The Role of Editor in Collaborative Modeling

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ABSTRACT
In business processes, modeling is usually a collaborative activity. In it stakeholders analyze or design business processes. One of the challenges is that group members have diverse backgrounds and conflicting interests which make it difficult to arrive at a model that represents a consensus. It is therefore important to study the way in which modeling teams are organized to overcome these problems. To approach this issue we investigated the modeling behavior of such groups with the help of a tool that supports collaborative modeling while at the same time allowing for the effective collection of data on modeling activities. Besides confirming known roles we also discovered a new one, editor, that only emerges in tool-supported sessions and that functions as a mediator between modeling experts and domain experts.

Categories and Subject Descriptors
K.6.1 [**Management of Computing and Information Systems**]: Project and People Management – *Systems analysis and design*

General Terms
Management, Design, Human Factors.

Keywords
Group modeling, tool-supported modeling, roles in modeling, e-collaboration, business process management.

1. INTRODUCTION
The purpose of this paper is to study the emergence of self-adopted roles in collaborative modeling of business processes. We are interested in observing which roles participants of a modeling session take on themselves if they can choose freely in which way they would like to contribute. There is already a substantial body of literature in this area as reviewed in the next section. But in these studies the roles are pre-determined before the session and participants are expected to behave according to their assigned roles.

The modeling process is portrayed as a highly organized activity that nevertheless delivers poor results. A central tenet in existing research is the important role of the facilitator. He coordinates the modeling session, elicits relevant information for model building from domain experts, and is often also involved in model creation.

We challenge both the necessity of a highly organized process and the role of the facilitator. We do agree, however, that a facilitator is usually necessary but model building can, at least in parts, be done by participants as well. We assume that the conventional modeling process forces a way of working on people that under-estimates their capabilities and puts too much work load on the facilitator leading to poor results in terms of model quality, participant satisfaction and consensus.

In that context we also address the role of the medium. In most studies the primary medium used is paper-based (e.g. flipcharts, brown paper, post-its) [1-4]. Such a medium might limit the way in which participants can contribute to model building. We have therefore provided the modeling teams with computer support to encourage new forms of behavior. They have not been forced to make use of that support, though.

The purpose of this paper is not to validate any claim. We rather want to explore the questions:

- What happens if we drop the strict organization of conventional modeling sessions and allow teams to organize themselves to a certain degree? Which roles emerge in such self-organizing teams with and without a facilitator?
- What is the role of the medium in that process? Will support by a computer tool lead to different, new behavior?

In the following we first take a look at the existing literature on collaborative modeling. We then proceed with a description of our research methodology. After that we analyze the data identifying roles in collaborative modeling. We then discuss the new role of editor and its function as a mediator between domain experts and modeling experts.

2. RELATED RESEARCH

2.1 Roles in Collaborative Modeling
In [5] modeling involves domain experts, modeling mediators and model builders. It is seen as an information gathering dialogue where knowledge is elicited from the domain experts. [4] acknowledges that modeling is not only a knowledge elicitation process but also a knowledge creation and dissemination process. We agree with the latter view and studied situations where the participants, apart from the facilitator, had no *a priori* roles.

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[2] 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. A detailed process model of both activities is given. [3] distinguishes between an elicitation and a formalization dialogue and develops a modeling procedure by generalizing existing procedures for specific modeling languages.

Other related work is that on brainstorming that provides methods for creating rudimentary models in an unstructured problem area (see e.g. [6, 7]). Our approach continues this work into the more structured phases of modeling.

Identifying roles is a major issue in the literature on collaborative modeling. In the simplest case it distinguishes two principle roles that deal with the concretization and formalization of knowledge, respectively. The former is called domain expert, the latter model builder or system analyst [2]. Other terms to the same effect are sometimes used. More advanced approaches further divide the concretization of knowledge into provision and elicitation yielding a third role. Besides the domain expert who now only provides knowledge there is an elicitor or model mediator [5] who extracts this knowledge from the domain expert and makes it accessible to the model builder.

Another division of labor that is often discussed is that between domain expert and facilitator or chauffeur. While most of the literature assumes the absolute necessity of a facilitator to manage the modeling session there is also empirical evidence that the chauffeur makes the group less productive and can slow down modeling by a factor of up to three [8]. 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.

An elaborate set of five roles is suggested by [9]: Facilitator, modeler/reflector, process coach, recorder and gatekeeper. The first two roles have already been mentioned. The process coach serves the facilitator in managing the modeling process, a role that is only necessary in large modeling projects. The recorder (sometimes called a scribe) is a person who records important events in the form of text and diagrams. This role is sometimes played by the facilitator. The gatekeeper acts as a devil's advocate for both the modeling team and the client organization, defending the modeling process against the client and the client's problem against the modeling team. We come back to this classification later.

2.2 Tool Support

Already in the 90s researchers at the University of Arizona were convinced that the use of computer support would substantially improve group modeling [10]. They built a group modeling support system built on existing electronic meeting systems. They used the IDEF0 activity modeling language but the tool was essentially a collaborative text editor for model input that was later complemented by a graphical viewer on a separate (!) workstation.

Manipulation of the graph itself was not possible. The approach was later extended to a graphical process language [11]. The tool was found successful for large groups around 20 people but less so for the typical group size of around 10 found in business process modeling. Negotiation was not supported and only one member of each team worked on the model while the others watched and commented.

Another example of tool support is collaborative graph editing where the focus is on real-time collaboration on the graphical representation of a model (What You See Is What I See) [12, 13]. The approach does not offer a mechanism for reducing the multitude of versions to a single model, though.

3. RESEARCH METHODOLOGY

The current study is of an explorative nature and takes on the form of a field experiment. From an epistemological point of view we take a constructivist stance, i.e. we assume that a model is a socially constructed (and negotiated) view on reality.

3.1 Set-Up of the Field Experiment

In the current study we observed the behavior of 14 modeling teams comprising a total of 58 participants who work for a large 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, i.e. the proposals made and the assessments of them (supports or challenges). They have been recorded by the tool described below.

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 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 modeling 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, and because each part of the process was only known to the people immediately concerned with it. 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.

Together with the group we decided in advance whether the sessions should be chauffeured; if so we determined a suitable facilitator who was also required to provide a model per round. Apart from this we did not make any role assignments and left it up to the participants to decide for themselves in which way they wanted to contribute. 6 sessions were chauffeured, 8 were not.

All participants had access to a networked laptop and the tool. They were sitting around a table allowing them to communicate face to face as well as via the tool. They could contribute in three different ways: by submitting a proposal containing their view (i.e. their personal version of the model); by assessing the proposal of somebody else (support or challenge accompanied by a rationale via the tool); or by uttering a verbal comment on it (e.g. suggesting improvements).

3.2 Data Collection Instrument

For data collection we used a computer-based tool that allows participants to make proposals, to look at each other's proposals and to react with critical comments or with counter-proposals. Figure 1 shows a screen shot of the tool.

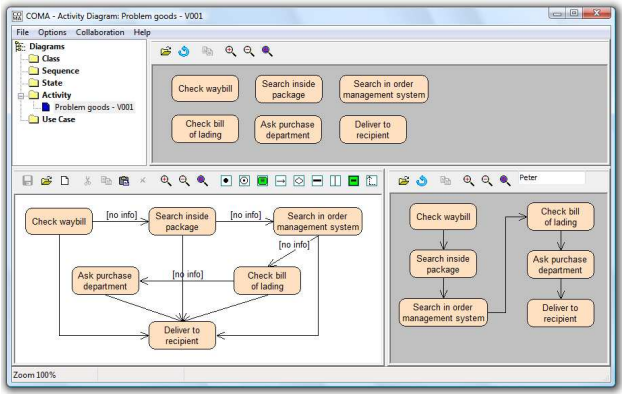

Figure 1. Screenshot of the tool

The model building view is divided into three areas. The upper one shows the current version that has emerged from the negotiation process so far. It is used as a reference for all other temporary versions such as the proposals and the local version. This means that suggested changes are always expressed in relation to the current version.

The lower left area contains the local version, i.e. it serves as a model editor. It also provides the pragmatic functions related to making proposals. Making a proposal implies that the local version is published, i.e. made accessible to the other modelers.

The lower right area allows each participant to load and view the proposal of someone else.

The negotiation view (a pop-up window) shows a list of pros and cons for the proposal (called supports and challenges). A proposal can be accepted as the new version of the model when a pre-defined number of supports has been reached, or the facilitator decides so.

The tool is useful for studying group modeling closely and for collecting data. E.g., the existence of version histories makes it possible to analyze the development stages of a model. Another example is the negotiation log that gives us deep insight into argumentation and the competition between different model alternatives.

A study supported by this tool can therefore also contribute to the development of new theories of the modeling process. In the work reported here we have used the tool for the effective collection of empirical data on the modeling process. The results we got are preliminary so far but they indicate a new avenue for research in collaborative modeling by suggesting a new role that can facilitate the modeling process when supported by a computer tool.

3.3 Research Validity

The nature of this study is explorative, i.e. the goal is not to validate or prove a theory but to find new roles in modeling that can be the basis for more in-depth research. Nevertheless, some validity concerns still arise. One is the influence of the data collection instrument. It cannot be denied that the use of the tool has had an impact on the way modeling was performed. But in developing the tool we have taken utmost care in not prescribing a certain way of using it. E.g. users can circumvent the assessment and voting process and can even bypass the whole negotiation. They can even decide not to make use of the tool at all.

The tool might be used for diagram-drawing alone and would then have a similar function as brown paper. Participants were also free to collaborate without the tool by engaging in personal talks or by working together on the same computer or by walking around and looking at somebody else's screen.

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. They covered different 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 are at least indicative. Please note that role distribution, i.e. the frequency of occurrence of each role, cannot be generalized.

In addition, all participants were at a similar power level so power distance played no role. If this is not the case the tool can be used in an anonymous way to allow team members to feel comfortable in speaking their opinion.

We assumed that participants seek a rational consensus. Political behavior can hardly be prevented by the modeling approach itself as people can always chose to fake a willingness to collaborate. In our study this could not be observed. According to the process manager, who has known them for years, all participants had an honest desire to understand the process.

The study is restricted to the as-is modeling of a complex business process. Some of the factors mentioned above will have a stronger effect in to-be modeling.

In chauffeured sessions there is a risk that the facilitator tries to manipulate the behavior of participants. We did not observe this in the 6 chauffeured session we conducted. The behavior of the non-facilitator members of the chauffeured groups in the observed categories did not differ from that of the non-chauffeured groups.

4. DATA ANALYSIS

The study aims at the identification of roles. A role is defined as a certain pattern of behavior. We therefore observe modeling behavior and classify it into different patterns. Each pattern is given an appropriate name. Classification of patterns is typically done by cluster analysis.

The data is subjected to cluster analyses and cross-tabulation to determine groups of participants that exhibit similar modeling behavior and can therefore be classified as roles. For each role we identify the profile of activities associated with it.

4.1 Analyzing the proposal behavior

One of the most important activities in collaborative modeling is to propose a local model that represents the individual view of a participant to the rest of the group for discussion, comments and assessments. We have therefore started our analysis of the empirical data there. The primary variable we investigated was the

number of proposals each participant made per round. Please recall that a round consists of all modeling activities that are required to achieve the next higher version of the group model. A participant can make a maximum of one proposal in each round but can replace an existing proposal with a new one thereby updating the old one. A participant can also decide not to make a proposal at all. The average number of proposals per round for a participant therefore ranges from 0 to 1. We discounted the facilitators whose role was already determined in advance.

To identify roles in modeling we looked for classes of modeling behavior in terms of proposals by way of cluster analysis. As the number of clusters was initially unknown we decided to perform a *k*-means cluster analysis (that assumes data is centered on *k* means forming *k* clusters) for reasonable values of *k* ranging from 2 to 5. The resulting cluster centers are shown in Table 1.

Table 1. Cluster analysis proposals

Clusters	Cluster centers					Closest neighbor	Largest diameter	Dunn index
2	0.11	0.77				0.10	0.27	0.38
3	0.00	0.31	0.78			0.13	0.20	0.64
4	0.00	0.28	0.65	0.87		0.05	0.12	0.43
5	0.00	0.22	0.34	0.87	0.65	0.04	0.11	0.36

To compare the quality of cluster analyses the Dunn index is a useful instrument [14]. It is the ratio of minimum inter-cluster distance to maximum cluster diameter. The distance measure is the nearest neighbor distance; the cluster diameter is the average distance of cluster members to the centroid multiplied by two. Table 1 lists the relevant measures. If we graph the Dunn index vs. the number of clusters we notice a spike at 3 corresponding to the maximum Dunn index, i.e. the clustering with the clearest cluster separation (small clusters far apart).

To further differentiate between proposals we also looked at their extent. We measured it in terms of the total number of changes that were made to the group model or the changed proposal. A change means adding, deleting or modifying a single model element. We have 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 resulting cluster profiles are shown in Table 2.

Table 2: Cluster profiles regarding proposals

Cluster	Proposals/round		Changes/proposal	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
1	.0000	.00000		
2	.3050	.10102	1.7000	.67495
3	.7839	.11904	8.6522	5.90538

4.2 Identifying Principle Roles

The profile for cluster 1 shows that the participants in it do not make proposals. We call them *Consultants* as their contribution consists in something else, i.e. comments and/or assessments, but not in the shaping of the diagrams. They provide advice in the form of domain knowledge.

The group members in cluster 2 make proposals occasionally, i.e. in less than a third of the cases, and their proposals contain only minor changes (1.7 on average) to the status quo. They do not submit substantially new models but rather corrections to the existing ones. So like the consultants they criticize the model but they do it in a more constructive way than voicing the criticism verbally. We have 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 call them *Modelers* (i.e. modeling experts).

Together with the pre-determined role of *Facilitator* this makes a total of four roles that were observed in this study. Most roles are in line with the ones identified in other studies (see section 2). The role of an editor is new though and will be discussed below.

4.3 Analyzing the Comments and Assessments

Each participant can express an opinion on a proposal in one of two ways. A **comment** is communicated verbally (face to face). It does not judge the proposal but gives concrete directions such as identifying alleged problems or suggesting possible changes. The proponent usually reacts to a comment by countering the criticism or by accepting it and making the required changes to the model.

An **assessment** is a more formal expression of opinion judging the proposal. It is done via the tool and it includes a vote in favor of (support) or against (challenge) the proposal and a justification of the judgment in text form. It is accessible to the participants and forms an important factor in the decision about the proposal. The proponent can react to it by revising the proposal accordingly and submitting the revision as a new proposal.

For each proposal we observed each comment and assessment that 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. We did not record the content. 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 us six new variables for the cluster membership.

Table 3. Cramér's V of the clusterings vs. the role variable and centers for optimal clusterings

	Clustering			Cluster		
	2-means	**3-means**	**4-means**	**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

We then performed one cross-tabulation each for the variable pairs *Role × 2-means c/p, Role × 3-means c/p, Role × 4-means c/p, Role × 2-means a/p, Role × 3-means a/p* and *Role × 4-means a/p* to determine the quality of the clusterings in terms of their correlation with the categorical variable. Cramér's *V* was used as the correlation coefficient between nominal variables. The results are shown in Table 3 (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 3 shows a summary of the cluster centers for the optimal clusterings (columns 5-8). Figure 2 and Figure 3 show the clustered bar charts of the optimal clusterings.

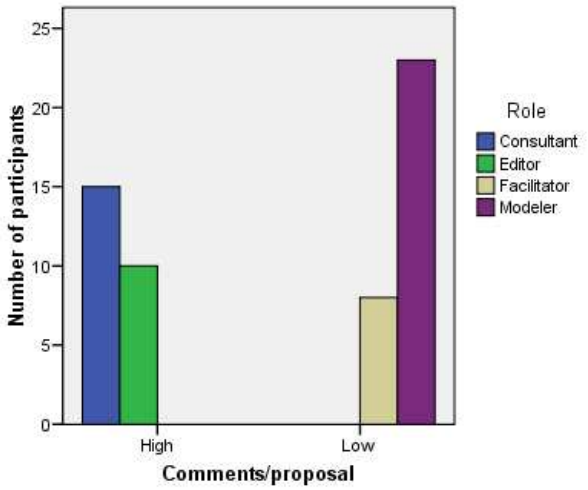

Figure 2. Clustered bar chart for the optimal comments clustering

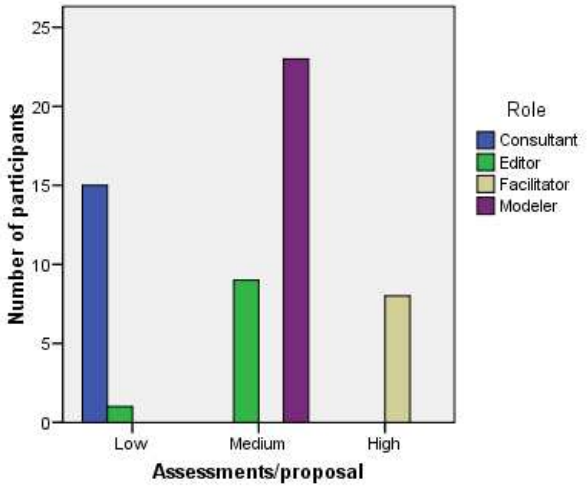

Figure 3. Clustered bar chart for the optimal assessment clustering

4.4 Roles and Their Behavior

In the figures we have labeled the clusters with a coarse categorization of the frequencies into the classes low, medium and high. For this we have divided 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 4.

Table 4. Role-activity pattern

	Proposals	**Comments**	**Assessments**
Facilitator	Always	Low (17 %)	High (87 %)
Modeler	High (78 %)	Low (22 %)	Medium (59 %)
Editor	Low (31 %)	High (72 %)	Medium (45 %)
Consultant	None	High (83 %)	Low (5 %)

A facilitator makes a proposal in every round as a mandatory part of his job. He comments rarely but assesses most proposals. This is probably because he has to make the final decision as to which proposal is accepted and that presupposes an assessment of the proposed models as well as being an assessment in itself.

The modeler has a similar profile for the most but she makes fewer assessments. Although her role does not require it she still does so fairly often which points to a pronounced interest in actively contributing to the solution beyond the creation of own proposals.

The editor makes 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 consultant 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 implies a more constructive role in model development than that of the consultant.

The consultant never makes proposals. This might be due to a lack in modeling literacy but can also be a sign of missing 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.

5. THE ROLE OF EDITOR

The role of the editor that we found in our explorative study is not mentioned in the literature on collaborative modeling to the best of our knowledge. The reasons for this might be twofold: on the one hand most modeling sessions are conducted with pre-assigned roles, i.e. the facilitator usually determines in advance who will perform which role. Participants stick to this assignment and do not have the freedom to exhibit behavior that falls outside their role.

On the other hand the medium used for modeling is often paper-based. This prevents roles from emerging which require more sophisticated support for modeling. The editor is a case in point. He assesses proposals and suggests or makes revisions. Especially the latter is hard to do on paper. Changes to a drawing can be done much more easily with a computer tool. So a potential editor is more likely to emerge in such a scenario.

The role of editor bears similarities with both the facilitator and modeler roles but has also distinct differences. While modelers would take it on them to come up with a new proposal usually in their area of expertise, editors would rather change existing proposals taking up suggestions by others and combining it with their own knowledge and that embedded in the proposal thereby fulfilling an important integrative function even if their changes were technically not comprehensive.

An editor therefore assumes the role of an "extra facilitator" to a certain degree, which substantially relieves the usual facilitator bottleneck often mentioned in the literature as an impediment to progress and consensus-building in modeling. Nevertheless, the editors did not interfere with the responsibility for the overall management of the session, which was still in the hands of the assigned facilitator.

But is the role of editor sufficiently beneficial to justify the use of a computer tool, which requires more preparation of a modeling session? In some cases editors have adapted proposals to cater for concerns voiced by other participants. In other cases they have "implemented" concrete changes suggested by somebody not able or willing to do it himself. Often this was done while the facilitator was busy with something else.

We have conducted unstructured interviews with all facilitators involved in the study to explore the potential benefits of the editor role. The benefits mentioned were shown to the other facilitators for confirmation after the interviews. The confirmed benefits are:

- Establishing a strong link between domain experts and modeling experts
- Promoting consensus by incorporating desired changes into the model
- Relieving modeling experts by performing parts of their job
- Helping domain experts in understanding the model and addressing their needs

While this list does not prove the necessity of the editor role it is a strong indication for the need of further research in this area. The mentioned benefits might easily outweigh the effort of using a computer tool.

6. CONCLUSION

The objective of this paper is to identify roles in collaborative process modeling. It resulted in the known roles of facilitator, modeler, and consultant but also in a new role called editor. This role is important as it fulfills two purposes required in modeling. Firstly it serves as a mediator that facilitates communication and mutual understanding among team members with different backgrounds; and secondly it represents a milestone in modeling capability development on the way to greater involvement in the creative part of modeling. 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.

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