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Collaborative Modeling of Processes: What Facilitation Support Does a Group Need?

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ABSTRACT

Collaborative modeling of processes is increasingly being used in practice. However, collaborative modeling is difficult. To overcome the difficulties, a professional facilitator can be used. Collaboration Engineering takes up the challenge to design collaboration processes that do not need a professional facilitator, but can be facilitated by practitioners. This research contributes to this by identifying what facilitation aspects are important in collaborative modeling and which of these aspects can be transferred to practitioners. Three facilitation aspects are considered important: (1) guarding the rules of the modeling technique, (2) checking for completeness and (3) translating elements in reality to modeling concepts. The first facilitation aspect can be taken over by a tool that controls the rules of the modeling technique. The second facilitation aspect most likely can be taken over by the practitioner, but for the third aspect a professional with modeling expertise is required.

Keywords

Collaboration Engineering, Collaboration, Facilitation, Process Modeling, Collaborative Modeling

INTRODUCTION

Business process modeling is used on a large scale to facilitate for instance Business Process Reengineering, ERP system implementation (Davenport, 1998), Total Quality Management, Workflow Management (Barros and ter Hofstede, 1998), E-business and Knowledge Management (Hlupic, 2003; Hlupic, Verbraeck and de Vreede, 2002). Models support conceptualization, communication, understanding, analysis, design and improvement of business processes and information systems (Kung and Solvberg, 1986).

Modeling should be increasingly collaborative for several reasons (Davenport and Stoddard, 1994; de Vreede, 1996; Lee, Hickey, Zhang, Santanen and Zhou, 2000; Vennix, 1996). Involvement during model development and analysis is important for model accuracy: no one person typically understands all of the requirements and understanding tends to be distributed across a number of individuals. Furthermore, involvement is important for verification: a group is better capable of pointing out shortcomings than the individual. Finally, involvement is important for creating buy-in: it is commonly held that individuals not participating in or represented during analysis and design are less likely to cooperate during implementation.

Nevertheless, models have traditionally been developed by individuals and small groups because of the complexity and difficulties involved when larger groups participate. One of the reasons is that non-modeling experts have to use the technique (de Vreede, 1996; Lee et al., 2000). Another reason is that collaborative modeling is plagued by the same problems as any type of group work: dominant or shy participants, misunderstanding, free-riding, lack of consensus, poorly defined goals, etcetera (Nunamaker, Briggs, Mittleman, Vogel and Balthazard, 1997). Yet another reason is that collaborative modeling results in complex visualizations of the relevant elements, a logic and relationships between these elements. In more traditional collaboration processes the result is written text on which people in general will more easily form perceptions and converge.

Facilitation of collaborative modeling is a way to deal with the difficulties as presented in the previous paragraph. Facilitation is considered among the most critical success factors for effective and efficient collaboration (Adkins, Burgoon and Nunamaker, 2002; Anson, Bostrom and Wynne, 1995; Dickson, Limayem, Partridge and DeSanctis, 1996; Niederman, Beise and Beranek, 1996). Facilitation is considered complex for which different high level skills are required, among which: communication skills, flexibility, understanding the group and its objectives, leadership, ego-less facilitation, understanding technology, managing conflict, directing the process and equalizing participation (Ackermann, 1996; Bostrom, Anson and Clawson, 1993; Clawson and Bostrom, 1996; Clawson, Bostrom and Anson, 1993; de Vreede, Niederman and Paarlberg, 2002; Dickson et al., 1996; Hayne, 1999; Niederman et al., 1996). Factors such as the high cognitive load, system complexity, corporate politics and organizational economics make competent facilitators not wide-spread (Morton, Ackermann and Belton, 2003) and make it difficult for organizations to keep high-quality facilitators in place (Briggs, de Vreede and Nunamaker, 2003). Therefore, many teams who could benefit from the intervention of professional facilitators in their collaborative modeling effort often have to do without them. One solution to this challenge is to design collaboration processes that can be facilitated by the practitioners themselves without the ongoing intervention of professional facilitators. Addressing this challenge is the domain of the newly emerged field of Collaboration Engineering. This research contributes to Collaboration Engineering by identifying what facilitation aspects concerning collaborative modeling of processes can be transferred to the practitioner and what facilitation aspects still need to be carried out by a professional facilitator.

The rest of this paper is structured as follows. In the next section background information on facilitation of collaborative modeling is provided. The method is described in the third section. Groups of students had to build conceptual process models without the intervention of a facilitator. This provided information on which facilitation aspects were overtaken by the group and which were not. The fourth section then presents the results. And the final section discusses the implications for practice and concludes with directions for further research into collaborative modeling from a collaboration engineering perspective.

BACKGROUND

This section provides background information on facilitation of collaborative modeling. Therefore, we first address facilitation issues in general. Then we focus on modeling expertise required to build models, demarcated in this research to conceptual process models.

Facilitation aspects have been addressed in many studies. Clawson et al. (Clawson et al., 1993) distinguish between technical facilitation and group process facilitation. Technical facilitation is aimed at assisting the participants with the technology and is often executed by a chauffeur or technographer (Dickson et al., 1996). Eden (Eden, 1990) divides group process facilitation into process facilitation and content facilitation. Process facilitation provides structure and general support to groups during the meeting. It involves ensuring that an equality of participation is achieved, blind alleys are not overly explored and time is managed appropriately. Content facilitation deals with analyzing the content of the data and summarizing relevant issues. Dickson et al. (Dickson et al., 1996) distinguish two types of process facilitation: task interventions and interactional interventions. Task interventions are meant to keep the group focused on the task. Interactional interventions focus on the participants and their relations.

The above cited facilitation functions are based on collaborative processes in general. A facilitator of collaborative modeling processes should not only be aware of the group dynamics and perform the facilitation functions as described above, but should also be an expert in the modeling method used (Ackerman, 1996; Richardson and Andersen, 1995; Rosenhead, 1989). Although it is clear *that* a facilitator should focus on the model as well during collaborative modeling, it is less clear *what* the facilitator as modeling expert should do and can do to support the participants in their modeling effort. This is the focus in this paper.

Modeling comes down to three essential elements: using a *grammar* and a *method* to construct *diagrams* (Hommes and van Reijswoud, 2000; Wand and Weber, 2002). The grammar provides a set of modeling concepts and rules that show how to combine the concepts. For example, the flowchart grammar has the concepts ‘activity’ and ‘precedence’. A rule in the grammar specifies that two activities can be connected only via a precedence. The method provides procedures by which a grammar can be used. A method makes explicit or implicit assumptions about how phenomena in the world should be interpreted. It enables the users to identify phenomena to be modeled and to map the phenomena into the grammar’s concepts and rules. The diagram is the product of applying the method and the grammar. For example, the diagrams generated by the flowchart grammar/method are flowcharts describing business processes.

Given these three elements, participants can be supported in their modeling efforts at three levels. The concepts and the rules of the grammar should be used appropriately. The method should be applied consistently as to map all relevant phenomena on to the grammar’s concepts and rules. And the diagram should be a complete and correct representation of reality without hidden assumptions. This research tries to identify the elements of modeling that the participants can guard themselves and the elements for which an expert is still needed. Similar research has been carried out into the use of modeling techniques and the development of better training programs. However, the focus has always been on the analysts instead of the users; little research has been conducted with mixed success that translates the strengths and weaknesses of a modeling technique into effects on the non-analysts-users, the participants (Dean, Lee, Pendergast, Hickey and Nunamaker, 1997-1998; Wand and Weber, 2002).

METHOD

To determine what elements of a modeling technique participants can guard themselves and for what elements they need support, groups of students were followed in their modeling efforts. Students from Delft University of Technology in the Netherlands follow a course on business process modeling. They have to complete several assignments, one in which they have to build a conceptual model of a business situation based on a case description. During the 2003 course, the students had to model the business processes of a mobile phone producer with one of two modeling techniques. Students received background information on each of the modeling techniques and worked in pairs on the assignment. The students used both modeling techniques for the second time during their study. In the year prior to this course, students were confronted with both modeling techniques for the first time. Although the students have had some practice with the modeling techniques, they are still considered inexperienced.

Two different modeling techniques were analyzed. The modeling techniques chosen are IDEF0 and flowchart. These are well known and wide spread modeling techniques for modeling business processes. It is advocated in literature to –in collaborative settings- use modeling techniques of which the essential features can be quickly and easily learned by the participants (Dean et al., 1997-1998; Mingers, 2003; Pendergast, Aytes and Lee, 1999; Pendergast, Dean, Lee, Nevstrujev and Katic, 1996). The participants are then free to focus on model content. Both, flowcharts and IDEF0 are intuitively easy to comprehend and use (Dean, Orwig and Vogel, 2000; Dennis, 1994). Flowcharts contain modeling concepts for decisions, activities, flows, documents and data stores among others. With a flowchart you model the flow through the processes in time. An IDEF0 is used to define what an organization does functionally. An IDEF0 consists of activities that are bounded by inputs, controls, outputs and mechanisms. An IDEF0 can be hierarchical, hiding details in the top and showing details lower in the hierarchy. Flowcharts do not have this characteristic.

The elements identified in the previous section were measured: the grammar, the method and the diagram. The degree to which the participants were able to guard these elements was measured objectively by analyzing the resulting models and subjectively by asking the participants for their perception on these. After the participants had built the model they were asked to individually fill in a questionnaire in which they were asked for their perceptions on these three elements: on a five point scale (Likert 5), students could agree or disagree with propositions. The questionnaire and the objective measurements were build around quality properties for the three elements, presented below. Quality properties for modeling techniques are widely published in literature. Different lists of quality properties were compared to construct one list out of these. The following publications were used for this comparison: (Falkenberg, 1996; Kesh, 1995; Lindland, Sindre and Solvberg, 1994; Moody and Shanks, 1998; Wand and Weber, 2002).

- The arbitrariness of a modeling technique relates to the degree of freedom one has when modeling. When the rules in the grammar and the procedures of the method show a low degree of freedom, results will be reproducible. When arbitrariness, however, is high, several different results are possible each with a different comprehensibility of the diagram. Although in the end we strive for low arbitrariness, it might be very well possible that the rules should be applied very rigid at the end, but not during the process of building a model (Pendergast et al., 1999). Students are asked to react to how rigid they have applied the modeling technique during the modeling process.
- The clarity of a modeling technique relates to the method. The procedures in the method focus primarily on two activities. First, identifying the phenomena in the application domain that should be modeled. Second, mapping the phenomena into the grammar's concepts. For example, when we build an object oriented model, how do we identify all relevant objects? And how do we know that these objects are to be modeled as objects or as attributes of objects? Students are asked to react to how clear the method was.
- The comprehensibility of a modeling technique describes the ease with which the modeling technique was understood. Students are asked to react to how comprehensible the modeling technique was.
- The correctness of a diagram can be split in two quality properties. The syntactic quality that indicates the extent to which the model conforms to the grammar, and the semantic quality that relates to the extent to which the model provides a valid and complete representation of the application domain. The syntactic and semantic quality of the diagrams is objectively evaluated by the researcher. For the semantic quality completeness and abundance are checked, both on the level of processes and elements. Process/element completeness is calculated by dividing the number of key processes/elements addressed in the model by the total number of key processes/elements in the case description. A completeness close to 1 indicates a model that takes all relevant issues into consideration. Process/element abundance is calculated by dividing the number of processes/elements in the model that do not exist in the case description by the total number of processes/elements in the model. An abundance close to 0 indicates that the model hardly contains elements that do not exist in the case description. For the syntactic quality, complexity and violation are checked. Complexity is determined by the number of processes and the number of elements addressed in the model. The degree of violation is determined by dividing the total number of errors made in applying the grammar and the method by the total number of processes and elements. The total number of errors can be higher than the total number of processes and elements, since several errors can be made in one and the same process or element. A violation close to 0 indicates that the model is according to the grammar and the method of the modeling technique.

RESULTS

In total, 47 groups used IDEF0 and 18 groups used flowcharts. The questionnaire on IDEF0 was answered by 81 students, and the questionnaire on flowcharts was answered by 30 students. The answers and models of students who handed in either only the model or only the questionnaire are not taken into account in the analysis. Six groups handed in IDEF0 models, but did not answer the questions on IDEF0. Five groups handed in flowcharts, but did not answer the questions on flowcharts. Eight students answered the questions on flowcharts, but never handed in their flowcharts. Students indicate that they use flowcharts because it allows the usage of explicit choices in the model. Reasons for using IDEF0, as mentioned by the students are: (1) familiarity with the modeling technique, (2) possibility of hierarchical models and (3) possibility of incorporating inputs, outputs, controls and mechanisms.

The semantic quality of the models is described in Table 1. About 80% of all relevant issues are captured by the students with IDEF0 and 60% with flowcharts. A facilitator might support the participants here by checking back with the users for completeness. Abundance is not that a problem: students include hardly any elements that are not part of the case description (7% for processes and elements together). A facilitator does not need to support the participants in this. A t-test was used to compare the differences between the two modeling techniques. For completeness it appears that the differences between IDEF0 and flowchart are significant (Sig < 0.05). This would indicate that IDEF0 is a better modeling technique to use by non-analysts users since it results in more complete models.

Aspect IDEF0 N=41 Flowchart N=13	IDEF0		FlowChart		T-test Sig 2-tailed
	Mean	StDev	Mean	StDev	
Completeness Process	0.88	0.18	0.62	0.33	0.016
Completeness Elements	0.82	0.19	0.53	0.25	0.001
Abundance Process	0.04	0.08	0.05	0.09	0.532
Abundance Elements	0.11	0.08	0.11	0.13	0.827

Table 1: Semantic quality

The syntactic quality of the models is described in Table 2. A t-test was used to compare the differences between the two modeling techniques. Except for the complexity of the processes, the differences between IDEF0 and flowchart are significant (Sig < 0.05). The students incorporated more elements in IDEF0 than in flowcharts (complexity). The completeness of IDEF0 models is greater than in flowcharts. And the abundance of elements in IDEF0 is not significant different from that in flowcharts. In this regard, IDEF0 is preferred over flowcharts to build models of business processes. Unfortunately, the violation of rules is higher in IDEF0 than in flowcharts. IDEF0 has more rules to pay attention to than flowcharts and apparently students are less able to guard these rules. A facilitator might be well able to support participants in this.

Aspect IDEF0 N=41 Flowchart N=13	IDEF0		FlowChart		T-test Sig 2-tailed
	Mean	StDev	Mean	StDev	
Complexity Process	14	6.1	12	10.8	0.628
Complexity Elements	91	41.2	8	5.1	0.000
Violation	0.27	0.40	0.10	0.12	0.027

Table 2: Syntactic quality

The results on arbitrariness, clarity and comprehensibility are presented in Table 3. Because of the small amount of respondents for flowcharts, it is not possible to draw firm conclusions on the significance of differences between the modeling techniques. The results on the questionnaire are, therefore, presented for IDEF0 and flowchart together. Most students indicate they start sketching before applying the rules (75%), but in the end they apply the method and the rules of the modeling technique (80%). About 50% of the students start off in text before using the modeling technique. With regard to clarity, many students indicate they know which modeling concepts to use for which element (65%). Students have more problems with identifying the elements in the case to incorporate in the model, or to leave out of the model (40%). With regard to comprehensibility, most students indicate that it is relative easy to understand the modeling technique (80%-90%)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N
We followed the method of the modeling technique (arbitrariness method)	7.4%	70.5%		21.1%	1.1%	95
We applied the rules of the modeling technique from the start (arbitrariness rules)	10.4%	71.9%		16.7%	1.0%	96
We started sketching before applying the rules of the modeling technique (arbitrariness diagram1)	15.6%	60.4%		21.9%	2.1%	96
We started off in text before using the graphical modeling concepts (arbitrariness diagram2)	6.3%	40.0%		44.2%	9.5%	95
It is obvious which elements of the case should be included in the model (clarity identification positive)	5.2%	41.7%	35.4%	17.7%		96
It is obvious which elements of the case should not be included in the model (clarity identification negative)	3.2%	35.8%	32.6%	28.4%		95
It is obvious with what modeling concepts the relevant elements of the case should be modeled (clarity mapping)	5.2%	61.5%	29.2%	4.2%		96
I could easily understand the diagram of the modeling technique (comprehensibility diagram)	36.5%	52.9%	8.2%	2.4%		85
I could easily understand the method of the modeling technique (comprehensibility method)	14.4%	66.0%	16.5%	3.1%		97
I could easily understand the grammar of the modeling technique (comprehensibility grammar)	11.0%	75.0%	10.0%	4.0%		100

Table 3: Quality properties

DISCUSSION AND CONCLUSIONS

The results presented in the previous section now guide the identification of implications for practice and research.

Implications for Practice

In literature it is advocated to use modeling techniques of which the essential features can be quickly and easily learned by the participants (Dean et al., 1997-1998; Mingers, 2003; Pendergast et al., 1999; Pendergast et al., 1996). The results show that although the modeling technique of flowchart is less complicated than that of IDEF0, IDEF0 is preferred to be used over flowcharts. The main reason for this is that students are better able to construct complete models with IDEF0 than with flowcharts. So, the modeling technique should not only be quickly and easily learned by the participants, it should also be complex enough to capture the versatility of business processes.

Given the above, it is advocated that the details of the modeling technique should then be guarded by a facilitator who understands the modeling technique, its grammar and its method (Dean et al., 1997-1998; Pendergast et al., 1999). The facilitator, possibly supported by a tool, should check for violations of the grammar and the method of the modeling technique. Furthermore, the results indicate that the facilitator should also guard the diagram itself: is it a complete representation of the business processes. The facilitator should continuously check back with the participants to come to models that describe the business processes in detail and completeness as required by the goal of the modeling process. Another supportive aspect is to translate elements in reality into concepts used in the modeling technique.

Now that it is clear what a facilitator can do to support groups in their modeling effort, the interesting question to answer from the Collaboration Engineering perspective is whether a practitioner can take over the facilitator role. One facilitation aspect, guarding the grammar and the method of the modeling technique, can be taken over by a tool in which the participants construct the model. The facilitation aspect in which the completeness of the models is checked can be taken over by a practitioner. A practitioner has to give back information to the group and ask for completeness. The last facilitation aspect, translating elements in reality into the concepts of the modeling technique, requires understanding of the modeling technique and cannot be supported by a tool. This facilitation aspect, therefore, cannot be taken over by a practitioner and for this aspect a professional facilitator will be required. Prior research showed that it is difficult for several reasons to combine traditional facilitation functions with facilitation aspects required for collaborative modeling in one person (den Hengst and de Vreede, 2004).

Implications for Research

This research contributes to Collaboration Engineering by identifying what facilitation aspects are important in collaborative modeling processes and which of these aspects can be transferred to practitioners. Three facilitation aspects are found to be important: (1) guarding the grammar and the method of the modeling technique, (2) checking for completeness and (3) translating elements in reality to concepts in the modeling technique. The first facilitation aspect can be taken over by a tool that controls the rules of the modeling technique. The second facilitation aspect most likely can be taken over by the practitioner, but for the third aspect a professional facilitator with modeling experience is required. This has several implications for further research.

Knowing what aspects a practitioner has to carry out does not tell anything on how the practitioner can be trained to do so. Further research is required for this, for example in the direction of thinkLets especially designed for collaborative modeling. A thinkLet frames a facilitation intervention in terms of three components: the *tools* to be used in a specific *configuration*, and the sequence of events and instructions to be given to the group (the *script*) (Briggs et al., 2003).

Translating elements in reality to concepts in the modeling technique is a facilitation aspect that is difficult to transfer to a practitioner, mainly because this requires modeling expertise. Further research should guide efforts in developing tool support or training for practitioners to overcome this lack in modeling expertise.

Furthermore, the students in this research were modeling a situation from paper. Real problem owners that have to model their daily situation might show different results. This study, therefore, should be replicated with real problem owners who also might have a different level of modeling experience.

Finally, this research incorporated only two modeling techniques. Further research is required to see if different modeling techniques show the same result. Research should focus on both more technical modeling techniques such as the UML object diagrams and less technical modeling techniques such as SSM rich pictures.

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