Using Serious Games to Teach Business Process Modeling and Simulation

Cláudia Ribeiro, João Fernandes, André Lourenço, José Borbinha and João Pereira
INESC-ID, Rua Alves Redol 9, Lisbon Portugal
Department of Information Systems and Computer Science, IST/UTL, Lisbon, Portugal

Abstract - Serious game and virtual-based environments have recently been used in business contexts to promote training of business related competences as is the case of business process modeling. Due to its characteristics modern BPM methods rely heavily on computers, since they are used as a tool for model, simulate and analyze a process and its effects on the organizations. Several authors argue that these approaches offer several limitations with respect to the modeling processes namely, they typically offer a low degree of collaboration between users, the simulations are simplistic and do not take into account the possible interaction of users during the simulation process and the interfaces are many time complex and abstract requiring an extensive training in order to use those tools. Serious games and virtual environments are mentioned as a promising approach for teaching and simulating BPM since due to their characteristics they can solve or minimize many of those limitations. In this paper we describe a serious game named ImPROVE for teaching business process modeling in a real-world context, the Manchester triage system. The simulation layer of the game was based on Time-based Activity-based Costing which also provides feedback information related to costing of activities in a business process.

Keywords: business process modeling, Time-based Activity-based Costing, Simulation, Serious Games

1 Introduction

Simulation is the process of designing a model of a real or imagined system and conducting experiments with that model. The purpose of simulation experiments is to understand the behavior of the system or evaluate strategies for operation of the system (Smith, 2009). Enterprises design and implement systems to fulfill certain functions. What often becomes a challenge is to identify the complex interactions and interfaces between different organization functions and the roles and responsibilities of the various stakeholders involved. Business Process Modeling is an important part of understanding and restructuring the activities and information a typical enterprise uses to achieve its business goals. It is also a powerful method used for better understanding business concerns and communication between stakeholders, allowing that every interested part is actively involved in these activities. Modeling and simulation are tools and methods that are widely used in enterprise engineering/organizational study where these are considered effective, efficient and economical for organizational analysis and design (Barjis & Verbraeck, 2010).

Games and game-like tools have been chosen as the means of information spreading and training for various reasons. Some of these include the visually impressive outlook, apparent easiness of the game user interface compared to conventional software, the way younger generations have been accustomed to the playing of games, and entertaining aspects of the gaming and the attractiveness of the gaming (Beck, 2004) (Prensky, 2001). The use of serious games in business contexts has grown dramatically over the last fourth decades and it has been reported that they provide three main benefits in promoting organizational learning, namely: (i) to orient and train new employees; (ii) to select current managers or future managers; and (iii) for ongoing management training (A.J. Faria, 2009).

In serious games human actors are the active decision makers whose actions will affect the future state of the simulation run. This active role of human players separates simulation games from pure simulations (Martin, 2000). Pure simulations use static rules to calculate the outcome of the situation. Human players are unpredictable therefore they might choose to do things that extend the possibilities taken into account by the original designer. This is one of the central problems with which modeling and simulation tools still debate nowadays. There is a considerable gap between the model of a sub-set of the reality, the model a current simulation tool support and the ability to view the results of simulating such a model in the real-world.

In this paper we argue that using serious games and their specific characteristics for modeling and simulating business processes could help bridge these existing gaps and therefore promote suitable tools both for promoting organizational learning as well as organizational change. For that purpose a serious game based on modeling and simulation Time-Driven Activity-Based Costing (TDABC) processes was developed and applied to a hospital emergency unit case study.

This paper begins with an overview of the current developments of serious games (section 2), namely their advantages and current use in educational contexts and some
examples of how they have been applied in business process modeling contexts. This is followed (section 3) by a brief description of the TDABC methodology and the advantages that serious games could provide when applying this methodology. Next (section 4), a detailed description of the ImPROVE game is provided. This game was developed in the context of a master class lecture and inspired by a real-world case, namely the current triage system of a Portuguese hospital emergency unit. Finally (section 5) conclusions are drawn pointing to the future scope for development that lies ahead in the vast and interesting field.

2 Serious Games and M&S

Serious game and virtual-based environments are an important response from the education technologist to the "digital natives" (Squire, 2005), a generation of students who were raised on interactive games and expect the same kind of interactive experiences from their education media. Indeed, it may possibly be wrong to call the use of serious games in education a novelty, since by nature young children begin to learn through games at their earliest years (Rieber, 1996).

Due to their characteristics, games can introduce clear advantages in supporting complex learning processes and knowledge transfer. Through games it is possible to simulate environments and systems allowing learners to experience situations that are impossible in the real world for reasons of safety, cost and time (Corti, 2007) (Jenkins, 2004).

Games and virtual simulations are often referred in the literature as experiential exercises (Gredler, 1994) in which people “learn by doing” avoiding “mimicry learning” (Turkle, 1984). They in fact increase greatly the learning outcomes since they easily change our mood towards the learning of specific topics (McGonigal, 2012). As Savill-Smith argue (Savill-Smith, 2004), games can support the development of a number of different competences such as: analytical and spatial skills, strategic skills and insight learning, recollection capabilities, psychomotor skills, visual selective attention, showing promising results when compared to traditional methods (Szezurek, 1982) (VanSickle, 1986) (Randel, 1992) (Van Eck, 2006).

The use of games in an education context is not a distant concept, they were adopted long time ago by organizations in a wide range of sectors, nowadays no pilot will ever pilot an airplane without an intensive training using simulation and games, no power plant manager will ever run a nuclear plant without an intensive training using simulation and games (Aldrich, 2004). We can thus conclude that, the organization that cares most about the training use simulations and games to do their training and to support some of their day-to-day processes.

The field of business is not an exception in the permeation to this kind of approach, the first business game widely recognized, ‘Top Management Decision Simulation’, was created in 1956 by the American Management Association. Since then, a great number of different business games have been developed (Carroll, 1954) (Faria, 2004) and used in management training by different business schools, faculties and professional associations all over the world (Walters, 1997) (Chang, 2003) (Sánchez Franco, 2009). Nowadays these games are seen as a useful tool to learn how to manage firms and to explore new strategic opportunities (Jensen, 2003).

Several authors referred that the most important advantages of applying games in a business context, are the immediate feedback, active participation of students, learning from the experience, observation of the key factors in an on-the-job situation, preparation for the uncertainty of business, and the high motivation to learn created by the competitive environment (Fu, 2009) (Gilgeous, 1996) (Zantow, 2005).

An activity that would benefit substantially by the introduction of these approaches is the Business Process Modeling (BPM). Due to its characteristics modern BPM methods rely heavily on computers, since they are used as a tool for model, simulate and analyze a process and its effects on the organizations (Tapani, 2008). A wide range of process modeling grammars (also called notation and technics) were proposed during recent years (Rosemann, 2006), generally they are composed by two dimension representation making use of shapes like circles, squares, rectangles. The authoring of such schemes is generally supported by process modeling tool suites (Hill, 1990), that provide a graphical model editor and sometimes some complementary functionality regarding simulation, bug detection, reporting and analysis (Recker, 2006).

Several authors argue that these approaches offer several limitations with respect to the modeling processes, they typically offer a low degree of collaboration between users, the simulations are simplistic and do not take into account the possible interaction of users during the simulation process and the interfaces are many time complex and abstract requiring an extensive training in order to use those tools (West, 2010). Serious-games and virtual environments are mentioned as a promising approach for teaching and simulating BPM since due to their characteristics they can solve or minimize many of those limitations.

Towards meeting these objectives, a large number of three-dimensional approaches for the representation of the process models have recently been suggested (Brown, 2009) (Streit, 2005). More than merely providing a modulation and simulation tool, these environments put humans as active decision makers, conditioning their actions states of the simulation runs, thus differing from the traditional tools. Due to their superior collaboration capabilities, games and virtual environments can enhance the process of distance collaborative process modeling allowing both analyst and domain experts to collaborate in the same modulation process (Frederiks, 2006).

Perhaps the most well known reference in this field is IBM INNOV8, which as IBM states made a major impact on business games. INNOV8 is a tri-dimensional serious-
game that virtually simulates a business environment where the player assumes the role of a project manager with the goal of through his analysis over the several companies’ internal business processes construct a more efficient company. The game focused on the introduction of BPM therefore the players do not need any prior knowledge of BPM methodologies to use INNOV8.

This game has been used for a few years in corporate and university environments allowing users to uncover process challenges and simulate real world business solution with clear benefits comparing to more traditional tools (Lapp, 2007).

3 Time-Driven Activity-Based Costing (TDABC)

Time-Driven Activity Based Costing is a costing methodology (Kaplan & Anderson, 2003), that aims at solving some of the problems of the traditional Activity-Based Costing, in which costs were calculated based on the assignment of resource expenses to activities that were verified through interviews and surveys. Although this is effective for small processes, it becomes inefficient and not at all accurate for more complex processes. To address this issue TDABC only requires two parameters: The unit cost of a resource (e.g. Logistics Department), that can be calculated from the total expenses related to that particular resource divided by its capacity (normally expressed in time), and the time needed to execute a particular task. With these two values we can know the cost of a particular activity simply by multiplying the time taken by the unit cost. Furthermore we define processes as a composition of activities.

Another ABC problem that TDABC aims to solve is that each time there is a small change or variation to an activity, there is the need for creating a new activity, for example standard packaging and hazardous packaging would result in two completely different activities, with TDABC we could have the same activity “packaging”, but with different times whether it’s a standard or a hazardous one. This greatly reduces the complexity of the processes since we can express all conditions in a single activity. TDABC also has the advantage of being able to give information about its own accuracy as well as help identifying waste, by comparing the calculated capacity of a given resource vs. the actual used capacity in a given period.

The TDABC methodology is used to analyze the costs resultant of a set of activities or of a process, but it can be used not only to see what was the cost of those processes but also to do what-if analysis, based on historical data. For instance it is possible with TDABC to see what would be the result of removing/adding an activity, or reducing/increasing the time it takes. On top of this TDABC also gives the ability to generate custom reports, to evaluate costs based on clients, departments, areas, etc. and to drill-down in order to identify the causes of waste.

Allying a game environment with TDABC is a breakthrough approach that has three major advantages:

1. What-if Scenarios – Using a simulation environment it becomes easier to do an impact analysis based on historical data, since it becomes possible to do adjustments to the various components of the model, using visually appealing elements, and get real time feedback, instead of being mandatory to change the whole model and then reapplying it to the data. Also, it becomes easier to simulate local changes, without having to contemplate the whole model.

2. Definition of Processes\Activities\Time Equations – A problem very common in the conventional implementation of an application that uses the TDABC methodology, is that the definition of all elements must be done using spreadsheets, tables or even by manually defining the time-equations. Obviously a process analyst is more used with Business Process Modeling Notations than with these methods. With a simulation it would be possible to ally a familiar concept like BPM, and at the same time give some assistance to the user by asking for needed values or warning for inconsistency. On another perspective a simulation would help teaching the steps to define a model.

3. Reaching all stakeholders – Another aspect of a simulation would be to help presenting results or to show the importance of certain data to both management and operational levels. For management it is always easier to make decisions based not only on ideas, but on real numbers as well. For operational level some decisions or changes are normally better accepted if their future impacts and advantages are shown. All these data would be possible to show using a simulation. Also regarding reaching stakeholders, this simulation/game could create a common ground on a company motivating every employee to the importance of an accurate definition of processes and activities and company’s global objectives.

4 ImPROVE: A Serious Game Based on TDABC

ImPROVE is a 3D serious game developed using the Unity3D game engine and it was based on a real-world example, specifically the implementation of the Manchester triage system (Manchester Triage Group, 2005) on a Portuguese Emergency unit hospital. Nowadays, triage is applied in various healthcare settings such as in mass casualty incidents, the intensive care unit, and emergency departments. Triage systems tend to rely on three different healthcare values. First, they intent to protect endangered human lives and human health. These systems therefore prioritize patients with urgent care need to treatment while less severely ill or injured patients can safely wait. However, in case several patients have to wait for life-saving interventions because one patient needs too many resources, the latter patient will not be treated first. This situation is
related to the second healthcare value, efficient use of resources. Because healthcare resources are scarce, these resources will be allocated to the patients in greatest need and with the largest probability of survival. The third and final value on which triage systems rely is fairness and refers to the use of established guidelines for allocating resources to patients. With these guidelines, decisions are made on the basis of standards instead of personal preferences.

In this context the ImPROVE game provides a player with the ability to model the business process underlying the hospital emergency unit and check its impacts on healthcare values and hospital costs using the simulation features. The game main screen presents the player with a 3D representation of a set of swim lanes (Figure 1), each one visually distinguishing responsible for sub-processes of the emergency unit business process. The dimensions and number of swim lanes are setup either on a xml file or they can also be easily changed in the unity3D Editor. A simple graphical user interface (GUI) was also developed in order to manage the creation of business process primitives (Figure 1), namely activity, decision points, start and finish. The main goal of ImPROVE is to assist and enhance business process modeling and simulation activities in order to provide two main benefits, promote organizational learning and organizational change. In this sense, the set of activities that can be used are pre-defined which clearly described the range of possible activities involved or otherwise done by people in the real-world setting. Therefore, when the player is building a business process feedback is provided in order to guide the player and also to prevent designing impossible sequence of activities and or decision points. Providing real-time feedback while modeling and or simulating a business process represents an important improvement comparing to current tools. This not also motivates the player as it also gives information to the player important for decision-making. In this manner, this knowledge could then be more easily transform in explicit knowledge and used successfully in the real world when executing similar activities.

![SwimlaneElement](image1)

While the player is building the business process the layer responsible for checking its validity and simulation is automatically creating the time equations for calculating the cost according to the TDABC methodology. For this methodology considerations of time are very important, therefore the player has the ability to setup each activity duration and cost driver in real-time by accessing a context GUI. The relationships between business process primitives are manually created by the player by pressing a specific swim lane element and choosing the appropriate link.

Once the business process model is finished the player has the ability to test its impact by simulating it. This operation will provide the player with visual information regarding patient health, waiting time and associated costs. These values are the most important for the final score of the game, therefore it given the possibility for the player to test the final model and respective setup information three times before he/she submits the final model. In each of the intermediate simulations the player can also have access to relevant information related to the current business process being simulated.

The business process model was developed on a separate unity3D scene in order to be easily integrated in a different context. Ultimately, an adventure game can be built around this base context and modeling and simulating a business process can be just one of the many activities of the game. Therefore, the use of serious games in a company could, for example, serve as tool to create a better understanding of the prevailing organizational culture (represented on the adventure part of the game, with characters, etc), structure, and processes to access the risks, chances, and necessities of organizational change.

![Swim lane representation](image2)

![Business process primitives: start, finish, decision point and activity](image3)
5 Conclusions

The potential of Serious Games and Virtual-based environments to promote training has already been recognized and put into practice in several application areas, as is the case of a wide range of military sectors, aviation, healthcare, and the energy sector. This potential has also been recognized in business contexts where several simulations and games have been developed in the last decades. As described previously, several authors referred that the most important advantages of applying games in a business context, are the immediate feedback, active participation of students, learning from the experience, observation of the key factors in an on-the-job situation, preparation for the uncertainty of business, and the high motivation to learn created by the competitive environment. These particular advantages could greatly benefit the activity concerning business process modeling because although there are a lot of tools that support this activity there is still a considerable gap regarding the ability to do bug detection, reporting and analysis. Due to these constraints, business process modeling methods are still nowadays based on research design and best practices. Serious games could help bridge this gap. In this paper an example of how this could be accomplished was presented. The ImPROVE serious game allows the player to model a business process and visually receive real-time feedback of the impacts of implementing that particular business process in a business context, which in the presented example was the emergency unit of a Portuguese hospital. The ability to receive real-time feedback as well as visually witness the impacts of making certain decision (e.g. deciding on a particular sequence of activities or using certain resources) brings the activity of modeling business processes closer to the real world therefore, to the on-job situations. This also promotes the transformation of tacit knowledge into explicit knowledge representing a shorten period between learning a competence and being able to apply it on a concrete or similar situation. Finally, although several advantages have been pointed out, there is still a lot of space for improvements, namely adding multiplayer support and collaborative tools could greatly increase knowledge transfer through socialization and promote collaboration between employees.

6 References


