SIMULATION AND KNOWLEDGE MANAGEMENT: SEPARATED BUT INSEPARABLE?

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INTRODUCTION

For many decades, simulation modelling has been one of the most well known decision support techniques. Simulation related research and empirical work have been traditionally published in areas such as Operational Research or Management Science. In contrast, knowledge management as one of the latest change management approaches is mainly being researched by business, management and ever more by the IT communities. Although there is still a considerable perplexity about what knowledge management (KM) actually is, and there are numerous definitions of knowledge management available in the literature (Hlupic et al., 2002), a general consent is that knowledge management is related to generation, codification and transfer of knowledge in organisations in order to improve business performance and decision making.

Simulation and knowledge management appear to be separated in literature, yet in our view they are inseparable in practice. A more detailed analysis of both areas reveals that they are interrelated in many different ways. For example, simulation models can generate new knowledge about business processes through "what if" analysis. The actual process of simulation model development usually involves an extensive collection of data that needs to be analysed, and this often results in generation of new knowledge. Data obtained from simulation models after experimentation, once analysed, can also generate a new knowledge for organisations. There are business simulation games (such as Tango KM Business Simulation Game supported by Sveiby Knowledge Management) specifically designed for managing organisational knowledge. On the other had, some KM tools, such as MagentA (MagentA Corporation Plc. White paper, 2000) can simulate missing business data.

This paper discusses the relationship between simulation and knowledge management. Links and interdependencies between these areas are investigated and discussed. Examples of synergy between simulation modelling and collaborative KM tools are given, and the implications of issues discussed in this paper are addressed. The paper concludes with the main observations from this research and proposes some lines for further research in this area.

SIMULATION AND KNOWLEDGE MANAGEMENT

This section discusses concepts of simulation and knowledge management separately, whilst the subsequent sections address their connections. Simulation modelling relates to the development of a model of the system of interest, writing a computer program which embodies the model and using this model to investigate the system's behavior when subject to a variety of operating policies Pidd (1998). This enables the most desirable policy to be selected. Simulation modelling has been traditionally used in areas such as manufacturing, health, traffic and more increasingly for business process modelling. For

Proceedings 14th European Simulation Symposium
A. Verbraeck, W. Krug, eds. (c) SCS Europe BVBA, 2002

example, business process models can represent different samples of parameter values, such as, arrival rates or service intervals, which can help identify process bottlenecks and suitable alternatives. Simulation models can provide a graphical display of process models that can be interactively edited and animated to show process dynamics.

On the other hand, knowledge management is the considered to be one of the more recent and popular change management programmes (Currie and Hlupic, 2003). It is apparent that corporate knowledge and knowledge management are becoming increasingly important for modern organizations. In turbulent business environments, one of the main sources of lasting competitive advantage is knowledge (Nonaka and Takeuchi 1995). Knowledge exists in a variety of places and formats, including databases, intranets, filing cabinets and peoples' heads. Information systems have the potential to assist in the codification, generation and transfer of knowledge. At the moment, however, the majority of knowledge management systems are designed to deal with structured data, where information is directly entered into fields or can be categorised in some manner.
The concept of knowledge management has emerged due to a change in business trends, which have evolved from an environment that was predictable and incremental, to one that is radical and discontinuous (Nonaka and Takeuchi 1995). As part of this evolution, Malhotra (1997) describes "knowledge in the minds of organisational members as increasing in value as a resource". However, much care needs to be taken during the information management process, as information overload, often due to the Internet, is thought to be responsible for the sudden proliferation in unstructured data that exists in many organizations (Moad 1998).

Knowledge management is essentially an organizing principle aimed at, similarly to other change management approaches, satisfying, and where possible, exceeding customer expectations. By providing the right information, to the right people at the right time, knowledge management techniques and software applications enable companies to design their operational processes to be truly dynamic (Malhotra 1997) and human resources to be truly effective. The normative literature has been unable to agree on a definition or even the concept of the term 'knowledge management' (Beijerse, 1999), (Hlupic et al, 2002). A possible reason for the vagueness and ambiguity that the word knowledge means different things to different people. An additional factor, which creates confusion, is that there are different types of knowledge namely, *explicit* knowledge where the information is easy to understand and financially tangible and *tacit* knowledge which is difficult to document or categorise and is non-financially tangible (Davenport and Prusak, 1998).

Furthermore, even though there are several definitions within the literature, it is increasingly evident that these do not adopt a multi-disciplinary approach. Indeed they often adopt a managerial perspective that does not accommodate the capabilities of information systems. Sveiby (1999) attempts to explain the concept of knowledge management by analysing research publications in this field. He claims that the people involved in knowledge management can be divided into two categories. The first one is where people come from a background which is computer and/or information science oriented who perceive knowledge to be an object and knowledge management refers to 'Management of Information'. The second category consists of people from a philosophy, psychology, sociology or business/management who consider knowledge to be related to processes and knowledge management to be the 'Management of People'.

The above issues related to knowledge management illustrate the fact that even within the KM area itself, there are different communities, schools of thought and approaches, and the literature does not address the role of modelling in the context of KM.

INTEREDEPENDENCIES BETWEEN SIMULATION MODELLING AND KNOWLEDGE MANAGEMENT

Although the literature normally separates simulation and knowledge management, a more detailed analysis of these areas reveals that there are many links between these two areas. For example, Figure 1 shows how KM is related to phases of simulation modelling process. Once a problem (system) to be modeled is identified, data about the system is collected and analysed. During this process, new knowledge about the system can be discovered, which can be used for problem solving and decision making. The next two phases of simulation modelling process relate to development of conceptual and computer models. More knowledge about the system can be discovered during this phase, and model development can be facilitated by collaborative tools (a type of KM tools) which is discussed in more detail in the next section. An operational simulation model is obtained through validation and verification (testing) of models, and this phase can also be supported by collaborative KM tools whereby knowledge needed for model testing can be elicited and generated with the help of these tools. These tools can also support the proces of designing simulation experiments, and as possible alternatives to be simulated are considered new knowledge about the system and alternative configurations can also be discovered. Analysis of output results can also be facilitated by collaborative KM tools, and output results obtained as a result of "what if" analysis can provide further knowledge about existing and alternative systems. Finally, considering

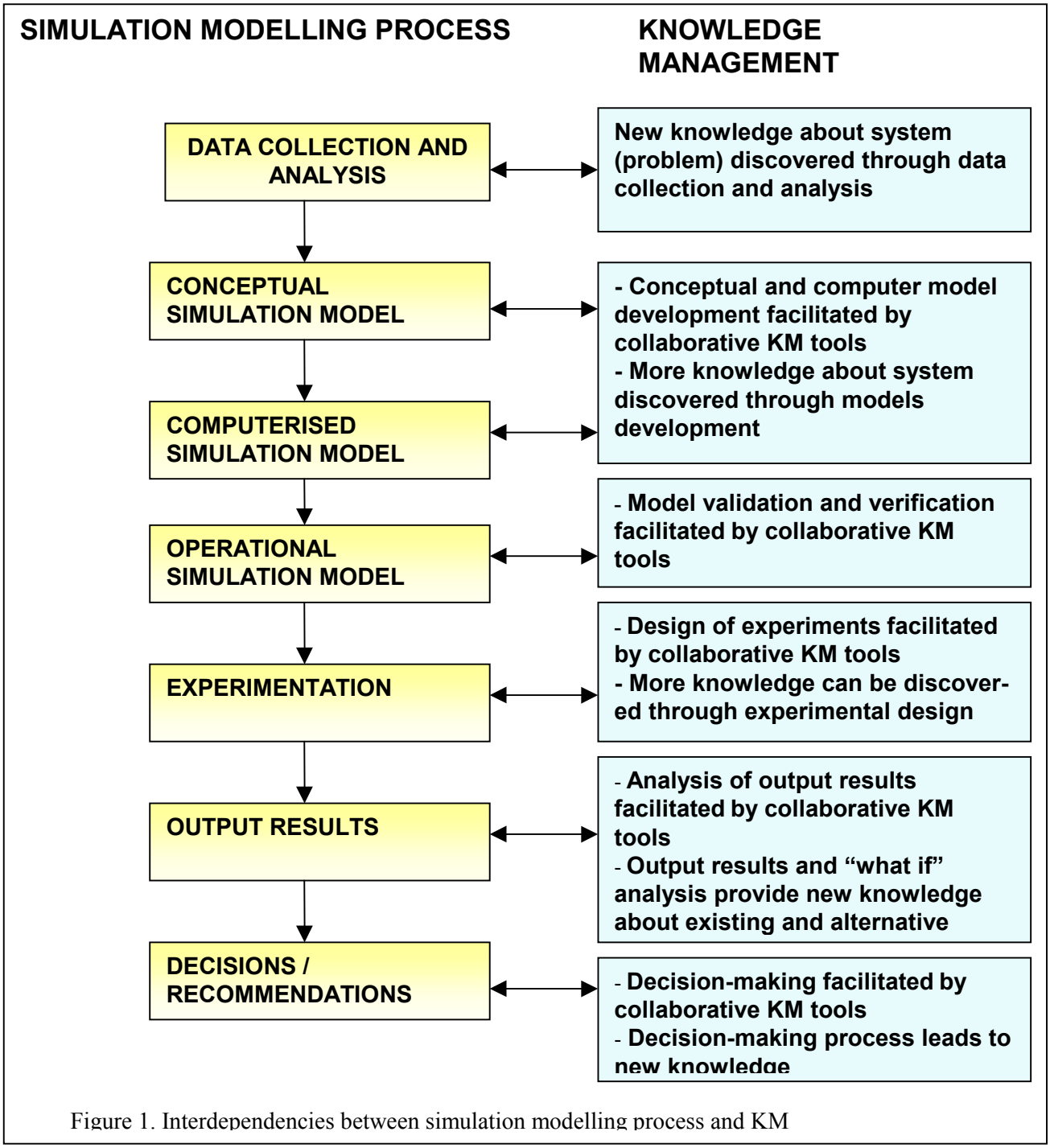

Figure 1. Interdependencies between simulation modelling process and KM

recommendations and decision-making that follow output analysis can be facilitated by collaborative KM tools and the decision making process itself usually leads to discovery of new knowledge (for example, new proposals and ideas for changes in real system can be generated on the basis of simulation results which may require additional experimentation).

In the context of knowledge management (see Figure 2), simulation models can be used to investigate knowledge management processes, knowledge flow and knowledge processing activities, to simulate missing data needed for knowledge management (e.g. MagentA software), or to evaluate alternative models of knowledge management strategies. Simulation projects relate to one-off or continuous study for evaluating knowledge management processes. Models are normally 'people' and information oriented, as the 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.

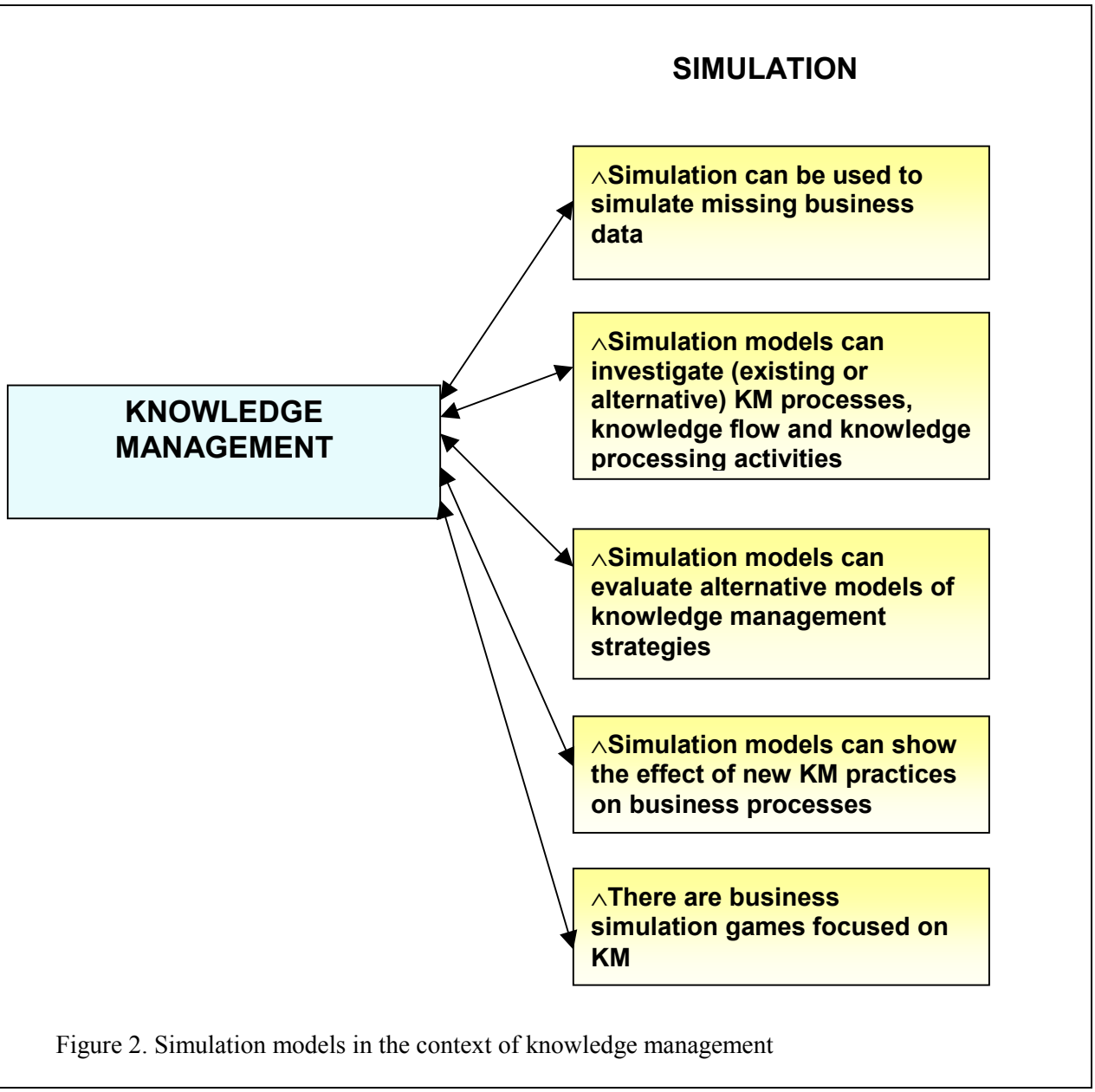

Figure 2. Simulation models in the context of knowledge management

Consecutive models were simulated to groups of stakeholders who then discussed their models using the GSS. The use of GSS together with dynamic simulation modeling enabled a powerful participative approach to be developed that enabled the collaborative design of organisational processes and the development of information system prototypes. In addition, Appelman et al. (2002) used GSS with the System Dynamics model building technique to support negotiations among a group of airlines and agents in an international process of negotiations. They found that GSS was useful in bringing together the conflicting political interests yet did not offer direct support to match the elicited stakeholder views included in the group model building. They suggested that the negotiation process could have been more successful had the GSS been used more to manage the conflict and the group model building, and less to model the desired outcome.

Boulger et al. (2001) describe how the groupware application NetMeeting was used in a major automotive company to facilitate simulation modelling. NetMeeting successfully linked a simulation modelling application across three sites (two in London, one in the USA). The authors have also noted that a company that provides modelling software to this automotive company has introduced NetMeeting for end user support. This, and the fact that NetMeeting is being used regularly in the company, demonstrates that knowledge management and simulation modelling appear to be a useful and effective combination.

ANALYSIS AND IMPLICATIONS FOR RESEARCH AND PRACTICE

Issues discussed in this paper reveal there are many interdependencies between simulation modelling and KM. Many benefits could be obtained from interdisciplinary approach that would involve the combined use of both approaches. For example, simulation models can facilitate KM activities and processes as models could be used to evaluate alternatives before they are implemented or models could be used to simulate missing business data needed for discovering knowledge patterns. Business simulation games can also be a valuable tool for investigating different business strategies related to knowledge management.

On the other hand, KM and in particular groupware tools can facilitate all phases of simulation modelling process. This approach is related to group modelling (Hengst and Vreede, 2003) which has started to gain more popularity in recent years. Experiences in pilots and field trials show the opportunities for the collaborative creation and evaluation of conceptual process models, for effectively incorporating the input and feedback from multiple stakeholders and subject matter experts through GSS, for increasing stakeholders' trust in the jointly created simulation models, for increasing stakeholders' comprehension of the workings of the model, for accelerating data collection, and for immediate model verification. Yet major research challenges lie ahead to fully benefit from the potential of the integration of simulation modelling and collaborative knowledge management tools. Examples include but are not limited to:

- The design of modeling building blocks to speed up the actual simulation model building during group workshops.
- The development of workshop design and facilitation guidelines for situations in which the stakeholders involved have different interests in the outcome of the modelling effort.
- Further increasing the speed of data collection through using expert estimations that are developed in Delphi-style collaborative workshops.

CONCLUSIONS AND FUTURE WORK

Knowledge management and simulation modelling are two areas investigated by different research communities. This paper has demonstrated that these areas are interrelated in many ways. Moreover, experiences from practice illustrate various points of overlap. Together, these experiences show that both simulation and knowledge management are actually very interwoven throughout the activity cycle of a simulation modelling project.

Further work in this area relates to conducting further case studies using collaborative KM tools applications during conducting simulation modelling studies, and recording the costs and benefits obtained from this approach. The concept of group modelling also requires further research both in methodological and tools related areas. Information on case studies where models are developed to facilitate KM activities and processes is rarely available and this is another area for further research.

It is hoped that the issues discussed in this paper will help initiation of activities both in the simulation modelling and KM communities, which will result in more interdisciplinary research, better working practices and cost savings for businesses and simulation modelling practitioners.

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