Toward an Understanding of the Collaborative Process of Process Modeling

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Abstract. Research on quality issues of business process models has recently begun to explore the process of creating process models. With growing complexity, the creation of business process models requires the presence of several, potentially spatially distributed stakeholders. As a consequence, the question arises how this affects the process of process modeling. For this purpose, we utilized a collaborative modeling environment based on Cheetah Experimental Platform for analyzing the collaborative process of process modeling. In this work, we present hypotheses describing observations of the collaborative process of process modeling obtained from exploratory modeling sessions. These hypotheses will be tested in future work.

Keywords: Collaborative Process Modeling, Process of Process Modeling, Cheetah Experimental Platform

1 Introduction

Business process models are heavily used in all types of business contexts [1] playing an important role for the management of business processes [2]. Process models are increasingly created in a collaborative manner, where a number of people actively contribute to the creation of a model [3]. The stakeholders in this problem solving activity provide different skills, expertise, and knowledge [4]. Even though, collaborative process modeling settings are increasingly found in practice [3, 5] and results in software engineering have shown that collaboration can increase quality and efficiency significantly [6], the way how process models are collaboratively created is hardly understood [3]. We extend existing work investigating the process of creating process models (i.e., *process of process modeling* (PPM)) which focuses on single modeler settings [1], toward a collaborative setting where multiple stakeholders (e.g., domain experts and model engineers) collaboratively create process models. For this purpose, we utilize collaborative Cheetah Experimental Platform (cCEP) [7] and its visualizations for analyzing the *collaborative process of process modeling* (cPPM) in order to gain an in-depth understanding of the cPPM. We performed exploratory modeling sessions with different team compositions and analyzed the cPPM using the visualizations of cCEP. In this paper we present preliminary findings and derive hypotheses based on observations of the cPPM, which will be systematically investigated in future work.

The remainder of this paper is structured as follows: Sect. 2 presents backgrounds on the PPM and introduces CEP. Sect. 3 then details the visualizations of cCEP. Sect. 4 outlines preliminary findings and presents hypotheses describing the cPPM. Related work is discussed in Sect. 5. Finally, Sect. 6 concludes the paper with a summary and outlook on future work.

2 Process of Process Modeling

This section provides background information on the PPM and how it can be analyzed using CEP for single modeler settings.

2.1 The Process of Process Modeling

Research on the PPM focuses on the modeler's interactions with the modeling environment [1], i.e., the *formalization* of a process model as described in [8]. During the PPM, modelers are facing the task of creating a syntactically correct process model reflecting the description of the real world's domain by interacting with the modeling environment [8]. The PPM can be described as a flexible, iterative process consisting of the three phases of comprehension, modeling and reconciliation [1, 9].

Comprehension. According to [10] a problem solver formulates a mental representation of the problem as a first step. When creating a process model, the limitations of working memory prevent modelers from creating a complete representation in a single step [9, 1]. Rather, the problem is broken down into small chunks which are addressed sequentially [9, 1].

Modeling. After formulating a mental representation of the problem, the modeler utilizes the constructs of the modeling language for creating a formal process model [9, 1]. For this purpose, the modeler interacts with the modeling environment by adding or removing activities, gateways and edges.

Reconciliation. Modelers may reorganize a process model (e.g., renaming of activities) and utilize its *secondary notation* (e.g., notation of layout, typographic cues) to enhance understandability [11].

In order to investigate the PPM in a systematic manner CEP—a specialized modeling environment for investigating the PPM—has been developed [12]. By recording all interactions with CEP, researchers are able to *replay* the creation of the process model step by step without interfering with the modeler's problem solving efforts, allowing a detailed analysis (cf. [1])[1].

3 Analyzing and Visualizing the Collaborative PPM

When process models are created collaboratively, the individual processes (cf. Sect. 2) are not sufficient. In addition, team processes take place during which teams exchange information, create solution options, exchange knowledge, evaluate and negotiate alternatives, and assess their own processes [13]. As a result, the team is building further knowledge and a shared understanding of the process model [13, 14]. In order to be able to analyze these processes cCEP extends CEP with support for collaborative modeling [7]. For this purpose, cCEP not only supports creating models, but also provides features needed when participants

[1] A demonstration of CEP's replay is available at `http://cheetahplatform.org`.

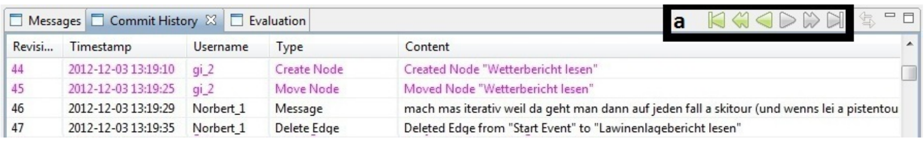

Fig. 1. The Commit History View of Collaborative CEP

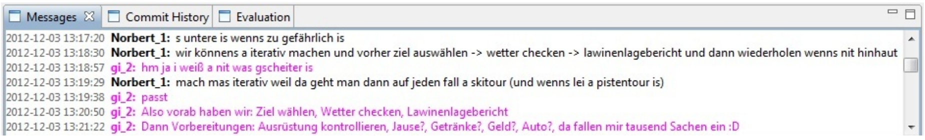

Fig. 2. The Communication Window of Collaborative CEP

are spatially separated from each other (e.g., the opportunity of communicating with each other) [5]. Furthermore, cCEP extends the replay functionality of CEP in order to be able to replay data retrieved from collaborative features (e.g., messages exchanged) [7]. This enables us to analyze team processes in detail in combination with the individual processes of single team members.

Beside capturing the cPPM, investigating the cPPM in a structured manner is essential. Therefore, cCEP provides visualizations for analyzing the collaborative process of process modeling (e.g., heat maps, active modeler diagrams).

Commit History View. Similar to CEP for single modeler settings (cf. Sect. 2), cCEP provides the ability of replaying the creation process after the modeling process ended. Within the commit history view (cf. Fig. 1) messages exchanged are listed in addition to model changes. Using the buttons on the top (cf. Fig. 1(a)) researchers are able to step back and forth within the cPPM [7].

Communication Window. When spatially separated participants are collaboratively solving a problem (i.e., creating a process model) means for exchanging messages, evaluating and negotiating alternatives, exchanging knowledge, and assessing their own processes are necessary [13]. Therefore, cCEP provides a chat window (cf. Fig. 2) which can be used for conversation protocol analysis (e.g. using Grounded Theory [15]) after the modeling session ends [7]. Particularly, when investigating the team processes conversation protocols stored in the chat window are needed.

Node's History Tooltip. When hovering with the mouse over nodes (i.e., model elements) cCEP reveals their history as a tooltip (cf. Fig. 3). Using this feature researchers can see how specific model elements evolved over time. They cannot only see by *whom* and *when* they were created but also *why* they were created. This can be identified because cCEP is linking messages to model elements, which were exchanged during creation of those elements [7]. Thus, those messages are displayed within a node's history revealing the intention behind the node.

Heat Map. [7] introduced measures for evaluating the cPPM (e.g., number of changes per node, number of comments per participant, and number of nodes created per participant). Fig. 4(a) lists the nodes with their numbers of model changes (e.g., create/delete node, add/remove sequence), layout changes (e.g.,

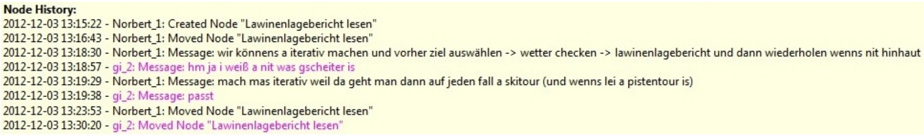

Fig. 3. The Node History of Collaborative CEP

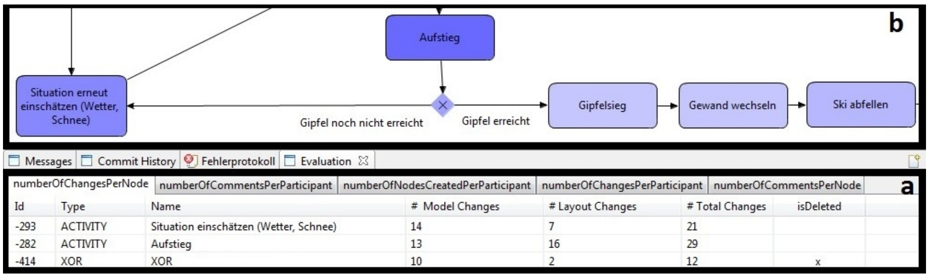

Fig. 4. The Heat Map and Measures Visualizing the Collaborative PPM

move node) and total changes (i.e., the sum of model and layout changes). This measure might indicate model elements that caused difficulties or controversy during the modeling process. Additionally, cCEP utilizes heat maps illustrating those measures (cf. Fig. 4(b)) where nodes changed more often appear darker. Using this heat map we are able to identify the most controversial elements right within the model. *Number of nodes created per participant* is another measure and might indicate the participants providing the most domain knowledge. Hence, those measures can be used to analyze the cPPM.

Active Modeler Diagram. Active modeler diagrams (cf. Fig. 5) display changes to the model or messages sent for each participant. For this, we filter interactions for creating model elements, sending messages, and laying out model elements and plot them on a time-line using different colors for each participant.

4 Identification of Hypotheses

In this section we present observations obtained from investigating the cPPM using visualizations presented in Sect. 3. Moreover, we derive hypotheses describing these observations. Specifically, these hypotheses are aiming at the phases occurring within the cPPM as well as the roles involved within the cPPM.

4.1 Setup of Exploratory Modeling Sessions

In order to test the visualizations of the cPPM (cf. Sect. 3) and investigate the cPPM we performed exploratory modeling sessions using pairs of model engineers. During each session, two participants (i.e., model engineers) collaboratively created a process model for planning a ski tour. All participants had experience with BPMN. Moreover, one of the participants within each pair was additionally familiar with the domain, acting as the domain expert during the modeling session. Since all participants were native German speakers, data presented within the diagrams is in German and translated to English where necessary.

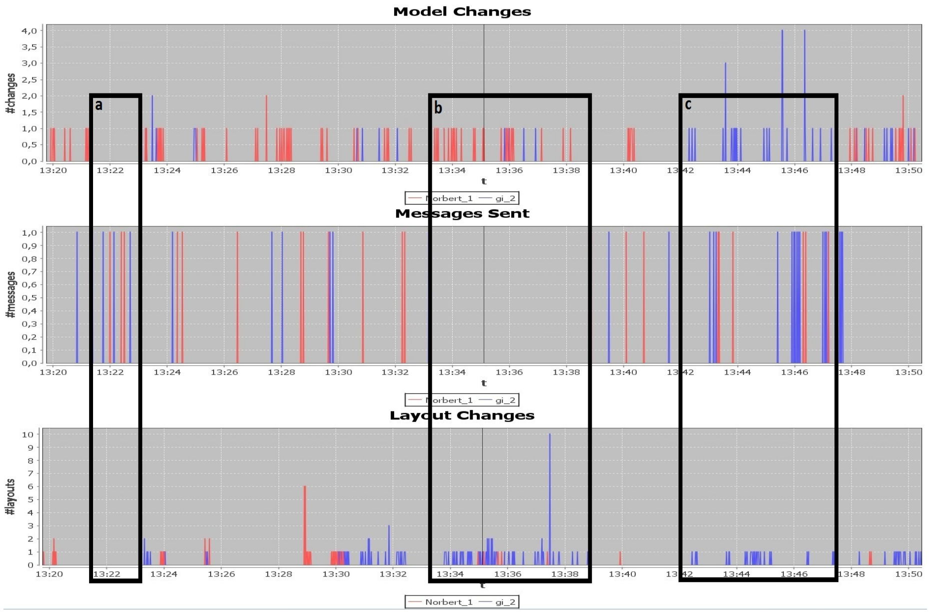

Fig. 5. The Active Modeler Diagram Visualizing the Collaborative PPM

4.2 Hypotheses Generation

The statements presented in this section are deduced from two modeling sessions using different participants. In future work we will not only test and validate the derived hypotheses using a higher number of participants but also conduct modeling sessions with various team compositions (e.g., model engineer and domain expert or more than two participants) for gaining an understanding of the cPPM within different team compositions.

Driver Featuring Controller. When analyzing the cPPM with two model engineers, their interplay can be compared to pair programming, a technique known from software engineering [16]. Similarly to [6] we were able to identify a *driver* who actively created the model and a *controller* who oversaw the problem solving efforts of the driver. The participant being the *driver* could be identified using the measure *number of nodes created per participant* (cf. Sect. 3) or using its visualization (cf. Fig. 6). Our two test cases suggest that the role of the driver is taken by domain experts. This led to our first hypothesis *H1: Domain experts take over the role of the driver*. Important for this hypothesis was the fact that all participants (including the domain expert) already had experience with BPMN.

Team Knowledge Building Phase. Several team knowledge building phases [13] (varying in duration) during which participants tried to understand the requirements to be modeled as well as the model that has been created so far could be identified (cf. Fig. 5(a)). As a result, this team knowledge building phase within collaborative modeling settings could be mapped to the *comprehension* phase (cf. Sect. 2) of the PPM for single modeler settings.

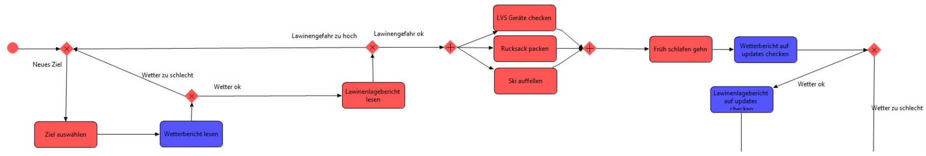

Fig. 6. Heat Map Visualizing the Creation Activities

Moreover, modelers tried to understand the solutions of their companions and tried to convince them of their own ones [17]. During those team knowledge building phases the participants stopped their modeling efforts as well as their reconciliation efforts leading to hypothesis *H2: Participants stop their modeling and reconciliation efforts in order to work on team knowledge building phases.*

Modeling and Reconciliation Phase. After such team knowledge building phases the driver extended the model. Again, this task corresponds to a phase of the PPM for single modeler settings (i.e., *modeling*) (cf. Sect. 2). Simultaneously, the controller reorganized other (e.g., older) parts of the model (e.g., renaming of activities, performing layout changes) (cf. Fig. 5(b)) which refers to the *reconciliation* phase of the PPM for single modeler settings (cf. Sect. 2). As a result the two successive phases within single modeler settings (i.e., *modeling* and *reconciliation*) were shared between the modelers and performed concurrently. Using this information we derived two hypotheses *H3: Both participants are actively changing the model (i.e., modeling and reconciling) at the same time* and *H4: Participants are concurrently working on different blocks of the model.*

Role Changing Phase. We were able to identify situations where the controller took over the leading role (i.e., driver) (cf. Fig. 5(c)). When analyzing the conversation protocols using the node's history (cf. Fig. 3) we were able to identify the reason for these role switches. In one case the controller had a simpler solution in mind and instead of explaining his idea he just changed the model himself. After discussing the new solution the original driver took over again and extended the model further. In another case the controller found a mistake in the model and interrupted the driver with a message. The controller then took over and corrected the model. This error searching behaviour of the controller resembles the controller role of pair programming [6]. Common to both role switches was the fact that the controller did not agree with the model created by the driver. Hence, the controller took over and corrected the model according to his knowledge of the domain. Hypothesis *H5: Role changes occur on disagreements* describes this observation.

5 Related Work

The PPM is concerned with the interaction of the participants (e.g., domain experts and model engineers) during modeling. The importance of the modeling process is acknowledged in [8]. There has already been research on the PPM for single modeler settings [1, 18] as well as on the cPPM where multiple stakeholders are creating process models [17, 19–22]. [17] investigates collaborative modeling settings concentrating on the negotiation phase of this process. We want to investigate the team processes involved within the cPPM and their interaction with the individual processes on a micro-cognitive level. Investigating a closely guided, wizard like conceptualization support is the focus of [19, 20]. In contrast, we want to analyze an unguided model creation process. The team-building processes when creating a model collaboratively using a proposal based tool (COMA) and allowing face to face communication are researched in [21] and evaluated using various measures (e.g., number of proposals per participant, comments per proposal). Our participants are able to synchronously work on the same process model. The practices employed within a collaborative modeling environment (i.e., ProcessWave[2]) are observed in [22]. Here, effectiveness and efficiency are measured using the notation of breakdowns. In contrast, we are not only interested in observing the difficulties participants are facing during the modeling process, but also the team processes taking place.

6 Summary and Outlook

This paper presented a tool to support collaboratively creating business process models as well as visualizing and analyzing the *process of process modeling* within collaborative modeling settings. Using these visualizations we analyzed the cPPM data we gathered in exploratory modeling sessions and derived hypotheses. Our modeling sessions showed that the collaborative creation of business process models resembles pair programming where one programmer actively solves a problem (i.e., the driver) and a second programmer oversees the problem solving efforts (i.e., the controller) [6]. Additionally, controllers were laying out other parts of the model while the drivers were modeling. This way, controllers were increasing a model's maintainability as well as a model's understandability [11, 26]. As soon as controllers identified problems they interrupted the drivers (e.g., by sending a message), took over the role of the driver and modified the models reflecting their knowledge. After a team knowledge building phase the participants were changing their roles back again. These findings give some insights into the phases occurring and the roles involved within the cPPM. As future work we plan to perform additional modeling sessions using our tool and its visualizations in order to validate these hypotheses. Furthermore, we will investigate settings with various team compositions (e.g., model engineer and domain expert or more than two participants).

References

1. Pinggera, J., Zugal, S., Weidlich, M., Fahland, D., Weber, B., Mendling, J., Reijers, H.A.: Tracing the Process of Process Modeling with Modeling Phase Diagrams. In: Proc. ER-BPM '11. (2012) 370–382
2. Becker, J., Rosemann, M., Uthmann, C.: Guidelines of business process modeling. In: Business Process Management, Models, Techniques, and Empirical Studies, London, UK, Springer-Verlag (2000) 30–49
3. Rittgen, P.: Collaborative Modeling – A Design Science Approach. In: Proc. HICSS '09. (2009) 1–10

[2] http://www.processwave.org/

4. Ssebuggwawo, D., Hoppenbrouwers, S., Proper, H.: Group decision making in collaborative modeling. In: Proc. EIS '09. (2009)
5. Mendling, J., Recker, J.C., Wolf, J.: Collaboration features in current bpm tools. EMISA Forum **32** (2012) 48–65
6. Williams, L., Kessler, R.R., Cunningham, W., Jeffries, R.: Strengthening the Case for Pair Programming. IEEE Software **17** (2000) 19–25
7. Forster, S., Pinggera, J., Weber, B.: Collaborative Business Process Modeling. In: Proc. EMISA '12. (2012) 81–94
8. Hoppenbrouwers, S., Proper, H., van der Weide, T.: A Fundamental View on the Process of Conceptual Modeling. In: Proc. ER '05. (2005) 128–143
9. Soffer, P., Kaner, M., Wand, Y.: Towards understanding the process of process modeling: Theoretical and empirical considerations. In: Business Process Management Workshops, Springer (2011) 357–369
10. Newell, A., Simon, H.: Human problem Solving. Prentice Hall (1972)
11. Petre, M.: Why Looking Isn't Always Seeing: Readership Skills and Graphical Programming. Commun. ACM (1995) 33–44
12. Pinggera, J., Zugal, S., Weber, B.: Investigating the process of process modeling with cheetah experimental platform. In: Proc. ER-POIS'10. (2010) 13–18
13. Fiore, S.M., Smith-Jentsch, K.A., Salas, E., Warner, N., Letsky, M.: Towards an understanding of macrocognition in teams: developing and defining complex collaborative processes and products. Theoretical Issues in Ergonomics Science **11** (2010) 250–271
14. Rittgen, P.: End-user involvement and team factors in business process modeling. In: Proc. HICSS '12. (2012) 180–189
15. Urquhart, C., Lehmann, H., Myers, M.D.: Putting the theory back into grounded theory: guidelines for grounded theory studies in information systems. Information Systems Journal **20** (2010) 357–381
16. Beck, K.: Extreme Programming Explained: Embracing Change. Addison-Wesley (1999)
17. Rittgen, P.: Negotiating Models. In: Proc. CAiSE '07. (2007) 561–573
18. Pinggera, J., Soffer, P., Zugal, S., Weber, B., Weidlich, M., Fahland, D., Reijers, H., Mendling, J.: Modeling Styles in Business Process Modeling. In: Proc. BPMDS '12. (2012) 151–166
19. Hoppenbrouwers, S., van Stokkum, W.: Towards combining thinklets and dialogue games in collaborative modeling : an explorative case. In: Proc. ECSCW '11. (2011) 11–18
20. Hoppenbrouwers, S., Weigand, H., Rouwette, E.A.J.A.: Setting rules of play for collaborative modeling. IJeC **5** (2009) 37–52
21. Rittgen, P.: The role of editor in collaborative modeling. In: Proc. SAC '12. (2012) 1674–1679
22. Hahn, C., Recker, J., Mendling, J.: An exploratory study of it-enabled collaborative process modeling. In: Proc. BPM Workshops '10. Volume 66. (2010) 61–72
23. Seeber, I., Weber, B., Maier, R.: CoPrA: A Process Analysis Technique to Investigate Collaboration in Groups. In: Proc. HICCS '12. (2012) 363–372
24. Nunamaker, J.F., Briggs, R.O., Mittleman, D.D., Vogel, D.R., Balthazard, P.A.: Lessons from a dozen years of group support systems research: a discussion of lab and field findings. J. Manage. Inf. Syst. **13** (1996) 163–207
25. Nunamaker, J.F., Dennis, A.R., Valacich, J.S., Vogel, D., George, J.F.: Electronic meeting systems. Commun. ACM **34** (1991) 40–61
26. Mendling, J., Reijers, H.A., Cardoso, J.: What Makes Process Models Understandable? In: Proc. BPM '07. (2007) 48–63