Possibilities of Multimedia in Business Process Modeling and Simulation

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Abstract: This paper discusses present solutions and future possibilities of multimedia in the Enterprise Simulation Laboratory at Helsinki University of Technology. Important challenges are addressed concerning the visualization, real time interaction and telepresence in complex, group mode business process modeling and simulation for organizational learning.

1. THE NEED FOR BUSINESS PROCESS MODELING AND SIMULATION IN ORGANIZATIONS

New paradigms, such as the extended enterprise, virtual enterprise and the value and supply chains, see enterprises as networks of business processes. Business processes are dynamic, complex chains of human, technology supported activities, connected by material and information flows, and integrated into an economic value chain to create value for the customer and profit for the stakeholders.

Survival in turbulent global competition requires effective and flexible operation of business processes, as well as continuous business process

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development and innovation. This calls for dynamic process understanding and learning in the organizations and in the whole network.

Human understanding develops basically through experience, in spirals of learning: concrete experience is transformed through observations and reflections into abstract concepts and generalizations, i.e. into a mental model of the situation. This model is then tested out in new real life situations, and refined again through new experience. The learning spiral continues in the dynamic interplay of experience and logic (e.g. Lewin 1951, in Kolb 1984, Lehtovaara 1998).

This spiral of learning has also to be created on the organizational level (Nonaka and Takeuchi 1995). Organizations need a *shared understanding* of their processes, not individual mental models, which deviate from one another and lead to contradictory action. This shared understanding has to be created and continuously developed in an efficient way. Instead of real life trial and error, methods are needed to model and test organizational processes through *group mode simulation* (e.g. Smeds 1994, Haho and Smeds 1997, Haho 1998). Through *joint experimentation* in the simulations, the business processes can be developed in a prototyping manner, and organizational learning can be accelerated.

2. VISUALIZATION FOR BUSINESS PROCESS SIMULATION IN SIMLAB

The complexity of the business processes sets high requirements *for valid simulation models*. Only valid models create correct learning experiences. The final test of model validity is the acceptance by the organizational members (Law and Kelton 1991). Visualization of the model is often the only way to help the members of the organization to understand it, and to accept it as a valid description of reality.

In addition to the modeling phase, visualization of the dynamic simulation runs supports the understanding of the functioning and output of the model. Visualization can also be used to create interactivity with the model during the simulation. After the simulation, visualization can be used to analyze and communicate the results.

The Enterprise Simulation Laboratory project SimLab (e.g. Smeds 1998, <http://www.simlab.hut.fi/>) develops new visual business process simulation methods for group simulations, to support industrial companies in developing their business processes to meet the objectives like customer responsiveness, delivery-time, delivery accuracy and time-to-market. In the group simulations, where the objective is to create a shared understanding of the business process, visualization is especially important. The visualized

simulation models allow the participants to share the same visual “enterprise space” and to experience jointly the simulated functioning of the business process. This serves as an important platform for the business process development project. (cf. Table 1)

Conceptual:	process charts and maps
Computational:	discrete event numerical simulation models
Visual:	visualization and projection of the conceptual and computational models on the virtual wall
Social:	facilitated, systematic discussion of the process with the business process people using real case examples
<hr/> Σ SimLab simulation: group simulation session supported by the above models, for shared process understanding, brainstorming and innovation	

Table 1: Business process modeling for group simulations in the SimLab project.

3.

TOOLS FOR VISUAL BUSINESS PROCESS MODELING AND SIMULATION

Recent developments in multimedia give new possibilities to model and simulate complex business processes in a visual way. The tools support the visualization of the modeling phase, the simulation runs themselves, as well as the analysis of the simulation output. Visual models and simulations can also be applied in a distributed manner through telematics. In the following, the present applications and some future possibilities of the SimLab project concerning visualization are discussed.

3.1

Modeling

Process modeling starts with *conceptual* analysis and model building of the process. Several software tools for process mapping and analysis are available already, such as ProcessGuide (Q.P.R.), currently applied in the SimLab project. This tool depicts the material and information flows and the activities of the processes and sub processes in a visual way.

In cases where material flows are simulated, conceptual modeling is followed by *computational* modeling. The software tools AutoMod and AutoSched are applied for the discrete event numerical simulations of material flows.

The physical environment of the simulation session: the room layout, furniture and setting, and the projected process models on the walls are *visual* elements of the business process model.

Finally, the participants in the simulation build up the *social* simulation model. All persons who are acting in the real business processes should in principle attend the simulation, as well as the relevant managers and process development staff from different organizational levels. Also representatives from other interfacing processes and units are often important players in the simulation. The process roles and the tacit as well as explicit knowledge of each participant are important modeling parameters. Thus the social composition of the simulation group (hologram structure, Smeds 1994) is crucial for the final validity of the business process simulation model.

3.2 Simulation

During the simulation session, the visual outputs of the conceptual and computational models are projected on a virtual wall, to create a shared picture of the process for all participants. The ProcessGuide and AutoMod modeling tools currently in use need to be developed further, because they are not flexible enough to support *real time visual interaction* for the analysis of alternative process solutions during the group simulation.

A generic, technologically robust solution for visualizing simulations is to use a distributed architecture that consists of a separate simulation engine and a visualization engine. This allows the computational load to be split among several machines, and as required, with proper open protocols, allows either part be exchanged to another solution depending on the needs of the problem at hand. For example, depending on the audience, the same simulation engine could control a business process chart presentation, a numerical simulation model or even a Virtual Reality model. And vice versa: a custom simulation engine optimized for real time modification could be harnessed to drive the VR model in the place of the commercial simulation engine.

A common problem in computational simulation is that the simulation model structures are static: only their parameters can be changed, and often only between runs, not during a simulation run. This is a clear problem for example in factory layout planning, where it would bring great benefit, if the layout could be changed in real time during the simulation session, and the statistics would immediately be changed to reflect the new situation. There already exist some solutions to this real-time interaction problem (ModelFact, Metzger and Haberl 1998), but no commercial grade programs exist as of yet.

An ideal tool for computational simulation would also allow combining business process data from operational databases to what-if analysis data, and then visualize the output. This would make it possible to compare the operational effects of what-if process experiments during the simulation.

Another important feature in both the conceptual and computational business process simulations would be the *measurability of alternative simulated process structures* during the simulation session. One important measure of business processes is *lead time*, which could be visualized in the process models through the length of the *critical path*. Process structures could also be compared by their *complexity*. The degree of structural complexity of a process model could be calculated applying a graph theoretical approach. This complexity measure could be used to assess the manageability of the alternative processes, and together with the critical path measure help in the trade off decisions between process manageability and time.

The social simulation, the group's systematic process discussion in the visual learning environment of SimLab, is guided by one or several facilitators. The facilitators' role is crucial for the success of the simulation. The facilitators should be able to control the different ways to display data during the simulation session, and also to store into the models the process improvement ideas that have been awakened during the joint simulation experience. The facilitators' flexible interface to the different visual models increases the efficiency of the social simulation. For the interaction with the simulation models, the facilitator can apply technologies like the wireless mouse.

3.3 Possibilities of telepresence

The social group simulations can in principle also be conducted in a distributed virtual group through telepresence, for which there are several potential techniques available (Fluckiger 1995). The simplest way – though in the beginning probably the most important – is telephone conferencing. Distant groups share the same visual simulation models through the Internet, and the actions are synchronized through audio only.

Videoconferencing would be the logical next step. However, the added value of seeing just the talking faces of other participants is arguable. The picture quality of videoconferencing systems is often not high enough to transmit more information than a static picture. It becomes more relevant in social situations, if the video shows emotions through facial or bodily gestures. If these are not visible enough in the video, we may have to rely on motion capture systems that copy a person's appearance to an avatar.

For recognizing a person in a group, her location in the room is an important cue. This information is lost, if we only have a single display that telematically shows one person at a time. The problem can be cured, by arranging virtual participants as TV screens on reserved places in the game room.

However, distributed business process simulations at SimLab do not require avatars with the persons' appearances, or virtual participants as TV screens, to achieve sufficient telepresence. Our aim is rather to use the high-resolution virtual wall to show all distant participants at once. In addition, their voices will be processed stereophonically such that they are heard from appropriate points on the screen.

Even more important that seeing the other participants, it is to see the shared documents and process models related to the simulation. This can be facilitated through Computer Supported Cooperative Work (CSCW), like whiteboard systems or shared application programs, projected on the virtual walls of each distant simulation group. Combining directional audio with individual pointers, each participant can show on the wall which part she is talking about.

3.4 Analysis of simulation results

For the post simulation analysis, a software tool prototype called Discus has been developed in the SimLab project (Gröhn *et al.* 1999). Discussion log data is collected with Discus during the simulation session. The whole simulation session is also video recorded for analysis.

After the simulation, the discussion log is visualized and analyzed. Discus shows the communication pattern as connectivity lines of different width and color, to characterize the communication flow (e.g. the amount of comments in general, the amount of comments by a single person, total speaking time of a person, individual participation and interaction in the discussion). We can find out e.g. the amount of comments exchanged between two participants, and the total amount of time used during these comments. Together with videotape analysis of the simulation session, Discus can be used to analyze also the contents of the communication and even the communication styles of the participants.

Discus helps us to analyze and measure the complexity of the communication flow. Neural networks, so-called Self-Organizing Maps (Kohonen 1995) are applied to the discussion log data, to detect the underlying communication patterns and group relationships affecting the inherent dynamics of the simulated business process (Gröhn *et al.* 1999).

In addition to discussion logging, Discus includes functionality for commenting various events on-line in a simulation session. In the first

applications we have used this feature to save remarks about the usability of the simulation tools used in the sessions. The feasibility of this feature was initially doubted, but the experiences were positive. Two computer literate observers have been using Discus simultaneously for discussion logging and storing usability remarks.

After a series of subsequent simulation sessions, the outputs of the conceptual, computational, and social models of alternative process structures are analyzed, compared and evaluated for business process development purposes. The evaluation criteria should be directly linked with the objectives of the process development project (e.g. process performance measures such as time, or measures of structural complexity).

4. FUTURE CHALLENGES

Major development challenges in the SimLab project concern the *group mode user interfaces* of the simulation models: How can the players interact directly with the models during the session, e.g. try out different layouts and information and material flows? And how can the actors in different geographical locations participate as a group in the same simulation, e.g. when simulating global business processes? And finally, how do we combine the conceptual, computational, and social simulation models into an efficient virtual learning environment for organizations?

One technological objective for multimedia in the SimLab project is to apply three dimensional Virtual Reality (VR) to business process simulations, to an area that is traditionally considered very '2D'. We aim to apply VR in a group mode, in an interactive way, and even over distances, by applying CSCW for telepresence during the simulation sessions.

The idea of a shared multimedia workspace is old, but it has not become available until low-cost multimedia systems. Using interactive technologies, multiple users can share the same visual learning space, with every idea easily accessible and displayable to others. It also brings a new meaning to the word visualization (previously used mainly for post process analysis of large numerical data sets), when the users can easily interact with the model during the simulation session.

Telepresence in business process simulation requires that multimedia based CSCW expands to distributed modeling and simulation. When the participants in a distributed process simulation are allowed to interact with the same model, sharing the same virtual space, the limitations of time and space virtually vanish, not to mention travelling costs. The key requirement is that distributed, multimedia based CSCW supports interaction over the Internet. The important social interaction with fellow members of the

dispersed simulation group is achieved through additional telematic techniques such as video and audio conferencing.

In the more distant future, using techniques such as the emerging MPEG-4 standard (Koenen 1998), it will be possible to transmit representations of the participants to geographically dispersed places. People across the world are able to share the same simulation experience as a virtual group (much like the world of Metaverse in the fictional novel *Snow Crash* (Stephenson 1992)). A few years ago this would have been considered unlikely, but the rapid development of the Internet has made it clear that such technologies can in principle become commercially available in the future.

Solutions to these multimedia and user-interface questions are developed in multidisciplinary research, guided by the real life requirements of three cutting edge industrial companies, which are developing their business processes and training their personnel through simulations as pilot companies of the SimLab project.

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