A General Process for Developing Business Simulations Games

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Abstract: Nowadays people, groups and organizations are increasingly confronted with problems and situations that show an increasing level of complexity. However, human abilities to deal with complex dynamic systems and processes, while behaving in a sustainable way, have not improved to the required extent. One way to deal with complex situation is the simulation approach: build a simplified model of this reality, learn from this simplified model, and, finally, translate the findings or knowledge back to reality. Simulation games are based on this idea. Nevertheless, if we want to make inferences about reality based on experiences and knowledge acquired in a simulation game, we have to be sure that the underlying conceptual model is a good, or valid, representation of the real situation. Based on knowledge gather from the simulation development process and Agent-based Modelling, this paper proposes a general process for developing business simulation games.

1 INTRODUCTION

A computer simulation is a computer program that attempts to simulate an abstract model of a particular system and conduct experiments with that model (Smith, 2009). Computer simulations are being used as a tool to explore and gain new insights in many scientific areas such as physics, astrophysics, chemistry, biology, human systems in economics, psychology, social science and engineering. In this context simulation typically emphasizes a more academic and throughout exercise, often involves a model of a process, and typically supports learning specific content or about decision making. Another important use of simulations is for educational purposes where they are often denominated simulation games. Some examples where they have been successfully applied are the following. Medical researchers and surgeons are increasingly trying out operating techniques on a virtual patient before testing or using them on real patients; navigation and flight simulators are used to try out complicated manoeuvres by ships or aeroplanes; preliminary designs of complex machines like nuclear reactors, products and processes are tested by way of three-dimensional simulation software, and so forth (Berends and Romme, 1999).

There isn't an agreement regarding the boundaries of what is a game and what is a simulation and where do these two concepts meet. In this paper we regard simulation both as a tool to explore and gain new insights in scientific areas and also as a tool for educational purposes, therefore we have adopted the definition given in (Galvão et al., 2000): "A simulation game is a mixed feature of a game - competition, cooperation, participants and rules, etc, with those of simulation - incorporation of critical features of reality. While the benefits outlined above have been known for long, today we find limited use of simulation games in organizational contexts both for learning or to support decision making. Several factors contribute to this, namely current simulation games: have lack of flexibility; lack of level-of-detail; lack of multi-state frameworks consisting of theoretical concepts; and the inability to support the creation of complex business models (Peters et al., 1998; Galvão et al., 2000; Garris et al., 2002).

Given these limitations, this article proposes a general process for developing business simulation games. We start by describing (section 2) the overall process of developing a simulation game. This process is based on proposals made by different researchers developing simulation games for different contexts. Next (section 3), we give an overview of the underlying concepts of Agent-Based Modelling. Then we move on (section 4) to a discussion where a general process for developing business simulation games is described as well as the current challenges in this area. Finally (section 5) conclusions are drawn

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pointing to the future scope for development that lies ahead on this vast and interesting field.

2 THE SIMULATION DEVELOPMENT PROCESS

Over the last decades several development processes have been proposed to devise business simulations (Mikkelsen. H and Riis, 1995; Peters et al., 1998; Martin, 2000; Galvão et al., 2000; Garris et al., 2002; Kriz, 2003; Smith, 2009). Most of these processes are directed at developing environments that are suitable for learning but a few also take into account the potential for promoting organizational change through aligning actors mental models or experimenting different situations. Although the development processes underlying the approaches described by those authors use different terms and their extent is at some level according to different stages it is also possible to, in a higher level of abstraction, to identify a number of stages that are common to all. Accordingly, we identified five different stages with three broad relationships, namely conceptualization, application and reflection. The general simulation game development process can be depicted in figure 1. Conceptualization

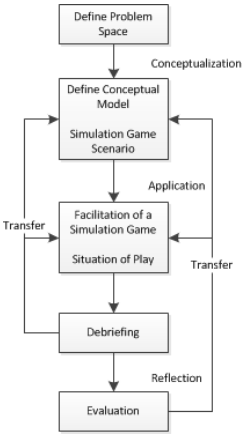

Figure 1: The general simulation game development process.

is composed by three main principles: reduction; abstraction; and symbolization (Peters et al., 1998). Reduction means that we make a selection of elements from the reference system (the domain of the problem at hand) that have to be included in the game model: We include the elements that seem relevant to us, and we leave out the elements that are less important. Abstraction implies that the elements included in the game model are not necessarily as detailed as they are in reality: We deliberately simplify them to make our model less complex. Finally, symbolization deals with the fact that the elements and relations of the reference system are modelled into a new symbolic structure, namely, into scenario, roles, rules, and symbols, which are the most important basic elements of a game. Some game elements may quite resemble their counterparts in reality, but other elements may undergo a metamorphosis and have a complete different appearance in the game model. The second relationship - application - is related to the game play. When players interact with the simulation game specific game reality emerges. The final relationship - reflection - is related to the acquisition of knowledge and the evaluation of the game play. After the game play, the players have access to a debriefing where they can view the overall progress throughout the game and also critically evaluate the level of interest of the situation that emerged in the simulation game.

As described previously, one of the factors that contributes to the limited use of simulation games in organizational contexts is the inability of current simulation to support the creation of complex business models. This is directly connected with the first two stages of the general simulation game development process, namely the definition of the problem space and designing the respective conceptual model. Next, we summarize the underlying concepts of Agent-based Modelling.

3 AGENT-BASED MODELLING

Formally, agent-based modelling is a computational method that enables a researcher to create, analyse, and experiment with models composed of agents that interact within an environment (Gilbert, 1998). Agent-based modelling has been successfully used in behavioural economics, political science and social sciences for studying social phenomena. It has been argued that these models include more realistic assumptions about behaviour, structure, and timing therefore, representing a powerful engine for generating insights in complex adaptive systems (Miller and Page, 2007). Agent-based models are characterized by the following (Chang and Harrington, 2006; Miller and Page, 2007; Macal and North, 2010):

- **A Set of Agents, Their Attributes and Behaviours:** The behaviour can be either according to rational models, behavioural models or rule based models.
- **A Set of Agent Relationships and Methods of Interaction:** An underlying topology of connect-

edness defines how and with whom agents interact.

- **The Agents Environment:** Agents interact with their environment in addition to other agents.
- **Model Outcomes:** Simulating a set of agents interacting in an environment provides insights into phenomena related to the part of reality being simulated.

The underlying assumption for using agent-based models to model reality in organizations is to view organizations as complex adaptive systems that emerge from the interactions among human agents. Under this assumption organizations have properties such as emergent behaviour, self-organization and evolution (Magalhães, 2004). In this context, to take an agent-based approach means not having to assign an objective to an organization and instead modelling the agents that comprise it with explicit attention to how decisions are made and how interaction of these decisions produce organizational output. In this sense researchers using this approach are interested in understanding how can organization behaviour be simulated using agent-based models, and which agents intrinsic properties have an impact on organizational performance. Therefore, in addition to the standard model building tasks, practical ABM and simulation requires one to (Macal and North, 2006) (i) identify the agents and get a theory of agent behaviour, (ii) identify the agent relationships and get a theory of agent interaction, (iii) get the requisite agent-related data, (iv) validate the agent behaviour models in addition to the model as a whole, and (v) run the model and analyse the output from the standpoint of link.

4 A GENERAL PROCESS FOR DEVELOPING BUSINESS SIMULATIONS GAMES

Based on the concepts presented (ABM) we have revisited the general simulation game development process and added intermediate steps that address the inclusion of social-human domain in the business simulation game conceptual model. Specifically we have added two steps related to the integration of ABM simulation during the development of a business simulation game. The complete process can be depicted in figure 2 and further details are explained next.

The general development starts with the definition of the problem space that consists in defining which part of the organization, specifically the situations that which to be analysed and experienced by players. Social systems are constructions. However, their meaning emerges from processes of participation and reification (Wenger, 2002). They are not structured by external information they receive but by internal structural conditioning and negotiated meaning (Klabbers, 2003). In the next phase the part of the reality chosen is observed as a social system and the underlying assumptions concerning decision models are defined. This assumptions can either be according to three main models for specifying human decision models: rational models; behavioural models; and rule-based models.

In the Validate Decision Models step the simulated data is analysed in order to verified the assumptions made in the previous step. Some researchers argue that ABM is a third way of doing science (Axelrod, 1997). Like deduction, it starts with a set of explicit assumptions. But unlike deduction, it does not prove theorems. Instead, an agent-based model generates simulated data that can be analysed inductively. Unlike typical induction, however, the simulated data comes from a rigorously specified set of rules rather than direct measurement of the real world. Whereas the purpose of induction is to find patterns in data and that of deduction is to find consequences of assumptions, the purpose of agent-based modelling is to aid intuition. In the next step the conceptual model is defined. This conceptual model besides the organizational agents decision models also has to include other related concepts from the organizational perspective of Enterprise Modelling approaches, like role and activities and also concepts necessary to integrate player modelling representation. The resulting conceptual model is then experience by players during a situation of play. This experience allows the player to interact with the simulation and visualize the results of doing certain actions, how decisions are made and how iterations of these decisions produce organizational output. In the Debriefing phase the conceptual model and the output results of the simulation game are compared to verified the correctness of the devised assumptions and conceptual model. Also, in this phase the acquired knowledge and skills are assimilated through reflective observation (Kolb and Kolb, 2008) and plans for organizational change to real situation are made. Finally, the complete process is evaluated and recommendations for improvements are proposed for the next iteration of the development cycle.

5 CONCLUSIONS

The use of simulation games in a organization, can serve as a tool to create a better understanding of

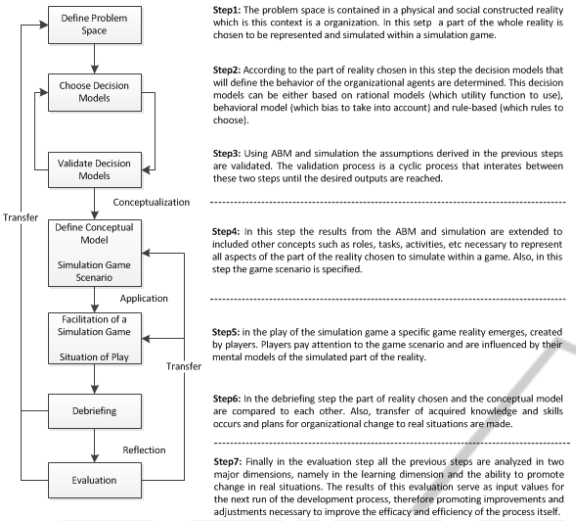

Figure 2: General simulation development process.

the prevailing organizational culture, structure, and processes to access the risks, chances, and necessities of organizational changes. Simulation games are a method used to support people and organizations in dealing with the sustainable (re)construction of their reality. Simulation games imitate organizational processes and changes them in an experiential and playful way. This aids organizations in their search for creative problem solution in a real-life situations. Nevertheless, if we want to make inferences about reality based on experiences and knowledge acquired in a simulation game, we have to be sure that the game model is a valid representation of the real situation. Therefore, the underlying simulation game conceptual model has to integrate the different perspectives of business. In this paper we describe a general simulation game development process. This development process is a cyclic process that has seven main steps that guide the implementation of a simulation game from the definition of the problem space until the evaluation of the output results. Future work will include the practical application of the proposed development process in case studies based on real-world situations. This study will provide further insights and will help to better characterized each step of the development process and respective results.

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