OperA and Brahms: a symphony?\textsuperscript{1}

Integrating Organizational and Emergent Views on Agent-Based Modeling

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1 Introduction

Organizations are intentionally formed to accomplish a set of common objectives, defined by its stakeholders and policy makers. The people that work for those organizations often only partially pursue those global objectives and requirements. Workers will pursue their own individual objectives as well, frequently resulting in a gap between the a priori designed flows of tasks and procedures reflecting the ideal activity of the organization (i.e., the work process), and the activities that actually get things done (i.e., the work practice) \cite{1}. This gap does not exist only because of the difference in objectives between individuals and the organization, but also because many policy makers abstract from work practice when they design work systems (i.e., business operations). For example, it is uncommon for a job description to include ‘socialize with co-workers’, ‘drink coffee’, or ‘read e-mail’.

In agent-based modeling and simulation (ABMS), the organizational view can be used to prescribe the desired outcomes of work processes in an organization. The emergent view can be used to describe the actual behavior of people in the organization, called work practice.

Policy makers can be supported in developing and evaluating operational concepts by simulating the normative gap between prescriptions of work processes and descriptions of work practice. Thereto, a Work Systems Modeling and Simulation framework (WSMS) has been developed, which integrates the organizational and emergent views on agent-based modeling. The WSMS is based on the integration of two independent, existing frameworks: OperA \cite{2} and Brahms \cite{4}. To verify and validate the WSMS, the case of Collaborative Traffic Flow Management in the United States’ National Airspace System was used. A scenario from this case was simulated using the WSMS. The results show that OperA and Brahms have been integrated successfully. The output of the simulation shows which organizational objectives were (not) met and which organizational policies were (not) violated. This way, policy makers can determine to what extent the actual work practice differs from the desired work process.

2 Work Systems Modeling and Simulation framework

The design and evaluation of work systems can be supported with agent-based modeling and simulation that incorporates both an organizational view (top-down) and an emergent view (bottom-up) on work practice. Most current modeling and simulation frameworks only focus on either one of these views. In this paper we show how two multi-agent modeling frameworks, OperA, a methodology developed to represent and analyze organizational systems, and Brahms, a language developed to describe work

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practice, have been integrated. The framework allows the modeling of both the organizational objectives and the emerging (possibly divergent) work practice. By running simulations using the integrated model, it is possible to determine to what degree the workers achieve the organizational objectives. The results of these simulations are used by both policy makers and workers themselves, to understand, test, and improve work practice.

Based on the complementary viewpoints of OperA and Brahms, we hypothesized that, after integration, the two frameworks could complement each other in the following two ways: (1) OperA adds the top-down (organizational) view to Brahms, Brahms adds the bottom-up (emergent) view to OperA, so that both perspectives are represented, (2) simulations can be run that show the gap between the two perspectives. In order to realize point 2, it is necessary to first convert the OperA model to Brahms, and then to implement the actual work practice. This is done by filling in the specific behavior of the agents, which were treated as ‘black boxes’ in the OperA model. This results in a model that is completely described in Brahms, represents both the organizational view and the emergent view, and which is executable for simulation. In this paper we present a mapping of OperA to Brahms that meets these requirements. Approaches such as S-Moise+ [3], RNS2 [5], and [7] are similar to this research as they aim to develop organizational models to support different levels of coordination and autonomy. However, the difference is that they aim to develop open, heterogeneous multi-agent systems from an engineering perspective, whereas we aim to develop more realistic models of work practice from a human-centered perspective. The second way in which we differ from these approaches is that we provide means to populate the organization with agents specified in some agent language.

3 Conclusions

The design and evaluation of work systems can be supported with agent-based modeling and simulation that incorporates both an organizational view (top-down) and an emergent view (bottom-up) on work practice. We have integrated two frameworks, each representing one of the two views. The integrated method makes it possible to simulate work practice, and to monitor the gap between the emergent behavior and the desired outcomes as defined by the organization’s policy makers.

This work contributes to our more general research objective: How can we improve models of work practice by incorporating the organizational view? What happens when agents become aware of the fact that they are violating a norm?, What is the influence of norms on work practice?, and: How do norms arise from work practice? New insights in these areas will lead to more realistic models of work practice, and thereby to improved agent-oriented system engineering methodologies.

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4 References