Business process modelling: potential benefits and obstacles for wider use

Vlatka Hlupic*
Westminster Business School

* At the time of publication Vlatka Hlupic was working for Brunel University, Uxbridge, Middlesex. UK.

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BUSINESS PROCESS MODELLING USING DISCRETE EVENT SIMULATION: POTENTIAL BENEFITS AND OBSTACLES FOR WIDER USE

VLATKA HLUPIC

Brunel University
Department of Information Systems and Computing
Uxbridge
Middlesex UB8 3PH, United Kingdom

Abstract: *As Organisations need to adapt to new business conditions and respond to competitive pressures, various change management approaches have been developed. Many studies suggest that the success of business change projects could be increased by developing dynamic models of business processes prior to their radical change. This paper investigates a potential of simulation modelling to be used for modelling business processes and argues the case for a wider use of simulation techniques by business community. It is postulated that discrete-event simulation can be considered as a missing link between change management approaches such as Just in Time [JIT], Total Quality Management [TQM] or business process re-engineering [BPR]. The usability of simulation modelling for evaluating alternative business process strategies is investigated, and the guidelines for achieving more widespread use of business process simulation are proposed.*

Keywords: Discrete-event simulation, business process modelling, change management approaches

1. INTRODUCTION

Simulation modelling is being widely used for modelling and analysis of systems in various application areas such as manufacturing, construction, transport, logistics, communication networks, health care, military etc. Another, gradually emerging application area of simulation is business process modelling (BPM).

Many organisations have to implement some sort of change management approach in order to survive in competitive business environments. Examples of such approaches include Total Quality Management (TQM), Just in Time (JIT), Business Process Re-engineering (BPR), Process Innovation (PI) and Knowledge Management (KM). Any change brings substantial risk as it is usually difficult to predict the outcome of changes before they are put into practice, and it is evident that the failure rates of business process change related project are high. For example, it is estimated that the failure rate of BPR projects is over 50% [Hammer and Champy, 1993].

It seems reasonable to claim that simulation modelling could offer a great potential in modelling and analysing business processes, and therefore reduce the risk associated with business process change. For example, these models can dynamically model different samples of parameter values such as arrival rates or service intervals which can help discovering process bottlenecks and investigating suitable business alternatives. Simulation models can provide a graphical display of process models that can be interactively edited and animated to show process dynamics. Most importantly, such models enable conducting of "what if" analysis that can be used to evaluate the consequences of changes before they are implemented.

This paper investigates a potential of simulation modelling to be used for modelling business processes and demonstrates the supporting role of simulation for business process change projects. It is argued that there is a need for a wider use of simulation techniques by business community. The paper is structured as follows. Following a discussion on the business process modelling methods and tools, the suitability of discrete-event simulation for business process modelling is investigated. Several management innovation and change programs including TQM, JIT, BPR, PI and KM are then presented, and a discussion on how simulation modelling could increase their effectiveness is provided. It is argued that simulation could be viewed as a missing link between these approaches. Furthermore, some guidelines on achieving more extensive use of simulation for business process modelling within the business community are proposed. Finally, the conclusions outline the main findings of this research.

2. BUSINESS PROCESS MODELLING METHODS AND TOOLS

The increasing business and academic interest in organisational change has resulted in a multitude of

approaches, methodologies, and techniques to support these design efforts [Wastell *et al.*, 1994], [Harrison and Pratt, 1993]. Kettinger *et al.* [1997] conducted an empirical review of existing methodologies, tools, and techniques for business process change and developed a reference framework to assist positioning of tools and techniques that help in re-engineering strategy, people, management, structure, and technology dimensions of business processes.

Although simulation is mentioned as one of the modelling methods in a survey conducted by Kettinger *et al.* [1997], the authors identified a need for more user-friendly multimedia process capture and simulation software packages that could allow easy visualisation of business processes and enable team members to actively participate in modelling efforts.

Business process modelling tools are continuously being released on the software market. Many of these tools represent business processes by graphical symbols, where individual activities within the process are shown as a series of rectangles and arrows. A majority of software tools for business process modelling have an origin in a variety of process mapping tools that provide the user with a static view of the processes being studied. Some of these tools provide basic calculations of process times. Other, more sophisticated, tools allow some attributes to be assigned to activities and enable some sort of process analysis. However, most of these tools are not able to conduct "what if " analysis and show a dynamic change of business processes and evaluate the effects of stochastic events and random behaviour of resources which is possible by using simulation models of business processes. Simulation software tools are able to model dynamics of the processes such as the build up of queues and show it visually, which then can enhance generating the creative ideas on how to redesign the existing business processes.

It is apparent that there is a lack of a comprehensive, scientifically established design methodology to structure, guide, and improve business process modelling efforts. Many authors argue that one of the major problems that contribute to the failure of business process change projects is a lack of tools for evaluating the effects of designed solutions before implementation [Paolucci *et al.* 1997, Tumay 1995]. However, the lack of modelling tools is only a part of the problem. Perhaps even more important obstacle for more widespread use of simulation for business process modelling is a lack of awareness of simulation within the business community.

3. THE SUITABILITY OF DISCRETE-EVENT SIMULATION FOR BUSINESS PROCESS MODELLING

Simulation models of business processes can help overcome the inherent complexities of studying and analysing businesses, and therefore contribute to a higher level of understanding and improving these processes. In terms of the business environment, simulation models usually focus on the analysis of specific aspects of an organisation, such as manufacturing or finance.

There are relatively few examples of using simulation for business process modelling available in the literature. A majority of these publications were written by simulation modelling practitioners rather than business analysis specialists. In one of articles related to business process simulation, authors [Tumay, 1995] discovered that over 80% of BPR projects used static flowcharting tools for business process modelling. Static modelling tools that are predominately used are deterministic and do not enable evaluating alternative re-designed processes. The use of business process modelling tools is usually focused on modelling current business process, without a systematic approach to evaluating business processes alternatives. On the other hand, simulation models can incorporate and depict dynamic and random behaviour of process entities and resources. A physical layout and interdependencies of resources used in processes under consideration can be shown visually and the flow of entities among resources can be animated using simulation as a modelling tool.

Simulation models provide quantitative information that can be used for decision-making and can be regarded as problem understanding rather than problem solving tools. There are several characteristics of simulation that make it suitable for business process modeling. For example, a simulation model can be easily modified to follow changes in the real system and as such can be used as a decision support tool for continuous process improvement. Furthermore, a process - based approach (world view) in simulation modeling terminology relates to a time-ordered sequence of interrelated events which describes the entire experience of entity as it flows through the system.

The visual interactive features of many simulation packages available on the market enable a graphical display of dynamic behavior of model entities, showing dynamic changes in state within processes. Simulation model can incorporate the stochastic nature of business processes and the random behavior of their resources. Finally, simulation models can capture the behavior of both human and technical resources in the system.

Simulating the effects of redesigned processes before implementation improves the chances of getting the processes right at the first attempt. Visual interactive simulation models, together with a variety of graphical output reports, can demonstrate the benefits of redesigned processes which is useful for business process re-engineering approval. Simulation could also be useful for focusing 'brainstorming' meetings, where various new ideas can be tested using a simulation model, and informed decisions can be made on the basis of model results.

To summarise, there are several characteristics of discrete-event simulation that make it suitable for business process

modelling [Hlupic, 1998]:

- A simulation model can be easily modified to follow changes in the real system and as such can be used as a decision support tool for continuos process improvement,
- A process - based approach (world view) in simulation modelling terminology relates to a time-ordered sequence of interrelated events which describes the entire experience of entity as it flows through the system,
- The flow of information within and between business processes can be modelled as the flow of temporary entities between processing stations,
- A simulation model of non-existing business processes can be developed and used for process design (rather than for redesign),
- Simulation models can capture the behaviour of both human and technical resources in the system,
- The visual interactive features of many simulation packages available on the market enable a graphical display of dynamic behaviour of model entities, showing dynamic changes in state within processes, and
- Simulation model can incorporate the stochastic nature of business processes and the random behaviour of their resources.

4. DISCRETE-EVENT SIMULATION: A SUPPORT FOR CHANGE MANAGEMENT PROGRAMS

It is important to address the supporting role of simulation for various business process change management approaches in the context of business process modelling. Five well known change management approaches are considered in this research: *Total Quality Management* (related to company-wide quality improvement initiatives), *Just-in-Time* (focused on inventory reduction), *Business Process Re-engineering* (involving a radical change of business processes in order to achieve better business performance), *Process Innovation* (focused on radical change of business processes and innovation of core processes) and *Knowledge Management* (related to systematic generation, codification and transfer of company knowledge). A detailed explanation of all these approaches is provided in [Currie and Hlupic, 2000]. Table 1 demonstrates how simulation can support these approaches and help increase their effectiveness.

Table 1. A comparison of five innovation and change programs

CONCEPT	*THE ROLE OF SIMULATION*
Total Quality Management [TQM]	Decision support system for continuous improvement, graphical display of physical elements, simulating dynamic changes of the system, communication tool, problem understanding tool, AS-IS vs. TO-BE models, random behaviour of system elements captured in models, manufacturing oriented models, models usually represent the flow of physical objects
Just-In-Time [JIT]	Decision support system for continuous improvement, graphical display of physical elements, simulating dynamic changes of the system, communication tool, problem understanding tool, AS-IS vs. TO-BE models, random behaviour of system elements captured in models, manufacturing oriented models, models usually represent the flow of physical objects
Business Process Re-engineering [BPR]	One off study for evaluating strategy for radical change, graphical display of business processes, simulating dynamic changes of the system, communication tool, problem understanding tool, AS-IS vs. TO-BE models, random behaviour of system elements captured in models, 'people' oriented models, models usually represent the flow of information
Process Innovation	One off study for evaluating innovation to core processes, graphical display of business processes, simulating dynamic changes of the system, communication tool, problem understanding tool, AS-IS vs. TO-BE models, random behaviour of system elements captured in models, 'people' oriented models, models usually represent the flow of information
Knowledge Management	Simulation models can be used to investigate knowledge management processes, to simulate missing data needed for knowledge management, and to evaluate alternative models of knowledge management strategies. One off or continuous study for evaluating knowledge management processes, graphical display of business processes, communication tool, AS-IS vs. TO-BE models, 'people' and information oriented models, models usually represent the flow of information/knowledge.

It is apparent that simulation modelling could play an important role in supporting all five approaches. Simulation models could provide a graphical display of physical elements and/or business processes, and capture dynamic changes. These models could be used as communication tools to help people to understand the current processes using AS-IS models, and to evaluate the impact of changes using TO-BE models. Random behaviour of system elements can be simulated by models as well as changes to the layout of systems, priorities, sequencing of tasks and

human resources management.

A major difference between change management approaches in the context of simulation is that models that support TQM and JIT are usually manufacturing oriented. They tend to represent the flow of physical objects (for example, the movement of parts between work centres). But models that support BPR, Process Innovation and Knowledge Management normally deal with the flow of information and how resources may be re-deployed. These models are usually 'people oriented' as business processes normally involve human resources.

In the context of TQM, simulation models can incorporate business activities undertaken by employees and provide a graphical display of tasks undertaken by different workers, their duration and sequence, dynamic changes of activities and any potential bottlenecks could be discovered. As such simulation models could be used regularly as decision support tools for continuous improvement. For example, a simulation model of a production system could be used for investigating operating strategies that would reduce the size of inventory, machine cycle times, assess various scheduling rules, or reduce the level of faults. By doing this, any changes to be done to the real system could be tested on the model to avoid risks of inadequate decisions, and business activities could then be better understood. When changes tested on the model are implemented in the real system, effectiveness of the system should be improved as well as the competitiveness of an organisation.

Whilst JIT has been viewed as a management philosophy of integrated manufacturing, planning and control in Japan, the western countries often see JIT in the narrow context of inventory control [Currie and Hlupic, 2000]. Simulation modeling can support both approaches to JIT. Real-time models of an integrated manufacturing system could incorporate models of inventory control systems, production design, and resource planning and scheduling. In addition, detailed models of inventory control systems can be used regularly to assess the impact of various JIT strategies, the inventory re-ordering policies, optimal levels of inventory and so on.

In the context of BPR, it is apparent that mistakes brought about by BPR can only be realized once the redesigned processes are implemented, when it is too late, costly and probably impossible to easily correct such errors. Although the evaluation of alternative solutions may be difficult, this may reduce some of the risks associated with BPR projects. For example, Hlupic *et al.* [2000] present a business process model of a telephony system of a large multinational company that has been used for determining business processes that needed to be radically changed. The impact of these changes was investigated using the model before the real system was changed.

Like BPR, the essence of Process Innovation is to radically reshape or even transform key business processes to enhance business performance. This approach emphasizes innovation and not just improvement. The focus is on one-time change. Here, simulation models may be developed to investigate key processes to determine innovation strategies, to develop a vision of new processes and to evaluate alternative models of new processes.

In the context of knowledge management, simulation models can be used to investigate knowledge management processes, to simulate missing data needed for knowledge management, or to evaluate alternative models of knowledge management strategies. Simulation projects usually relate to one-off or continuous study for evaluating knowledge management processes. Models are normally 'people' and information oriented, as they models usually represent the flow of information and knowledge, or could show the effects of new knowledge management practices on business processes. Such models could incorporate human resources and their involvement with knowledge management, and they are not concerned with movements of physical objects within the system.

5. GUDELINES FOR MORE EXTENSIVE USE OF BUSINESS PROCESS MODELLING

So far, the paper has argued for the need to use discrete-event simulation for business process modelling, in order to reduce the risk associated with business process change projects. However, it is apparent that the potential of simulation for business process modelling has yet to be recognised within the business community. Relatively few publications on business process change and simulation were mainly written by simulation specialists and there is little evidence about the awareness of simulation within the business community. For example, the ProSci's 1997 Benchmarking Study [ProSci, 1997] analysed over 60 large international organisations who went through BPR exercise. The study has analysed the issues such as the reasons for redesigning business processes, methodology and modelling tools used, applying change management concepts, and the role of managers within BPR teams. It is interesting to note that the study revealed that only less than 10% of the companies used simulation software as a modelling tool. Other tools used include flowcharting tools, spreadsheet, project management tools, word processors and database development tools.

A survey on the use of simulation software [Hlupic, 2000] revealed that only about 6% of the survey participant used discrete-event simulation packages for business process modelling. Another example of inadequate use of simulation for BPR relates to the fact that the information about simulation modelling provided on the course on BPR (attended by the author of this paper) by a large and well known international IT training company was both very brief and in some aspects incorrect.

There are many ways to improve this situation and increase the awareness of simulation potential in business process modelling arena. Some of the guidelines and strategies that

could be employed include:

- More widespread teaching of simulation on business and management courses both at undergraduate and postgraduate level,
- Increasing the awareness of top management about the potential benefits of business process modelling,
- Wide dissemination of the information about successful BPM case studies,
- Introducing special journals on BPM,
- Providing more books on BPM, and
- Providing better software tools for BPM.

6. CONCLUSIONS

This paper has investigated the potential benefits and obstacles in using discrete-event simulation for business process modelling. It is apparent that whilst simulation can support business process change related projects and reduce the risk associated with such projects, it still not being widely used as a business process modelling method within the business community. The DTI sponsored study found that £300 million could be saved by British Industry per year if simulation was more widely used within the manufacturing sector, and it would be interesting to find out how much could be saved and how many business process change projects could become successful if simulation models were developed and experimented with prior to change of business processes. Regardless of precise estimations, it is apparent that a more widespread use of simulation for business process modelling can increase the rate of success of business process change projects, which should then results in savings in resources and better service provided to the customers.

It has been demonstrated that discrete-event simulation can support five most popular change management approaches. It could be claimed that modelling provides an important means of discovering the essential aspects of the organisational system where improvements will make a real difference in performance as well as providing a sound basis for managing the consequences of the agreed actions [Ackermann *et al*., 1999].

There are many reasons why simulation modelling should be used as a process modelling tool. For example, a new business process might involve a decision about capital investment that is difficult to reverse. It is usually too expensive to experiment with the real business processes, especially if this involves large scale organisational change. In many cases the variables and resources for new processes are not determined or understood. The process of simulation model development can facilitate a deeper understanding of some of these issues. The value of simulation depends on the model validity and the likelihood that the results of model experimentation may be replicated and implemented in the real processes.

In addition to modelling business processes to support BPR, Process Innovation and Knowledge Management approaches, simulation modelling could be (and has been) used in a manufacturing sector to support TQM and JIT strategies. In conclusion, it could be claimed that simulation modelling could be viewed as the missing link between these change management approaches, particularly as it may help to delineate the boundaries between them and how they may work in practice. In addition, another important benefit of simulation is its ability to provide continuity for change management in companies where the fads seem to come and go.

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AUTHOR BIOGRAPHY

VLATKA HLUPIC is a Senior Lecturer in the Department of Information Systems and Computing at Brunel University. She received a Dipl.Econ. and an M.Sc in Information Systems from the University of Zagreb, and a Ph.D. in Information Systems at the London School of Economics, England. She has published over 100 papers in journals, books and conference proceedings mainly in the area of simulation modelling and business process re-engineering. She acts as a consultant for a variety manufacturing and service companies, as well as having held a variety of lecturing posts in England and Croatia. Her current research interests are in simulation software evaluation and selection, simulation of business processes and knowledge management. Dr Hlupic is a Chartered Engineer, European Engineer and a member of several professional organisations including the British Computer Society, the Operational research Society of Great Britain and the Institute of Teaching and Learning in Higher Education, and the director of the Brunel Centre for Knowledge and Business Process Management at Brunel University. Dr Hlupic is an Associate Editor of *Simulation*.