Modeling and Simulating Work Practice

BRAHMS:
a multiagent modeling and simulation language for work system analysis and design

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SUMMARY

Many organizations spend a lot of time and effort analyzing the knowledge people within the organization use to perform their work. This is often done to make the work process more efficient, or to manage the knowledge resources (man, machine, or other) better. To do this, the first thing that is often done is to model the current state of the work process, after which the process is redesigned to be more efficient. Modeling work processes is a very complex task that clearly needs to be supported by effective modeling tools. There are a number of modeling tools and approaches that are used today. However, none of these approaches allow for the representation of a work process at a *work practice level*—the level at which people within the process perform their work in the real world.

This dissertation presents a methodology and supporting tool for modeling and simulating the work practice. The main research question being answered is the question of representing people working together, collaborating and communicating, situated in the real world, using tools and creating artifacts, all the while being constraint by the environment they are in. The thesis first reviews existing modeling tools and models that, in one way or another, represent people as cooperating agents. It is shown that every tool being reviewed lacks, in some fundamental way, the ability to represent all the important aspects from the theory of modeling work practice. The work presented here is testing a new computer language and methodology, with supporting tools for modeling and simulating work practice. The software tool presented and tested—and proven to be a significant improvement over available modeling tools—is called Brahms. Specifying how the Brahms modeling language can be used to represent a work practice operationalizes the presented theory for modeling and simulating work practice. The second part of the thesis presents the application of Brahms in three real-world work practice case studies.

A work practice is defined as the collective activities of a group of collaborating people who communicate together, while performing synchronous and asynchronous activities. Most often, people view work merely as the process of transforming input to output. This thesis claims that the individual activities, that make up a work practice, not only have to do with the transformation of input to output, but more important with the collaboration between individuals in action, in pursuit of a goal. Imagine soccer players who collaborate their activities in pursuit of scoring a goal. Just focusing on the input and output of the activities of the players would not only be very difficult, if not impossible, but it would miss the opportunity to understand what is really going on.

This dissertation presents a different view, namely describing work as a practice, a collection of psychologically and socially situated collaborative activities of the members of a group. The purpose of modeling a work practice is to understand how, when, where, and why collaborative activities are performed, and to identify the effects of these activities. Besides this, it is also important to understand the reasons why these activities occur in the way they do. The central theme is to find a representation for modeling work practice. The thesis first defines what is meant by the term *work practice*, and how it relates to communities of practice, activities, collaboration, communication, artifacts, and geography. Then, the Brahms multiagent modeling language is presented. Brahms models can be simulated to show the effects of the activities of groups of people, their collaboration and communication, while situated in a geographical environment, using tools and artifacts to perform their collaborative work.

The Brahms software tool is applied, verified, and evaluated in a case study of the ALSEP Offload task performed during the Apollo 12 lunar mission. This first case study is a study about the use of Brahms for developing *descriptive* models. This case study shows a detailed simulation model of the work practice of the Apollo 12 astronauts offloading the ALSEP on the Moon. The second case study shows the application of Brahms and its associated methodology in the development of a *predictive* model. This subject of this case study is predicting astronaut behavior during error situations and the communication patterns during the ALSEP deployment activity on the Moon. This case study is based on the historical data from two work practices, namely the Heat Flow Experiment deployment during the Apollo 15 and 16 missions. The subject of the third and last case study is the design of a *prescriptive* Brahms model, for a work system design of mission operations for a future robotic mission to the Moon. The thesis ends with an evaluation of the use of Brahms in the case studies to answer the research question. Besides the main research question, a secondary research question is answered. What is the added value of a model-based approach? The answer is given based on the modeling methodology used in the case studies.

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