Visualizing human behavior and cognition: The case of process modeling*

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1 Introduction

Nowadays, business process modeling is heavily used in various business contexts. For instance, process models help to obtain a common understanding of a company's business processes [1], facilitate inter–organizational business processes [2], and support the development of information systems [3]. Still, process models in industrial process model collections often display a wide range of quality problems [4], calling for a deeper investigation of process model quality.

In response to the demand of process models of high quality, researchers recently have begun to take into account the processes involved in their creation. In this context, the *process model development lifecycle* involves several stakeholders, who drive the creation of the process model in *elicitation phases* and *formalization phases* [5]. In *elicitation phases*, information from the domain is extracted and used in the *formalization phase* by *process modelers* for creating a formal process model [6]. Since requirements evolve over time, model development usually comprises several iterations of elicitation and formalization, resulting in an evolving process model.

This extended abstract can be attributed to research on the formalization of process models intended to provide a brief overview on how visualizations have been utilized in the past and will be used in the future in order to gain a deeper understanding of the *formalization* of process models—the *process of process modeling (PPM)*. For this, two existing visualizations will be briefly sketched (cf. Section 2). Further, an outlook on how such visualizations can be extended toward more advanced concepts, i.e., cognitive load, is provided (cf. Section 3). The paper is concluded with a brief summary in Section 4.

2 Visualizing the PPM

In order to investigate the formalization of process models, i.e., PPM, we started by recording all interactions of modelers with the modeling environment in an event log (cf. [7]). These interactions provide the basis for both visualizations illustrated in this section.

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PPMCharts. [8, 9] propose a visualization of all interactions during the PPM based on Dotted Charts (cf. Fig. 1). Each interaction is represented as a dot on the canvas. Dots on the same line indicated interactions to the same element, e.g., creating a node and moving it later. This visualization is used in [10] for identifying a correlation between structured modeling and the quality of the resulting process model. This direction is further pursued as described in [11] to derive the Structured Process Modeling Theory (SPMT). A detailed description of PPMCharts can be obtained from [9].

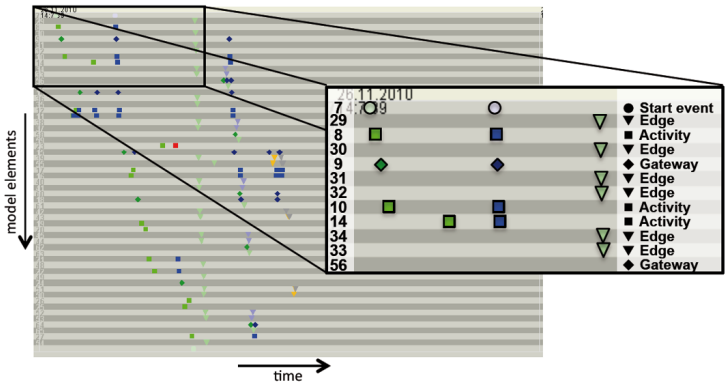

Fig. 1. Example of PPMChart

Modeling Phase Diagrams (MPD). Modeling Phase Diagrams (MPDs) were proposed to abstract from the interactions with the modeling environment to gain a better overview of the PPM [12]. For this, MPDs abstract from the interactions by forming phases of the PPM. Interactions indicating modeling, such as adding content by creating nodes and edges, are mapped to *modeling* phases. Similarly, interactions indicating clean–up, such as laying out the process model, are mapped to *reconciliation* phases. Finally, phases of inactivity usually indicate cognitive activities like understanding the problem, and hence are mapped to *comprehension* [12]. In Fig. 2, the different phases are represented by different types of lines. While the horizontal axis represents time, the vertical axis indicates the number of elements in the process model. Similar to PPMCharts, MPDs have evolved into a series of PPM measures that allow quantifying the various aspects of the PPM (cf. [13]). A detailed description of MPDs can be obtained from [12, 13].

3 Cognitive load—Adding a new dimension to the PPM

In the future, additional data sources could be explored to provide additional perspectives on the PPM. For instance, *cognitive load*, i.e., the mental load for performing a task, could be integrated into MPDs (cf. Fig. 3). This could be promising since overstraining the capacity of the modeler's working memory by a mental task likely results in errors [14] and therefore may affect how process

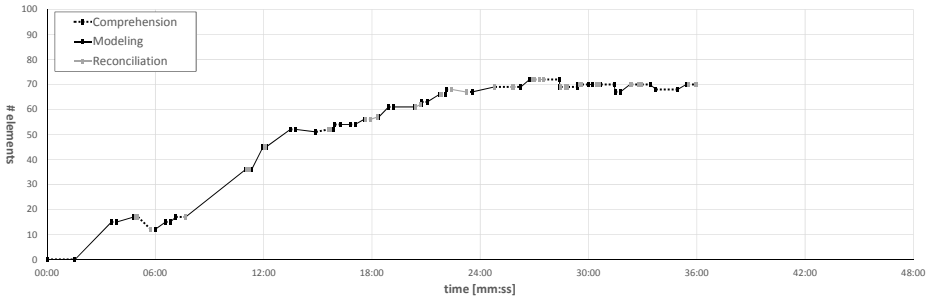

Fig. 2. Example of a Modeling Phase Diagram

models are created. By continuously measuring mental effort, deeper insights should be possible into how and why errors occur while creating process models. Various techniques for measuring cognitive load can be applied, such as the measurement of the diameter of the eyes' pupil (*pupillometry*), heart–rate variability, and rating scales [15]. Especially pupillometric data and rating scales (i.e., self–rating mental effort) have been shown to reliably measure mental effort and are widely adopted [16]. As illustrated in Fig. 3, phases of high cognitive load could be identified in order to understand their causes. A more detailed description on how continuous cognitive load measurement might be used for analyzing the PPM is provided in [17].

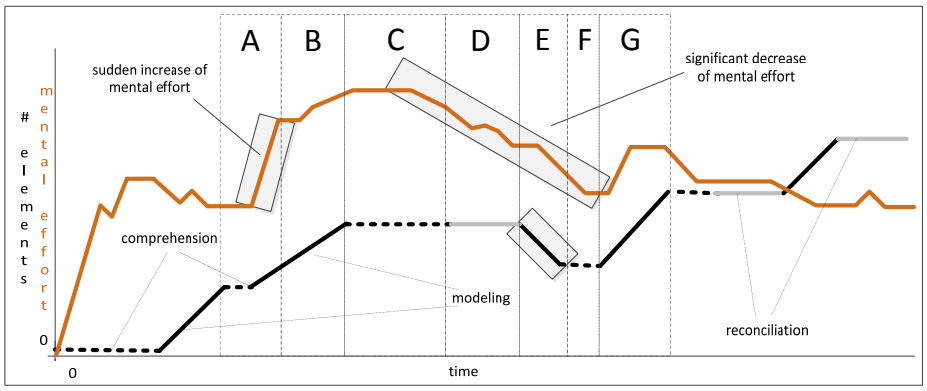

Fig. 3. MPD including mental effort visualization

4 Conclusion

While providing only a glimpse of information on visualizations and their use in the context of the PPM, this extended abstract provides an indication regarding the usefulness of such visualizations. Each of the two existing visualizations has been essential for the development of more complex theories. Without such visualizations, the development of respective theories would not have been possible.

References

1. Bandara, W., Gable, G.G., Rosemann, M.: Factors and measures of business process modelling: model building through a multiple case study. European Journal of Information Systems **14**(4) (2005) 347–360
2. Zhao, X., Liu, C., Yang, Y., Sadiq, W.: Aligning Collaborative Business Processes—An Organization–Oriented Perspective. Transactions on Systems, Man, and Cybernetics, Part A: Systems and Humans **39**(6) (2009) 1152–1164
3. Dumas, M., van der Aalst, W.M.P., ter Hofstede, A.H.M.: Process Aware Information Systems: Bridging People and Software Through Process Technology. Wiley–Interscience (2005)
4. Mendling, J.: Metrics for Process Models: Empirical Foundations of Verification, Error Prediction, and Guidelines for Correctness. Springer (2008)
5. Hoppenbrouwers, S.J., Proper, E.H., van der Weide, T.P.: Formal Modelling as a Grounded Conversation. In: Proc. LAP'05. (2005) 139–155
6. Hoppenbrouwers, S., Proper, H., Weide, T.: A Fundamental View on the Process of Conceptual Modeling. In: Proc. ER'05. (2005) 128–143
7. Pinggera, J., Zugal, S., Weber, B.: Investigating the Process of Process Modeling with Cheetah Experimental Platform. In: Proc. ER–POIS'10. (2010) 13–18
8. Claes, J., Vanderfeesten, I., Pinggera, J., Reijers, H.A., Weber, B., Poels, G.: Visualizing the Process of Process Modeling with PPMCharts. In: Proc. TAProViz'12. (2013) 744–755
9. Claes, J., Vanderfeesten, I., Pinggera, J., Reijers, H.A., Weber, B., Poels, G.: A visual analysis of the process of process modeling. Information Systems and e–Business Management (2014) 1–44
10. Claes, J., Vanderfeesten, I., Reijers, H.A., Pinggera, J., Weidlich, M., Zugal, S., Fahland, D., Weber, B., Mendling, J., Poels, G.: Tying Process Model Quality to the Modeling Process: The Impact of Structuring, Movement, and Speed. In: Proc. BPM'12. (2012) 33–48
11. Claes, J., Vanderfeesten, I., Gailly, F., Grefen, P., Poels, G.: The structured process modeling theory (spmt) a cognitive view on why and how modelers benefit from structuring the process of process modeling. Information Systems Frontiers (2015) 1–25
12. 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
13. Pinggera, J.: The Process of Process Modeling. PhD thesis, University of Innsbruck, Department of Computer Science (2014)
14. Sweller, J.: Cognitive Load During Problem Solving: Effects on Learning. Cognitive Science **12**(2) (1988) 257–285
15. Paas, F., Renkl, A., Sweller, J.: Cognitive Load Theory and Instructional Design: Recent Developments. Educational Psychologist **38**(1) (2003) 1–4
16. Zugal, S., Pinggera, J., Reijers, H., Reichert, M., Weber, B.: Making the Case for Measuring Mental Effort. In: Proc. EESSMod'12. (2012) 37–42
17. Pinggera, J., Zugal, S., Furtner, M., Sachse, P., Martini, M., Weber, B.: The Modeling Mind: Behavior Patterns in Process Modeling. In: Proc. BPMDS'14. (2014) 1–16