site.

2.3 Case: Design of a Knowledge Management Application
In a medium-sized consulting company with about 150 consultants and some smaller affiliated companies, we are taking part in the process of designing and introducing a knowledge management (KM) application. Providing an efficient platform for storing and retrieving organizational information, the applications aim at supporting knowledge sharing among the consultants, collaborative knowledge building and qualification, as well as the establishment of new standards in project documentation. The system is designed to match certain envisioned use cases, especially certain information needs occurring during the acquisition and execution of projects.

The application builds on the Knowledge-Management-System Livelink® (www.opentext.com), which provides web-based document management services enhanced with several features for the management of tasks, workflows, search and retrieval, categorization of contents etc. The software constrains the design to arrange the contents in one hierarchy. All users have to deal with this hierarchy and it therefore constitutes one critical success factor for the whole project. It became one major issue of the design process. In November 2001 the application runs for about 6 months with about 150 users and consists of a few hundred folders extending into the 6th or 7th level of substructures at many places. At the top level, the hierarchy includes sub-areas for news (1), internal projects (2), internal services (3), knowledge communities (4), organisational units called competence centres (5), customers and projects (6), process knowledge (7), locations of the company’s facilities (8), and affiliated companies (9).

In addition to the primary hierarchy of contents, the design process generated templates to replicate substructures and classification schemes for structured descriptions of documents,

<table>
<thead>
<tr>
<th>Advise</th>
<th>Diagram</th>
<th>Guideline</th>
<th>Map</th>
<th>Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agenda</td>
<td>Diary / Journal</td>
<td>Handbook</td>
<td>Masterthesis</td>
<td>Proposal</td>
</tr>
<tr>
<td>Approach</td>
<td>Directory</td>
<td>Information</td>
<td>Method</td>
<td>Protocol</td>
</tr>
<tr>
<td>Article</td>
<td>Dissertation</td>
<td>Instruction</td>
<td>Offer</td>
<td>Settlement</td>
</tr>
<tr>
<td>Bidding</td>
<td>Documentation</td>
<td>Invoice</td>
<td>Order</td>
<td>Software</td>
</tr>
<tr>
<td>Book</td>
<td>Draft</td>
<td>Layout</td>
<td>Organizational chart</td>
<td>Study</td>
</tr>
<tr>
<td>Contract</td>
<td>Expenses</td>
<td>List</td>
<td>Overview</td>
<td>Summary</td>
</tr>
<tr>
<td>Correspondence</td>
<td>Figure</td>
<td>Livelink-Element</td>
<td>Photo</td>
<td>Template</td>
</tr>
<tr>
<td>Description</td>
<td>Form</td>
<td>Logo / Icon</td>
<td>Presentation</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Scheme for document classification

In a medium-sized consulting company with about 150 consultants and some smaller affiliated companies, we are taking part in the process of designing and introducing a knowledge management (KM) application. Providing an efficient platform for storing and retrieving organizational information, the applications aim at supporting knowledge sharing among the consultants, collaborative knowledge building and qualification, as well as the establishment of new standards in project documentation. The system is designed to match certain envisioned use cases, especially certain information needs occurring during the acquisition and execution of projects.

The application builds on the Knowledge-Management-System Livelink® (www.opentext.com), which provides web-based document management services enhanced with several features for the management of tasks, workflows, search and retrieval, categorization of contents etc. The software constrains the design to arrange the contents in one hierarchy. All users have to deal with this hierarchy and it therefore constitutes one critical success factor for the whole project. It became one major issue of the design process. In November 2001 the application runs for about 6 months with about 150 users and consists of a few hundred folders extending into the 6th or 7th level of substructures at many places. At the top level, the hierarchy includes sub-areas for news (1), internal projects (2), internal services (3), knowledge communities (4), organisational units called competence centres (5), customers and projects (6), process knowledge (7), locations of the company’s facilities (8), and affiliated companies (9).

In addition to the primary hierarchy of contents, the design process generated templates to replicate substructures and classification schemes for structured descriptions of documents,
customers, projects, and consultants’ skills. Figure 5 shows a mind-map diagram of the customers and projects branch (6) and the template for retention of project information. Mind mapping was one of the favourite representation techniques employed during the design stage. After the system had been introduced, the mind-map lost its function as a tool for planning changes in the hierarchy. However, the project-team keeps the mind-map up to date and uses it as training material. Table 1 shows the scheme for classification of documents. Such metadata schemes were documented using Excel.

<table>
<thead>
<tr>
<th>What?</th>
<th>Library Case</th>
<th>Business Card Case</th>
<th>KM Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>A diagram representing the procedures and structures of the future practice of two working groups</td>
<td>Two diagrams: one representing the current procedures and structures; and another one representing the future procedures and structures based on the usage of the web interface.</td>
<td>A hierarchy of existing and to be generated contents and a categorization scheme for contents</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Why?</th>
<th>Library Case</th>
<th>Business Card Case</th>
<th>KM Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>A new software system was to be introduced. At the same time the two working groups should be reorganized.</td>
<td>It was the goal to identify those parts of the current working practices that would be affected by the usage of the web interface.</td>
<td>Regulating and standardizing the documentation of projects; Facilitating the localization of contents in an extensive archive;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>To what extent?</th>
<th>Library Case</th>
<th>Business Card Case</th>
<th>KM Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>The diagrams cover the (planned) practice of the two working groups for acquiring and cataloguing new books. They show tasks and work processes employing the system, the division of labour among the users, and roles which are affected by the introduction of the system. In some places internal structures and procedures of the system became part of the description.</td>
<td>The external representation shows the complete process of producing business cards: starting with the order placed by the customer, the printing, ending with the delivery of the cards and the invoicing.</td>
<td>A categorization scheme is meant to cover all contents by providing around 50 content-types. The hierarchy contains different levels of detail. For project documentation detailed hierarchies are stipulated. For building knowledge communities the design is less detailed.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Techniques and methodologies</th>
<th>Library Case</th>
<th>Business Card Case</th>
<th>KM Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>The diagrams were developed using the notation SeeMe.</td>
<td>The diagrams were developed using SeeMe (notation as well as editor).</td>
<td>Content hierarchies were constructed using mind-mapping techniques. The categorization scheme was represented in a simple list of content types.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process of creating the represented structure</th>
<th>Library Case</th>
<th>Business Card Case</th>
<th>KM Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a first phase an overview of the main steps of the process was developed. During the following sessions for each main step one or more detailed descriptions were developed. Special cases were collected during the process and detailed later on. During the last session the whole model was checked.</td>
<td>The researchers created the diagrams after they had been informed verbally by one of the managers.</td>
<td>Content hierarchies and categorization schemes were compiled by an initial brainstorming and subsequently revisited in four workshops. Since the introduction of the system in spring 2001 both, the hierarchy and the classifications have undergone minor changes. A more substantial redesign is planned.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participation</th>
<th>Library Case</th>
<th>Business Card Case</th>
<th>KM Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>There were six practitioners with different roles from the two groups participating in the meetings. The diagrams were represented on pin boards first and then transferred and aesthetically improved by an experienced modeller.</td>
<td>Two researchers and the responsible manager were actively involved. Other employees gave input on a case-by-case basis.</td>
<td>In addition to the core project team, which consisted of the project leader, one consultant, and two researchers, the chief intranet editor took part in the creation of the hierarchy. The hierarchy was discussed with the project’s steering committee including the managers of four other departments.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Summary of the three Case Studies
In the design process, the heads of some influential competence centres, the core project team, consisting of academic researchers and consultants from the knowledge management unit, and a former intranet editor as a delegate from the internal services were involved. The processes stretched over three months and included several smaller and bigger workshops. During the workshops, brainstorming techniques, wallchart print outs and projections were used both to visualize and to discuss the hierarchy and the accompanying classification schemes.

3 Chances and risks of supporting the reflection on structure

3.1 Transparency of Organizational Structure

As members of an organization reflect on their practice and their organisation using an externalised representation of structures and processes they become aware of certain properties of their practice and the organization. In particular the members of a transparent organisation create an understanding of the following:

1. The goals of the organisation.
2. The members of the organisation.
3. Their place in the structure of the organisation.
4. Their tasks and responsibilities.
5. The prerequisites of their actions: upon whom and what do they depend?
6. The effects of their own actions: Who is affected by their actions? Who depends and in which way on their actions?
7. The importance of their actions for the organisation as a whole.

Two of the case studies in which we used a modelling technique to explicate organizational processes support the argument that modelling activities increase the level of organisational transparency. Using the modelling language SeeMe we modelled roles, actions and entities and thereby created awareness for all of the seven aspects of organizational transparency mentioned above – although the level of clarity is not the same for all aspects in both case studies. In the case of the MZD the focus was on the dependency between actions. One indicator of the success of the modelling was that we did find a need for coordination that had not been thought of before: using the web interface an order will be passed through to production immediately without informing the sales people. The sales people, however, are responsible for preparing the delivery documents and the invoices. This implies that the information about a new order needs to be given to sales people nearly at the same time as to production.

In the case of the library, members of two different working groups had to exchange information about their work and then create an integrated work process. They focused on tasks and responsibilities. The fact that the participants understood each other’s work in the end, and that they were able to create an integrated organization of their work, supports the notion that modelling can enable organizational transparency. One participant stated it this way: “OK, now that we have developed an overview of the tasks there [in the others field of work] you know now that this and that will be working.”

The current state of the case studies implies that the benefits of the modelling activities have, up to now, been limited to the participants of the process. The coming weeks and months will show whether and how the models will be used to increase the organizational transparency for other members of the organizations. Creating organizational transparency using diagrams may cause problems for some participants who are not able to understand an expression with a new complex diagrammatic notation, so that for them this

---

1 In the library project there was a Kick-Off-Meeting recently where the whole library was informed about the plans. The project group decided to use the diagrams to give an overview of the future practice.
would not be a helpful tool for reflection. In the case studies for example some people were reluctant in using this kind of method, but they still were able to relate ideas and comments to the diagrams. It is hard to imagine these people sitting at their desk and trying to find personal solutions, by creating diagrams themselves. For them it might be helpful to provide alternative representations, so that these people still have the possibility to find a helpful documentation they feel comfortable with.

In the case of the KMS, the aspect of organisational transparency is not as obvious as in the other cases. The question was whether or not a detailed structure for the KMS should be prescribed by the design team or not. One advantage of a precise structure given by the design team is that trainees as well as early users are informed about possible categories of information even though they may not yet be filled. This adds to the picture of the planned usage of the KMS and thereby increases organisational awareness. However, the content hierarchy’s and the process diagrams’ efficacy to support organizational transparency are difficult to judge at this point in the project.

3.2 Continuous reflection on practice

Organizations and their environment are changing continuously. To keep members’ understanding up to date reflection is needed. Members should reflect on their practice continuously and develop a coherent and consistent understanding from their point of view. This can also be understood as maintaining a structure in members’ minds that matches the experience made in actions. Doing this continuously is an idealized point of view as the practice in organization gives little opportunity for reflection. Extra effort is needed for this. Also in the field of Workflow Management Systems some authors already mentioned that models of work processes can be useful even outside the scope of workflow technology. Dourish (1996) writes that models can be useful “… for individual and group reflection on process, for documentation or organisational learning purposes.” That graphical representations such as diagrams are superior to plain text when describing complex matters is confirmed by authors like Goguen [8].

There are certain issues that can arise if practice and personal understanding of practice are not actively kept in match. One might be that structures develop in different directions in different parts of the organization. As a result extra effort is needed to reintegrate work results again. One example can be found in the Knowledge Management Case: certain structures and categorization schemes were selected, some of which were mandatory in the beginning. In practice it became clear that especially the schema in particular was not complete or not completely understood by everybody. One may want to put extra effort into developing a better scheme. The other option would be to try to make everybody understand the scheme. In this case, the categorization was made open for new entries so that everybody may use the existing scheme, but if this is not sufficient, new categories can be introduced. This solution makes the individual work more efficient, because it is easy to categorize. This solution stresses the personal and situational viewpoint. From a wider organizational viewpoint this open and evolving structure looks different. The goal of having a consistent categorization scheme for all documents also has an efficiency aspect, looking at retrieval quality and costs. Therefore it is helpful, to revise the structures after a while. With both viewpoints we reflect practice and develop different solutions. In real organizations practice needs to be reflected with both a personal and situated viewpoint as well as an organizational viewpoint, and for both levels appropriate opportunities are needed. Diagrams as external representations of mental models can support both levels. As situations and perspectives of members are always different by nature, this may give rise to conflicts, which will be discussed in more detail in chapter 4.2.

There are risks that personal reflection is reduced because of modelling projects. To change diagrams may be a too complex task so that individuals try to avoid touching the
representations and even avoid thinking about possible and helpful changes of practice. Looking at representations as a dogma and sticking to the negotiated practice once and for all, might be an extreme result of this phenomenon. Due to the state of our cases this was not the case there so far.

4 Chances and Risks in the Explication of Internally Represented Structures

4.1 Organizational Walkthrough

When planning to change the way an organization functions it is usually not feasible to run tests with various options and then choose the one that performs best. Visualizing possible future structures and processes by means of modelling can be a substitute for what in other fields would be done using simulations. We use the term “Organizational Walkthrough” to describe the activities of testing organizational structures and processes using artefacts like models by creation and reflection of cognitive artefacts namely diagrams. While Scenarios [5] tend to concentrate on one workplace, we try to take a broader view on the organization. Organizational walkthrough can thus be considered a pre-stage to “organizational change” – an aspect we discuss under category C. The difference between the two aspects is that organizational walkthrough does not have the immediate intention to change reality. Rather it is a method to evaluate whether an intended change will bring about the desired effects. Part of this method is to create artefacts on which the discussion is then based; therefore, organizational walkthrough belongs to category B. Once the evaluation has shown a positive result, organizational change would be the step which follows organizational walkthrough.

Our case studies show that modelling can support organizational walkthrough. In the first two cases, the models of the work processes were used to evaluate the effects of an organizational change. The participants wanted to ensure that they knew what would happen if they changed their organization in the intended way. The models enabled them to identify critical points. In the library, the team found it difficult to explicitly describe the role for a certain person. The cause of these difficulties was the contradiction between the director’s orders to fully integrate all workplaces on the one hand, and the intention of the group to find workplaces for all members on the other hand. The team felt that this person could not handle a fully integrated workplace where she had to be able to perform all tasks. Now the fact that this contradiction existed was probably known in the group even without the models. But by using modelling, the group was able to discuss various options for solving the problem without actually trying them out and thereby bringing the person in question into a bad position. In the MZD the modelling forced the responsible person to think about all aspects of producing business cards triggered by an order placed through the web interface. During this process it became obvious that there were aspects like the preparation of the delivery documents that had not yet been thought through. Although it would have been possible to run through the process using mock-orders in this case (other than in the library, nobody would have been harmed), we think that using models to visualize the process with all of it’s different possible paths is more efficient and complete.

In both cases the creation of the models was an integral part of the organizational walkthrough. However, we can also think of situations where existing diagrams are used to verify whether a new task can be fulfilled with an existing organization.

When we say that organizational walkthrough supported by modelling seems to be a good way to prepare organizational change, we do not say that it is sufficient to sit in a meeting room and draw diagrams. The case study at the MZD showed that quite clearly: in designing the web interface, the first idea was that the production site would be informed about a new order by e-mail. The common means of notification by the e-mail client was planned to be used. When visiting the production site, it became quite obvious that this
would not work: the PC was placed in the corner of a room on a desk so that it was not guaranteed that a visual sign such as an opening window would be noticed. A normal acoustic sign would also not be heard because the room was filled with the noise of the printing machines.

We argue that models as artefacts can be very helpful when thinking and talking about organizational change – we do not say that models can replace a thorough knowledge of the real world.

4.2 Conflicts

When documenting structures and processes – be it for future or current activities – conflicts and discrepancies will become overt without even explicitly looking for them. In the following we try to shed light on some of the mechanisms that can take place.

When creating a model of future working processes – e.g. in the frame of an organizational walkthrough – the participants have the chance to forestall and resolve conflicts that could arise when installing the new organization. The case study in the library provides us with examples for this. Since the group had to agree on one way to draw the diagram, any conflict about the organization of the new work had to be resolved while working on the diagrams. This gave them the chance to discuss matters without being in any emergency situation and without the need for an instant solution.

For existing conflicts in an organization, the explication of structures and processes can be helpful to state the area of conflict more precisely, to find an objective level for discussion and to seek solutions. This is true for open as well as for hidden conflicts; but, of course, this method is limited to conflicts that are caused by organizational problems rather than interpersonal conflicts.

Obviously there is the risk of becoming involved in discussions about hypothetical situations and possible conflicts about which nobody knows whether they will ever take place or not. There is also the risk that it might be difficult to find a solution for a conflict in a group meeting, whereas a solution would easily be found in the real situation. For both types of risk it is important that the method used for the explication of structures and processes leaves room for vagueness. The facilitator of meetings in which people work on the external representation of structure must help the group to find the right level of detail. On the one hand it is not helpful to be too imprecise. The chance to resolve conflicts before they really arise comes from the need to agree on one way to explicate an internal structure. On the other hand, it can be efficient to remain vague on certain aspects – the solution in reality might be much easier than an extended discussion on the explication.

The fact that explicit structure contravenes tacit consent is the root of the problems that can be caused by using models to represent working practices. Our case studies do not contain an example of this; however it is easy to imagine that there are organizations that function on the basis of unspoken agreements. Lucy Suchman [23] describes a similar potential for conflict when she points out that there exists a kind of service work that will not be visible if it is performed well. She argues that “bringing such work forward and rendering it visible may call into question the grounds on which different forms of work are differentially rewarded, both symbolically and materially.” In these cases one has to judge carefully whether conflicts that become open during the explication of the organization’s structure can be dealt with in a positive way, and that this will eventually lead to an improvement.

The case study in the library gives us an example of how conflicts can be caused by the activity of creating an externally represented structure. While working on and discussing the diagrams, the group who performed the acquisition of books felt that they were pressured not only to describe but to justify their working practices – even those who were not immediately affected by the introduction of the new technical support system. In the inter-
views that we conducted a few weeks after the group meetings, one of the participants said that there “were many things that had been fixed in the other group … procedures that had so far nothing to do with this [the activities that were represented in the diagrams] and that met a lack of understanding because it could not be made plausible why things were handled in this way …” Without the work on the external representation of the processes there would not have been the need to explain anything to anybody. The facilitator of the meetings had the responsibility to reduce the tension caused by this perception.

4.3 Participation

The explicit representation of organizational structures and processes is a good basis for consultative as well as representative participation because there are artefacts on which feedback and discussions can be based. On the other hand, the mere existence of such artefacts will stimulate discussions even if those who created the artefacts had not intended this. If these discussions are not embedded within a participatory process they can be harmful to the organization as a whole. In the context of this paper it is important to note that the explication of structure can be a very helpful means to support participation but that participation is more than drawing diagrams. Organizations that want to make their structures explicit but are not willing to embark on a participatory exchange, might be confronted with conflicts that stem from disappointed expectations. Creating and discussing external representations of structures requires much effort from the participants: in our case study in the library it took 11 meetings of about two hours. Employees who are willing to do this will be frustrated if this effort does not lead to visible results.

It is not undisputable whether representations of structures and processes can be helpful in the design of computer systems. Robinson and Bannon [14] describe the effect of “ontological drift” which means that representations of reality are interpreted in different ways once they have been passed from one semantic community to another. They conclude that there is no “objective reality that can be usefully “captured” in a model and subsequently used as a sufficient basis on which to develop a computerized system.” We agree with this statement – external representations of reality are always representations of individual interpretations of reality (fig. 1). However we still think that these representations can be very useful when designing socio-technical systems. Our case study in the library gives an example of how the explication of working processes can enable people to participate in the process of organizational change. The participants in the group meetings were qualified librarians who had no experience in modelling techniques. Not all of them were able to acquire a detailed understanding of the specific modelling language used. However all of them were able to express proposals for changes within the diagrams and thus they were able to participate in the design of their future working processes. In this sense external representation of structure in diagrammatic notation can become a shared tangible artefact that supports individuals to participate in the definition and development of the technical support of their working place. We argue that the explicit representation of processes and structures can help to overcome the gaps between semantic communities.

5 Chances and Risks in the reproduction of represented structures in design and activity

Depending on what diagrams or other representations describe and on the way they are employed in design and activity, the impact on practice varies to a great extent. In the library case representations were built to reflect on consequences of the introduction of a given software-system and to design organizational routines and the division of labour in accordance with the system. In the business card example, representations were part of an integrated approach to design work and technology at the same time. However, like in the
library case, activities represented in diagrams (cf. fig. 3) were never meant to become steps of a formal workflow, they were represented to reflect and to (re)design organization only. In contrast, the content hierarchy and the categorization schemes designed in the KM case were completely translated into features of the computational artefact. We use the library and the business card example to discuss the impacts of building representations in general (5.1) and concentrate on the KM case to analyse the consequences of the transition into computational artefacts (5.3). Reflecting on the impact on design (5.2) and on organizational change we compare observations from all case studies (5.4).

5.1 Guiding and Coordination of Activity

The theory of structuration [7] clearly points out that individual as well as social representations of structures are an essential prerequisite for any kind of social activity. Implicitly represented as well as “formulated” structures like rules and resources are ubiquitous. They regulate turn taking as well as signification in communication, they legitimate sanctions, and they facilitate power, for instance. Accordingly, the represented structures from our case studies have an impact on practice in multiple ways. There is a general impact on activity as well as potential costs and benefits which are connected to special modes of using represented structures.

At a personal level, expressing organizational relations in diagrams is a means to create clarity for acting in the organization. In the case of the university library, for example, participants expressed that the necessity of creating an expression in diagrams, forced them to be clear about the discussed issue. While discussing things without this necessity of creating one model, contradiction between different viewpoints remain opaque. Restricting the representations to spoken language, vagueness and incompleteness are less visible to the participants. They discuss an issue, without getting to the point of agreeing on one way of action. To create a model it is necessary to achieve a greater clarity about what should be expressed then in verbal discussions; in this sense using formal notations helps eliminating ambiguity (c.f. [9]). This support for clarity does not only support transparency and facilitates the resolution of conflicts as discussed in section 3.1 and 4.2. Providing agreed upon and less ambiguous grounds, representations become resources users can draw upon to execute and coordinate activity, too.

In the mentioned projects there are many decisions about future practice. Most of the time they are not even visible to the participants, because there is no real divergent discussion about the decision. Everybody agrees instantly. On other issues, conflicts become visible while trying to express one or more variants of the model or propose changes to a model representing the different points of view. With the goal to create one representation everyone agrees upon, there is the need to discuss the visible conflicts and come to an agreement. Arising problems at the workplace can be avoided in advance or discussed at a forum away from the emergency situations that need instant solutions and where there is no time for the discussion.

5.2 Quality of Design

Social construction and negotiation of explicitly formulated structures significantly influence practice. When represented structures are used, however, to configure computational artefacts or organisational routines additional consequences arise. In the library case, the process of modelling lead to a change in the goals of the whole project. Constructing diagrams to envision the future work procedures, the group had started to question the selected software’s benefits and finally decided not to introduce this piece of software. If we agree with the participants’ point of view, the reflection stage inhibited the introduction of a system that did not match the requirements of the users.
The impact of the adoption of representations in design is not always as obvious as in the library case. In the business card case, however, we found some evidence that representation work contributed to the quality of design, too. For instance, the participants of the modelling stage mentioned that the diagram helped them to identify gaps and inconsistencies in their plans for the future service. In the KM case, both chances and risks of using design-representations become visible. On the one hand the adoption of the mind-mapping techniques and the application of a drawing-tool allowed flexible handling and presentation. On the other hand, the techniques applied were kind of hypothetical or theoretical in that they only reflected on a few examples of the to be organized contents. As mentioned earlier when the categorization scheme was put to practice this emerged as a significant drawback. Many users came up with contents that did not match the categorization scheme. If the categorization had been developed in closer connection with practice, perhaps this problem would have been recognized earlier.

5.3 Enactment of Designed Solution

Embedding structures in software systems can enhance the effectiveness and the efficiency of an application by automating specified procedures, by providing specialized functionality for pre-specified requirements, and by establishing standards which users can draw upon to coordinate activity. However, when an explicit structure is brought to practice so that it has relevance for activity, specific risks and costs apply, too: unfamiliar, complex, or poorly designed structures cause cognitive burden especially for sporadic users and can lead to inappropriate use causing exceptions and violations of rules other users have to cope with later on. For instance, users who have to solve the violating situation lack the support they are accustomed to and have to develop new strategies. Obligations to match their solution with standards or requirement ensuring the continuation of dependent activities cause additional effort. Or elsewhere users are demanded to contribute to the adaptation of the structure so that it will incorporate future occurrence of similar situations. Even in situations where users manage to bring a structure in coordination with their situation, structures can induce learning and adoption costs, too. In order to be efficient the structure’s benefit must outweigh all of these costs.

In the KM case, some substructures like, for instance, the structures for project documentation, organizational units, and for process knowledge were designed in more detail than others. Similarly to workflow models the details of the structures were meant to support recurring activities anticipated by the design team, e.g. searching for materials from previous projects, looking for contact persons, etc. This reasoning envisions certain usage scenarios that should benefit from the detailed design. Not surprisingly, the detailed structures violated requirements that were not considered during the design stage, too. However, the pre-specified content hierarchy was generally accepted. Most users reproduced the suggested hierarchy for projects at least partially and some adapted it (fig. 4). During the training users’ feedback on standardizing the documentation of projects in this way was positive.

Many significant problems came from the classification of documents scheme’s side (table 1). The pursuit of completeness in the specification of document types evidently annoyed users. Users constantly complained that the list did not match their requirements and suggested the introduction of additional categories. However, subsequent adaptations lead to a list causing even more objection than the first one. Now users complained that they could not decide on an appropriate category. As a consequence, the previously mandatory categorization routine was temporarily set to discretionary mode.
5.4 Organizational Change

Referring to researchers in the CSCW community, Bannon [2] points out that nobody “is arguing against the need for the representation of work per se, rather the argument is over what it is that you are doing when you build representations initially, and how they are to be used in subsequent stages of the design process.” Once a structure has been defined and even documented using modelling techniques, one could argue that the existence of these diagrams fixes organizational habits and thereby inhibits organizational change and innovation.

Defining a content hierarchy and a rigid content classification scheme for the knowledge-management-system, the design team in the third case study performed a creative process of organizing knowledge for the individual users of the system. It was the unspoken goal of constructing such an extended structure to prevent divergent processes that result in inconsistencies. However, providing such a detailed framework for content retention, incongruous knowledge will most likely not be entered into the system. Innovation concerning the structure might not come to pass because the users do not think about the organization of their knowledge – they rather try to fit information into the existing structure. Since innovation is always the result of a creative process, one could even assume that the number of innovative ideas in general will not increase because creativity is not supported by rigid structures. Several authors – e.g. Suchman [22] – point out the negative effects of structures prescribed by designers. Nevertheless, the users in this case surprised the researchers by asking for such a prescription. Later, we observed many subtle adaptations to the given hierarchy and some users even made detailed propositions to the initial design. One suggestion was for instance, to add functionality so that project documentations could be rearranged more easily when the project team agrees on new hierarchies. The adaptations and the suggestions showed that in certain environments an initial design may nurture or seed creative thinking, too.

In the first two cases where work processes were defined using modelling techniques, it is likely that these models will be used to define tasks for employees and to train new members of the groups. Thereby the defined structures and processes will be reinforced in the process of their usage – they might even develop a sort of power like a written law. A danger could be that people will not think about alternatives even if the structures and processes described by the models turn out to be incomplete or even wrong. The diagrams could be used as a dogma by those unwilling to allow change. It could also be that changed circumstances will not be represented by updating the diagrams. This would lead to the effect that the actions described in the diagrams will still be carried out because people were told to do so, although they do not match the environment anymore.

We think that such a scenario is one potentially negative effect of modelling. However we would argue that the diagrams could be used to promote innovation by enabling organizational walkthrough (see above). It is important how the diagrams are used within the organization: our goal is to use them in a more descriptive way – providing a group with a model of their interaction – than in a prescriptive way. We extend this position by saying that the usage of representations also has to be continuously reflected on during the course of change within an organization. We agree with Suchman when she writes:

“The aim is a design practice in which representations of work are taken not as proxies for some independently existent organizational process but as a part of the fabric of meanings within and out of which all working practices – our own and others’ – are made.” [23].

6 Conclusion

Since the critique of modelling and explicit representation of work reached an intensive level of discussion (e.g. [14] or the Winograd/Suchman debate [24],[22]), a lot of progress
has also been made with the improvement and flexibility of modelling methods. We think that some of the success we found in our case studies was possibly due to the usage of notations which are, on one hand flexible, and on the other hand standardized enough to serve as a homogeneous basis for communication. Furthermore, the software tools which are used to develop and to present models have also improved. With a semi-structured method, representations become possible without sticking to formalization and still having the advantage of supporting articulation work in the context of coordination and cooperation. It becomes obvious in our case studies that reasoning about organizational structures needs explicit representations since the overall relationships of an organization cannot be experienced and reflected on from the viewpoint of the activities which are carried out by a single actor.

Our conclusion is that there are great opportunities to reap more benefits than costs from the application of explicitly modelled representations of cooperative work. From this point of view it is reasonable to summarize the characteristics of a modelling methods which can support the achievement of these benefits. The method should provide possibilities:

- to deal with the dynamics of structures and to indicate it
- to switching between maps and scripts in the sense of Schmidt [17]
- to express uncertainty incompleteness and the limits of representing
- to vary the level of detail and of abstraction. This provides flexibility concerning the distance or proximity between models and concrete work situations
- to integrate information about the modelling work itself into the model (meta-reflection)
- to represent not only activities and resources but a variety of aspects which are relevant for cooperative work, such as interest relations, roles and competencies,

Another important point is flexibility which is provided by a software-based editing and presentation tool. Since we do not always know in advance what kind of aspects should be represented, it is sensible to offer electronic hide and show mechanisms concerning the level of detail and the level of abstraction. With the help of appropriate tools, not only the appropriate presentation of the structure but also aesthetic improvement is possible to facilitate the usage and understanding of explicit models in the course of training or participatory design. Furthermore, it should also be supported by tools to convert representations from one modelling notation to another. This can serve for the development of technical systems as well as for the flexible interaction between formal and informal communication.

All in all, the modelling method and the appertaining tools should help to create models as boundary objects (in the sense of Star [18]) which are plastic enough to adapt to local needs and viewpoints as well as robust enough to serve for communication across sites.

Acknowledgements

We thank the participants of the E-CSCW 2001 Workshop on “Structure and Process: the interplay of routine and informed action” especially Paul Dourish and Håvard Jørgensen for many valuable comments on previous versions of this paper.

References


