Self-organization of interorganizational process design

Peter Rittgen

Received: 13 March 2009 / Accepted: 15 September 2009 / Published online: 1 October 2009

© Institute of Information Management, University of St. Gallen 2009

Abstract Interorganizational process design is challenged by a number of factors: There is no central governance, processes change over time and the stakeholders from the different organizations can hardly meet physically to agree on a mutually acceptable process. A process modeling session in the traditional way can therefore not be executed. In this paper we try to overcome the problems by offering an approach that allows for distributed process modeling and negotiation. Complemented by video or telephone conferencing the whole design can be done without any physical meeting. Much of the design work can even be done offline at the stakeholders' discretion.

Keywords Systems design and implementation · Computer-mediated communication and collaboration · Case studies · Field experiments

JEL M15 · IT Management

Introduction

When organizations in a network want to organize work amongst and between them they face a number of serious challenges. For one there is no central governance that could take decisions on how to design the interaction process. This means that the process design has to be negotiated and agreed upon.

Secondly, the economic environment and with it the demands on the interorganizational process change frequently, which makes it necessary to use a procedure for process update that works with a minimum of effort.

And this already brings us to the third point: Process design usually requires workshops with all the stakeholders, which in our case might be distributed over the whole world. Frequent re-design workshops therefore become unfeasible.

The aim of this paper is therefore to find a **process modeling procedure** that allows for distributed collaboration in an asynchronous manner (i.e. not requiring people to work on the design at the same time) keeping the required synchronous parts to a minimum so that they can be performed via a video or teleconference if supported by a suitable modeling tool.

But an agreement can only be reached when the stakeholders collaborate closely and in a creative way. By collaborative we mean that all participants of a modeling session take a direct and active role in creating the model as opposed to the indirect influence they usually have via the facilitator of the session. This means that we depart from the assumption that participants cannot do models themselves or at least make changes to them.

If the stakeholders develop their designs independently there will be an endless discussion about the pros and cons of each design and we will never reach consensus. Our approach therefore puts consensus-building, together with negotiation, in the focus of a procedure for collaborative design of interorganizational processes.

Given the situation described so far we need a **tool-supported** procedure with a minimum of synchronous steps that involves all stakeholders in an active and creative process design that leads to a consensus model. In the absence of central governance this procedure should also

Responsible editor: Kai Riemer

P. Rittgen (✉)
University of Borås,
Allégatan 1,
50190 Borås, Sweden
e-mail: peter.rittgen@hb.se

work without a facilitator and it should not force a specific **role** on each stakeholder. In other words, each stakeholder should be free to contribute in the way he or she wants. This means that the virtual modeling team with members from all organizations in the network should be able to organize itself to a certain degree. We call this procedure COMA (COLlaborative Modeling Architecture).

Our study identifies patterns of self-organization of modeling groups and the structure of the modeling process, i.e. we ask the question: What happens if we allow group members to do whatever they deem necessary in order to reach the goal of describing a process that everyone can agree on? What roles will members take on? In which way will they collaborate?

The resulting roles and patterns show that the COMA procedure leads to a stable situation and to meaningful models, even if no facilitator is present. This means that the COMA procedure can also be used under the conditions that are present in an interorganizational situation. This is our major contribution.

We also contribute to the area of collaborative modeling the notion of true collaboration which means working together closely; so instead of everybody working only with the facilitator, people in our approach work with each other. We believe that this improves modeling substantially, both in terms of model quality and in terms of modeling speed and satisfaction with the modeling process.

As the collaboration is to a large extent supported by a computerized tool, we also contribute a new kind of specialized electronic meeting system to the field of eCollaboration, namely the COMA tool.

Related research

Collaborative modeling processes have been studied from a number of different angles, e.g. the structure of the process itself, its organizational environment and techniques to support it. In (van Bommel et al. 2006) modeling involves domain experts, modeling mediators and model builders. It is viewed as a form of information gathering dialogue where knowledge is elicited from the domain experts. This view can be challenged because modeling is a social and communicative process where much of the information is created by and through the process rather than gathered from domain experts. We have therefore studied situations where the participants had no a priori roles but contributed to the modeling session in the way they deemed reasonable.

(Frederiks and van der Weide 2006) emphasizes the importance of natural language as the primary medium and identifies two principal activities and associated roles: the domain expert who concretizes an informal model and a system analyst who abstracts a formal

model. (Hoppenbrouwers et al. 2006) distinguishes between an elicitation and a formalization dialogue and develops a modeling procedure by generalizing existing procedures.

(Hoppenbrouwers et al. 2005) acknowledges that modeling is not only a knowledge elicitation process but also a knowledge creation and dissemination process. It is viewed as a structured conversation.

We agree that modeling is a conversation but we claim that it is a specific type of conversation, namely a negotiation. This idea is implicitly present in (Hoppenbrouwers et al. 2005) where the dialogue structure contains negotiation elements such as propose and accept. We elaborate this point in the following sections. (Hoppenbrouwers et al. 2005) also advocates the use of controlled language and validation. We consider the latter as problematic as it has often been observed that domain experts falsely agree with a model not being fully aware of all its implications.

While the approaches discussed so far address the structure of the modeling process itself, (Persson 2001) and (de Araujo and Borges 2007) look at the environment in which this process is embedded. They study the influence of situational factors on modeling. The authors' aim is to create an environment that facilitates and supports participative modeling in enterprise or software engineering, respectively.

Another type of work that is related to ours is that around brainstorming methods that can be considered as methods for the creation of rudimentary models in an unstructured problem area (see e.g. (Belton et al. 1997; Conklin et al. 2003)). Our approach continues this work into the more structured phases of modeling.

Yet another view on collaborative modeling is related to techniques that support the modeling creation. An example of that is studied under the heading "collaborative graph editing" where the focus is on real-time collaboration on the graphical representation of a model (WYSIWIS=What You See Is What I See). (Meire et al. 2003, 2007) suggest a technique that allows for transparent multi-person editing of a diagram by providing a mechanism to manage a hierarchy of local model versions. The approach does not offer a mechanism for the reduction of the ensuing multitude of versions to a single model, though, which is our aim. But the live character and immediate interaction of this method are strong motivational factors for engaging participants and keeping them involved.

Research methodology

In principle our study follows a design science approach (Hevner et al. 2004). Based on a first empirical study we developed an initial "theory" of the collaborative modeling process and an artifact (tool) that supports this process. The tool, as a concrete realization of this theory, was then used

in two different ways: First, to test the validity of the initial theory by putting the tool into a practical usage context; and second as an instrument to collect further, more detailed data on the modeling process to refine the theory. It is this second aspect that we address in this paper.

The preparatory study consisted of controlled student experiments with the aim of discovering the principle nature of the modeling process and some basic activities in it. The results were the Collaborative Modeling Architecture (COMA) and the COMA tool. Part of this work is published in (Rittgen 2007). We summarize the results in the sections “The COMA Approach” and “The COMA Tool” as far as is necessary.

In the main study we observed 14 modeling teams comprising a total of 58 participants. The latter were employees and consultants working for a manufacturer of mobile network components, henceforth called MobCom. We collected data on the group size, number of modeling sessions, rounds per session and the activities of each member: the proposals made, the assessments regarding each proposal (supports or challenges) and the verbal comments to each proposal. The former two have been recorded by the tool; the latter were noted as ticks in a quadratic matrix over the participants to record source and target of the comment, i.e. a tick in row two, column four refers to a comment made by group member two and directed to group member four. A modeling session is determined by a modeling assignment, e.g. “Develop a model for the handling of problem goods.” All assignments concerned a part of the business process analysis of the Customer Distribution Center of MobCom. Each session consists of a number of rounds at the end of which a new version of the group model emerges.

The data is subjected to different statistical analyses to determine types of participants (roles), the profile of each role, team organization, elementary modeling activities and a generic procedure for tool-supported modeling.

The COMA approach

The Collaborative Modeling Architecture (COMA) is the result of a study of the modeling behavior during group modeling sessions. The study took on the form of semi-structured observation of student modeling groups. Data was collected with the help of the think-aloud process-tracing methodology (Ericsson and Simon 1993; Srinivasan and Te’eni 1995), the transcription of conversations during modeling and the produced models themselves. The pre-categorization was done based on the semiotic ladder (Stamper 1991) from organizational semiotics which distinguishes 6 levels: physical world (signals), empirics (patterns), syntactics (formal structure), semantics (mean-

ings), pragmatics (intentions) and social world (beliefs). (Rittgen 2007) discovered that the majority of the activities take place on the pragmatic and social levels. In this paper we therefore focus on these two levels.

The social level

The social norms within a modeling team are mainly made up of rules for determining whether a proposal is accepted or rejected. We observed that these rules do not have to be opposites which allows for situations where a proposal can be neither rejected nor accepted. A termination rule was applied occasionally to force a decision if a negotiation got stuck. We witnessed two types of rules:

- *Rules of majority*, where a certain number of group members had to support or oppose a proposal in order for the whole group to accept or reject it (e.g., more than half). A tie-break rule was sometimes specified involving seniority issues.
- *Rules of seniority*, where the weight of a group member’s support or opposition was related to his or her status within the group. This status could be acquired (e.g., by experience) or associated with an appointed position (e.g. an experienced modeler).

The pragmatic level

On the pragmatic level we observed the utterances during a modeling session and classified them into pragmatic categories such as question, answer, model proposal, change request, comment and so on. We thereby discovered that the majority of the activities on the pragmatic level were associated with negotiation. This is surprising as modeling is often pictured as a creative act with some input from domain experts. An analysis of the dependencies between activities on the pragmatic level revealed a workflow-like negotiation structure that follows a certain pattern. The activities in this pattern were used to build a tool that supports precisely these activities as they were the ones we observed in unsupported modeling (i.e. with only paper and pencil).

The COMA tool

The architecture of a collaborative modeling tool is still under investigation. Some authors have suggested groupware systems that help in collective sense-making (Belton et al. 1997; Boehm et al. 2001; Briggs et al. 2003; Conklin et al. 2003; Hoppenbrouwers et al. 2006) which is part of modeling. They are suitable when we focus on ideation and divergent tasks, e.g. as in brainstorming (Nunamaker et al. 1997). But our aim is to build consensus and make different

views converge. Convergence is harder to achieve than divergence (Clark and Brennan 1991) and requires facilitation and advanced mechanisms such as negotiation support, i.e. a mechanism that facilitates structured arguments and decisions regarding modeling choices. A first step in this direction was made with the EMS-IDEF0 tool (Dean et al. 2000).

The authors name a number of benefits a collaborative modeling tool can provide, e.g. reduced modeling time, increased model quality and increased group productivity. Due to tool restrictions they could not be fully leveraged. The COMA tool aims at leveraging them by adding support for graphic modeling, local views, their mutual exchange and evaluation, and their final convergence to a common model. To achieve this we shaped the functionality of the tool after the insights from the preparatory study (Rittgen 2007). Regarding the syntactic level of the modeling process we relied on an existing modeling tool. COMA is therefore primarily situated on the pragmatic and social levels. On the former it specifies distributed model negotiation, which can be seen as a special case of a distributed decision support system (Aiken et al. 1995). The social rules are supported by the tool, too.

Negotiation in the COMA tool

Distributed model negotiation means the coordination of the efforts of a number of modelers. The results from the preliminary study suggest that such a system must provide the following functions:

- Propose a model
- Support a proposal (argument optional)
- Challenge a proposal (constructive argument obligatory)

In addition each modeler needs a view of the modeling process:

- The current stable version of the model as agreed upon so far
- A version that can be edited by the modeler
- The proposals made by the other modelers

Regarding the negotiation status a modeler needs the following information:

- What are the arguments for and against a proposal?
- How many supports and challenges are there?

The user interface of the COMA tool

The modeling view is divided into three tabs. The middle one shows the current group version. It is used as a reference. This means that suggested changes are made in relation to the group version. Figure 1 shows a screenshot of the COMA tool.

The left tab contains the local version, i.e. it serves as the model editor. In addition to that it provides the pragmatic functions related to making proposals. Making a proposal implies that the local version is published. A negotiation view shows a list of pros and cons for the proposal (supports and challenges, a pop-up menu not shown in the figure). Depending on the currently active social rule this determines acceptance or rejection of the proposal. The facilitator might also force a decision. An accepted proposal makes all competing proposals obsolete so they will be deleted (but they still exist locally). If a proposal is accepted it becomes the new current version, i.e. the middle tab is updated.

Fig. 1 Screenshot of the COMA tool (version 2)

Figure 1 shows a snapshot of the modeling process at a certain stage. The pragmatic functions and the list of pros and cons are provided as pop-up menus. They are not shown in the figure. The group was in charge of developing a model for the handling of so-called problem goods, i.e. goods with an unclear recipient. In a first step they simply wrote down all the activities that are involved thus arriving at the first version V001. One member, Peter, knows from experience that the activities are performed in a certain sequence. He draws the respective diagram by copying all elements from the group tab and simply adding the arrows and rearranging the objects. He proposes this diagram and thereby makes it accessible to the other group members who can now comment on it or also suggest their own versions.

Jenny, the group member from whom the screenshot in Fig. 1 was taken, decides to load Peter's proposal in her proposal tab (the right one). She takes a closer look at it and agrees with the principle sequence but she is quite sure that the search for the recipient is terminated as soon as the recipient is identified and that further steps are skipped. She draws the respective diagram in her local editor window (left tab) and makes a counter-proposal.

When comparing the two competing proposals the other group members decide that Jenny's proposal is more in line with the actual procedure and they log respective supports for her proposal. The new proposal was subsequently adopted by the group as version two.

Roles in collaborative modeling

As explained in the introduction the aim of this study is to identify roles, team patterns and a modeling procedure. Identifying roles is a major issue in collaborative modeling. In the simplest case it distinguishes two roles dealing with the concretization and formalization of knowledge. The former is called domain expert, the latter facilitator, model builder or system analyst (Frederiks and van der Weide 2006). Other terms to the same effect are sometimes used. More advanced approaches divide concretization into provision and elicitation yielding a third role, the elicitor or model mediator (van Bommel et al. 2006) who extracts knowledge from the domain expert and makes it accessible to the model builder.

While most of the literature assumes the necessity of a facilitator there is also empirical evidence that the facilitator makes the group less productive and slows down modeling by a factor of up to three (Dean et al. 1994). But the absence of the facilitator requires a more active involvement of the other team members in modeling as well as a good tool support as has been pointed out by the same authors. Finding out to which extent this is possible is part of our study.

The setup of the study

The 14 teams consisted of employees and externals of MobCom with different backgrounds: software developers, project managers, logistics managers, purchasers, sales people, process managers and operations staff from the logistics unit. The teams had 3 to 6 participants and were assigned 2 to 4 tasks. Each task concerned the modeling of a certain part of the business process of the Customer Distribution Center which handles all logistics operations, inbound and outbound. The division into tasks was necessary due to the complexity of the process, which e.g. consists of more than 150 major steps just for the reception of goods. Each assigned task was handled within a modeling session, which consisted of 1 to 5 rounds. A round is terminated when the group has developed a new version of the model.

We did not make any role assignments and left it up to the participants themselves to decide in which way they wanted to contribute. All participants had access to a networked laptop and the COMA tool. The participants could contribute in three different ways: by submitting a proposal containing their view; by assessing the proposal of somebody else via the tool; or by uttering a verbal comment on it via Voice-over-IP.

Analyzing the proposal behavior

An important activity in modeling is to propose a model that shows the individual view of a participant to the rest of the group for discussion, comments and assessments. We therefore started our analysis of the empirical data there. The primary variable is the number of proposals each participant made per round. A participant can make a maximum of one proposal in each round. The average number of proposals per round for a participant therefore ranges from 0 to 1.

To identify roles we looked for classes of behavior in terms of proposals by way of cluster analysis. This means that we looked at the recorded activities to see which people make proposals and how much they differ from the respective group model. People with similar behavior are then put into one cluster. As the number of clusters was initially unknown we decided to perform a *k*-means cluster analysis for reasonable values of *k* ranging from 2 to 5.

To compare the quality of the different cluster analyses the Dunn index has been found a useful instrument (Bezdek et al. 1997). It is the ratio of the minimum inter-cluster distance to the maximum cluster diameter. The distance is "nearest neighbor"; the cluster diameter is the average distance (radius) of cluster members to the centroid times two. If we graph the Dunn index vs. the number of clusters we see a spike at 3 showing the maximum Dunn index, i.e.

the clustering with the clearest separation (small clusters far apart).

To further differentiate between proponents we also looked at the content of their proposals. We measured it in terms of changes made with respect to the current version of the group model. An added, removed or changed element (vertex or edge) was counted as one change and the total number of changes to the group model was recorded for each proposal. We performed a two-step cluster analysis with the three clusters identified so far as the categorical variables and *Proposals/round* and *Changes/proposal* as continuous variables.

The profile for cluster 1 shows that the participants in it do not make any proposals. We therefore label them *Informants* as they contribute comments and/or assessments but no diagrams. The group members in cluster 2 make proposals only occasionally, i.e. in less than a third of the cases, and their proposals contain only minor changes (1.7 on average). They do not submit substantially new models but rather corrections to existing ones. So like the informants they criticize the model but they do it in a more constructive way. We therefore labeled them *Editors*.

Cluster 3 is characterized by a high frequency of proposals (78 %) and an equally high number of changes (8.7). This group of participants actively works on the model and accounts for most of the content of the final version. We are therefore justified in identifying them as *Modelers*.

Analyzing comments and assessments

Each participant had two ways of expressing opinions. A comment is communicated verbally to the proponent. It may contain praise or dispraise but mostly it gives concrete directions such as identifying alleged problems with the model or suggesting possible changes. The proponent usually reacts to a comment by countering the criticism or by agreeing to it and making the required changes. An assessment is a more formal expression of opinion. It is done via the tool and it includes both a vote and a textual justification. It is accessible to others and is important for the acceptance decision. The proponent can react to it by adapting the local model accordingly and making a new proposal.

It should be noted here that the local model can be seen as the decentralized version of the process design, whereas the group model can be seen as the centralized model that is accepted globally.

For each proposal we observed each comment and assessment and recorded their source and target. For an assessment this data is collected by the tool; for a comment we have ticked it off manually on an observation schedule. From this we computed the variables *Comments/proposal* and *Assessments/proposal*. We ran a *k*-means cluster analysis on both with *k* ranging from 2 to 4 which gave six new variables for clustering.

We then performed one cross-tabulation each for the variable pairs *Role* $\times$ *2-means c/p*, *Role* $\times$ *3-means c/p*, *Role* $\times$ *4-means c/p*, *Role* $\times$ *2-means a/p*, *Role* $\times$ *3-means a/p* and *Role* $\times$ *4-means a/p* to determine clustering quality in terms of correlation with the categorical variable. A cross tab shows the joint distribution of two or more variables and allows for an easy comparison by visual inspection. In our case the variables are the number of clusters (2-3) and the respective number of comments or proposals. Cramér's *V* was used as the correlation coefficient. The results are shown in Table 1 (columns 1-4).

Regarding comments the 2-means clustering represents the best fit with a clear distance to the others. In the case of assessments the coefficients are closer to each other with 0.979 being the maximum but closely followed by the 2-means value (0.91). A visual inspection of the respective clustered bar charts confirms that the 3-means clustering is indeed the best fit. Table 1 shows a summary of the cluster centers for the optimal clusterings (columns 5-8).

We have labeled the clusters with the frequency categories low, medium and high by dividing the interval [0, 1] in three segments of equal size. If we summarize all the results regarding role behavior, we arrive at the role-activity pattern in Table 2.

The modeler usually proposes a model. Although her role does not require it she still makes assessments fairly often which points to a pronounced interest in actively contributing to the solution beyond the creation of own proposals. The editor contributes occasional proposals with minor corrections but is very active in making comments to the proposals of others. His rate of comments is lower than that of the informant which might indicate that he expresses some of his comments in the form of direct corrections to the model, i.e. as proposals. He is also fairly active in assessing proposals which again implies a more constructive role in modeling than that of the informant. The informant never makes proposals. This is probably due to a lack in modeling literacy but can also be a sign of missing

Table 1 Cramér's *V* of the clusterings vs. the *Role* variable and centers for optimal clusterings

Clustering	2-means	3-means	4-means	Cluster	1	2	3
Comments/proposal	1.000	0.698	0.648		0.79	0.20	
Assessments/proposal	0.910	0.979	0.836		0.07	0.55	0.87

Table 2 Role-activity pattern

	Proposals	Comments	Assessments
Modeler	High (78 %)	Low (22 %)	Medium (59 %)
Editor	Low (31 %)	High (72 %)	Medium (45 %)
Informant	None	High (83 %)	Low (5 %)

motivation. She makes comments on most of the proposals but assesses them rarely. The latter can be interpreted as poor agreement with the project goals or as an attitude of not being responsible for the project results.

Team patterns in collaborative modeling

The previous section focused on the activities of each team member. We now want to go one step further and understand how the individuals collaborate and in which way the team is structured. Are there certain patterns of team organization? As each team member was free to decide which role he wants to play and how he contributes to the teamwork it is not self-evident that certain patterns emerge. Most of the patterns identified in the literature and mentioned in the preceding sections are the results of careful planning and the roles are assigned to the participants beforehand. But will self-organized teams also tend to develop certain structures?

To answer this question we have used the results from the role analysis and analyzed the data again with respect to the identified roles. For each team we have assigned (*ex post*) a role to each member according to the member's activity profile. We have then used the data from the comments and assessment matrices to map the communication between group members. As a result we got 14 graphs that we categorized according to the roles that are present in the respective graph. We determined a suitable name for each of the four categories that we found.

This left us with 4 final categories that subsume all team organizations observed in our study. We chose a prototypical graph for each of the categories to visualize the generic team organizations. The results are in Table 3, including the number of teams exhibiting this pattern.

We have termed the team organizations in the first row full cooperation. In them all team members actively contribute as modelers and work very closely in advancing the model. It is noteworthy that most communication is formal, i.e. takes place via the tool in the form of assessments and rationales. This might be due to a preference for formal exchange in general that is in line with the formal nature of the modeling activity but a major reason is the reluctance to distract a fellow modeler by making a synchronous verbal comment that requires

immediate attention. The decision to accept a proposal is made by the group in a democratic fashion. The selected proposal is often the one with the largest number of supports. If no unique best candidate exists the group discusses the options to arrive at a decision. Sometimes this means that they merge two proposals into a new one that then becomes the new version of the group model.

Supported cooperation involves both modelers and informants. This is the most usual form that has been observed. The modelers form a cooperative core as in full cooperation but they are supported by a team of informants that provide the necessary domain knowledge and make sure that the model develops in the “right” direction, i.e. in line with domain concerns and organizational objectives. The informants contribute suggestions in the form of verbal comments which the modelers incorporate into their models if appropriate. This can involve some discussion to make sure that the comments are understood in the intended way.

Partial cooperation occurs when the team contains editors. The editors partly join the core modeling team where they contribute with proposals and assessments. But at the same time they are also on the informant team where they support the modelers with comments. This dual role gives them a mediator status. Depending on the kind of issue they want to raise they decide whether to implement the resulting changes directly into the model or, in the case of more substantial revisions, to make a respective comment. The editor role is very important, not only because it mediates between modelers and informants but also because it is a stepping stone between those roles that reduces the gap between IT and domain experts.

The single-modeler situation comes closest to the team organization suggested by most of the literature where a facilitator is the model creator, decision-maker and elicitor of knowledge. All other team members are informants that provide the input for modeling as well as comments on the suitability of the output.

The collaborative modeling procedure

To understand the constructive part of team modeling we traced the use of the tool and the comments in terms of activity sequences. As basic activities we considered the major functions that the tool provides plus the comments, which also contribute directly to model creation. This resulted in the following activities: Start round, Create local model, Propose local model, Load other proposal, Load own proposal, Support/challenge proposal, Look at assessments, Address challenges, Adapt local model, Make comment, Address comment, Look at negotiation, Accept proposal. The observation schedule contained a column for

Table 3 Patterns of team organization

Full cooperation	2	Everyone models and interacts with everybody else.
Supported cooperation	4	A core of a few people model and cooperate closely with each other, the others support them by providing information.
Partial cooperation	5	Some people model and cooperate closely, the others adapt the models or provide information.
Single modeler	3	Only one person models, the others contribute information.

each participant where the abbreviated activity was recorded in the correct time order.

We analyzed the observed data by first constructing a square matrix over the activities where the entry in row i and column j corresponds to the relative frequency of activity i directly preceding activity j . From that we derived the adjacency matrix by setting all entries below 0.01 to 0 and all others to 1. This implies an elimination of statistically insignificant sequences that occur in less than 1 % of the cases.

The next step is the construction of the corresponding graph, which is shown in Fig. 2 where the edges are labeled with the activities to increase readability.

The diagram in Fig. 2 shows all the paths that can be travelled but it does not imply that all the participants walk along all the paths. Depending on their role team members have a preference for certain paths. The typical paths per role are as follows:

- Informant:** Load other proposal → Make comment
- Editor:** Load other proposal → Support/challenge proposal
- Create local model (based on another proposal) → Proposal local model
- Modeler:** Create local model → Propose local model
- Load own proposal → Look at assessments → Address challenged → Adapt local model → Propose local model
- Address comment (by countering it)
- Address comment (by changing own model) → Adapt local model → Propose local model

It should be observed that these results apply to modeling with the COMA tool. Nevertheless, the tool was developed to support the activities that were observed in modeling session not supported by the tool which lends some credence to the hypothesis that the generic process paths in Fig. 2 play a role in any collaborative modeling project although they are certainly not complete.

The steps that involve the tool can be done in a distributed and asynchronous way; the verbal communication will require a synchronous teleconference.

Discussion

The study we present is part of a larger effort that follows the principles of design science research. The prototype of the COMA tool was for example developed in two iterations of the design science cycle. The first one was built on the theoretical results that came out of an empirical study that involved the observation of modeling behavior of students (Rittgen 2007). This first version was then used in a student experiment where the goal was the evaluation of the tool. The empirical feedback from the questionnaires was then used to build an improved version 2 of the tool, the one we used in this study.

In the current study the tool is no longer the objective of the research but an instrument that collects data about modeling behavior more efficiently. So we leave the inner design circle and enter the rigor circle. The purpose of this circle is to produce theoretical results also called contribu-

Fig. 2 The collaborative modeling procedure with COMA

tions to the knowledge base. In our case they consist of the roles that people adopt in the team, patterns of team organization and the modeling process (procedure). Other important findings are that people even without prior modeling knowledge are able to create real-life models with little initial training and that teams are able to organize themselves in such a way that the business process knowledge and the modeling skills of each participant are used in the best possible way under the circumstances.

But we also recognized that team work could be improved if members had a higher level of motivation. The COMA tool gives people the pleasure of showing their creativity but some people are still not very active. We therefore plan to investigate other mechanisms that could work as an incentive for a more active involvement in modeling. The approach so far only considers as-is modeling and needs to be extended to to-be modeling. We will also take a more comprehensive look at the factors that determine the success of modeling. In addition we also work on a process modeling procedure that embeds the tool in a well-defined procedure for arriving at sound models.

Another issue is that of interorganizational collaboration and eCollaboration. In a traditional process modeling exercise the participants usually come from all the organizational units within a company. But these units have some independence so they can be seen as an analogy to an interorganizational scenario. In this sense we are confident that this approach will also work for participants from different organizations, especially because the tool support allows them to work together at different physical places while connected via the tool and a video or audio conferencing system.

Can the findings be generalized? It is dangerous to extend the results from a single case study, albeit done very thoroughly, to a larger population of organizations. This is especially true in modeling where the context, i.e. the organizational setting, plays a very important role. We have therefore conducted similar case studies in other organizations that confirm the results but also deliver further insights into the modeling process. The involved organizations worked in the insurance, healthcare, engineering and public administration sectors and employ between a few hundred and many thousand people. Respective publications are forthcoming.

We think that our case study is unique in that we allowed teams to organize themselves whereas the rule is to have a strict organization determined from outside or by the facilitator. While this gives the facilitator a strong position to ensure a result, it also introduces two major problems: facilitator bias and bottleneck. The content of the model is determined by the facilitator and hence filtered by his perceptions. He also becomes a bottleneck in the modeling

process because everything has to go via him, delaying the process and slowing down the individuals' deliberation processes. COMA has the potential to eliminate both of these concerns.

The COMA procedure has so far only dealt with process modeling but we are confident that the approach can also be used in other areas as it already contains diagrams for data modeling, use case modeling and so on, although the procedure has yet to be developed for these areas. The COMA tool stores the models in an XML format so that they can be imported into other modeling tools or model management systems.

Conclusion

The objectives of this paper are to identify roles and team patterns in self-organized modeling to see whether the COMA procedure induces stable modeling behavior even in the distributed, unfacilitated scenario of interorganizational process design and whether the participants find their roles and contribute in a constructive way to reach a consensus on the process model. This is our most important contribution as other modeling methods do not work in interorganizational settings.

The identified emergent roles are that of modeler, informant and editor. The latter is important as it serves as a mediator that facilitates communication and mutual understanding among team members with different backgrounds. Many editors did not have a modeling or even engineering background which makes it a likely role for practically any stakeholder in the modeling process. This opens up a chance for greater stakeholder involvement, which in turn increases the accuracy of models and ultimately the quality of information systems as perceived by the ones concerned.

Regarding the second objective of team pattern identification we have seen that the self-organization of modeling teams does not lead to chaos. It does not even lead to shifting role behaviors or a plethora of organizational forms. Instead it yields a limited amount of well-structured and well-behaved patterns that function even in the absence of a facilitator provided that sufficient modeling and model assessment competence is available in other members.

To assess the validity of the results the influence of the data collection instrument is relevant. It cannot be denied that the use of the tool has had an impact on the way in which modeling was performed. But in developing the tool we have taken utmost care in not prescribing a certain way of using it. Users can, for example, circumvent the assessment and voting process. They can even bypass the whole negotiation. In an extreme case the tool can even be

used as a conventional single-person diagram drawing tool. Apart from that the participants were also free to collaborate without the tool by engaging in personal communication or by working together on the same computer or by simply walking around and looking at somebody else's screen. We are therefore confident that the tool augmented the participants' possibilities of collaboration rather than restricting them to a specific behavior. As a consequence we believe that the results are valid with respect to the roles and team patterns we identified.

Another validity concern is the selection of participants. In our study they were all recruited from the same company but from a wide range of different departments: purchase, sales, process and quality control, arrival, dispatch, packaging, software development etc. This means that they covered a variety of backgrounds regarding domain expertise and modeling literacy which ensures that a broad range of possible behavior has indeed been observed and that the results concerning roles and team patterns are valid. It should be observed, though, that the distribution of roles and team patterns, i.e. the frequency of occurrence of each role or team pattern, cannot be generalized. Other studies will find different amounts of e.g. editors or full-cooperation teams as the distributions in our study are owed to the particular combination of participants with engineers and software developers being somewhat over-represented.

As a further limitation we should mention that we observed modeling outside of people's day-to-day work environments, as modeling was organized in the form of a project. If modeling becomes part of normal work-life where the responsible parties from different organizations regularly adapt the models to changing requirements, we might observe other roles and patterns.

In our study we did also not look at the effectiveness or quality of the outcomes of the four different patterns of organization. We assumed that each group would form a team organization that is optimal from their point of view for solving the problem at hand. Nevertheless a future study looking at this issue could reveal relevant insights.

References

- Aiken, M., Vanjani, M., & Krosp, J. (1995). Group decision support systems. *Review of Business*, 16(3), 38–42.
- Belton, V., Ackermann, F., & Shepherd, I. (1997). Integrated support from problem structuring through to alternative evaluation using COPE and V.I.S.A. *Journal of Multi-Criteria Decision Analysis*, 6(3), 115–130.
- Bezdek, J. C., Li, W. Q., Attikiouzel, Y., & Windham, M. (1997). A geometric approach to cluster validity for normal mixtures. *Soft Computing*, 1(4), 166–179.
- Boehm, B., Grunbacher, P., & Briggs, R. O. (2001). Developing groupware for requirements negotiation: lessons learned. *IEEE Software*, 18(3), 46–55.
- Briggs, R. O., de Vreede, G. J., & Nunamaker, J. (2003). Collaboration engineering with thinklets to pursue sustained success with group support systems. *Journal of Management Information Systems*, 19, 31–63.
- Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. In L. B. Resnick, J. Levine & S. D. Teasley (Eds.), *Socially shared cognition* (pp. 127–149). Washington, DC: American Psychological Association.
- Conklin, J., Selvin, A., Buckingham Shum, S., & Sierhuis, M. (2003). *Facilitated Hypertext for Collective Sensemaking: 15 Years on from gIBIS*. Paper presented at the Proceedings of the 8th International Working Conference on the Language-Action Perspective on Communication Modeling (LAP'03), Tilburg, The Netherlands.
- de Araujo, R. M., & Borges, M. R. S. (2007). The role of collaborative support to promote participation and commitment in software development teams. *Software Process Improvement and Practice*, 12(3), 229–246.
- Dean, D., Orwig, R., Lee, J., Vogel, D. (1994). Modeling with a group modeling tool: group support, model quality, and validation. In *Proceedings of the Twenty-Seventh Hawaii International Conference on System Sciences. Vol. IV: Information Systems: Collaboration Technology Organizational Systems and Technology, 4–7 Jan 1994* (Vol. 4, pp. 214–223). Los Alamitos, CA: IEEE Computer Society Press.
- Dean, D. L., Orwig, R. E., & Vogel, D. R. (2000). Facilitation methods for collaborative modeling tools. *Group Decision and Negotiation*, 9(2), 109–127.
- Ericsson, K., & Simon, H. (1993). *Protocol analysis: Verbal reports as data*. Boston: MIT.
- Frederiks, P. J. M., & van der Weide, T. P. (2006). Information modeling: the process and the required competencies of its participants. *Data & Knowledge Engineering*, 58(1), 4–20.
- Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *Management Information System Quarterly*, 28(1), 75–105.
- Hoppenbrouwers, S. J. B. A., Lindeman, L., & Proper, H. A. (2006). Capturing Modeling Processes—Towards the MoDial Modeling Laboratory. In R. Meersman, Z. Tari & P. Herrero (Eds.), *On the Move to Meaningful Internet Systems 2006: OTM 2006 Workshops—OTM Confederated International Workshops and Posters, AWESOME, CAMS, COMINF, IS, KSinBIT, MIOS-CIAO, MONET, OnToContent, ORM, PerSys, OTM Academy Doctoral Consortium, RDDS, SWWS, and SebGIS, Proceedings, Part II, Montpellier, France* (Vol. 4278, pp. 1242–1252). Berlin, Germany: Springer.
- Hoppenbrouwers, S. J. B. A., Proper, H. A., & van der Weide, T. P. (2005). Formal Modelling as a Grounded Conversation. In G. Goldkuhl, M. Lind & S. Haraldson (Eds.), *Proceedings of the 10th International Working Conference on the Language Action Perspective on Communication Modelling (LAP'05)*, Kiruna, Sweden (pp. 139–155). Linköping and Borås: Linköpings Universitet and Högskolan i Borås.
- Meire, A. P., Borges, M. R. S., & de Araújo, R. M. (2003). Supporting collaborative drawing with the mask versioning mechanism. In J. Favela & D. Decouchant (Eds.), *Groupware: Design, implementation, and use, 9th International Workshop, CRIWG 2003, Autrans, France, September 28–October 2, 2003, Proceedings* (Vol. 2806, pp. 208–223). Berlin: Springer.
- Meire, A. P., Borges, M. R. S., & de Araújo, R. M. (2007). Supporting multiple viewpoints in collaborative graphical editing. *Multimedia Tools and Applications*, 32(2), 185–208.
- Nunamaker, J. F. J., Briggs, R. O., Mittleman, D., & Vogel, D. R. (1997). Lessons from a dozen years of group support systems research: a discussion of lab and field findings. *Journal of Management Information Systems*, 13(3), 163–207.

- Persson, A. (2001). *Enterprise modelling in practice: situational factors and their influence on adopting a participative approach*. Department of Computer and Systems Sciences, Stockholm University.
- Rittgen, P. (2007). Negotiating models. In J. Krogstie, A. Opdahl & G. Sindre (Eds.), *Advanced information systems engineering, 19th International Conference, CAiSE 2007, Trondheim, Norway, June 2007, Proceedings, LNCS 4495* (pp. 561–573). Berlin: Springer.
- Srinivasan, A., & Te'eni, D. (1995). Modeling as constrained problem solving: an empirical study of the data modeling process. *Management Science*, 41(3), 419–434.
- Stamper, R. (1991). The semiotic framework for information systems research. In H. Nissen, H. Klein & R. Hirschheim (Eds.), *Information systems research: Contemporary approaches and emergent traditions* (pp. 515–517). Amsterdam: North-Holland.
- van Bommel, P., Hoppenbrouwers, S. J. B. A., Proper, H. A. E., & van der Weide, T. P. (2006). Exploring Modelling Strategies in a Meta-modelling Context. In R. Meersman, Z. Tari & P. Herrero (Eds.), *On the Move to Meaningful Internet Systems 2006: OTM 2006 Workshops - OTM Confederated International Workshops and Posters, AWESOMe, CAMS, COMINF, IS, KSinBIT, MIOS-CIAO, MONET, OnToContent, ORM, PerSys, OTM Academy Doctoral Consortium, RDDS, SWWS, and SebGIS, Proceedings, Part II, Montpellier, France* (Vol. 4278, pp. 1128–1137). Berlin, Germany: Springer.