On using simulation games as a research tool in project management

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Abstract

The objective of this article is to provide an overview of the scope and applications of simulation games in project-management education and research. The author presents a brief literature survey discussing the range and classification of simulation games in project management. In addition, the author reviews important pedagogical views on simulation games and looks into the possibilities of simulation games as a tool in project-management research. He found no supporting evidence that simulation games have been used in project-management research.

Introduction

A study based on the Felder Learning Style Index was conducted in 2005 at the Norwegian University of Science and Technology (NTNU) (Hussein & Nyseth, 2005). The study confirmed the existence of different learning styles among student groups taking part in a project-management course. The Index of Learning Styles (ILS) results provide support for arguments of variation in engineering teaching strategies, as presented earlier by Felder (1993). Our study shows that the vast majority of students (82 %) who have participated in our questionnaire are 'active learners'. Strictly lecture-based teaching that provides no active and cooperative learning experiences inside or outside the classroom, works to the disadvantage of the majority of the student population. The survey also shows that a considerable majority of the student population (69 %) are 'sensing learners'. Instruction that emphasizes only abstract concepts at the expense of concrete real-world applications and examples puts the sensing majority at a disadvantage. Simulation games are a well-suited instructional strategy for this target group.

While assignments, case studies and role plays provide training and experience with reality, the unique characteristics of simulation games as an education tool is the inclusion of a time-line (Chuda, 1996).The inclusion of 'time' as an element in a simulation game implies that game participants have to cope with their previous decisions as the game evolves. Raia (1966) has concluded that simulation games when used as supplementary teaching aid, can enhance learning and heighten student interest. The game artifact itself can be a board, computer, Internet, a classroom and so on. However, most of the reported simulation games in the literature take place in a computer-assisted environment (e.g. Rowe et al., 1968; Estes & Herring, 1974, Deitzler, 1978; Harris & Flower, 1984; Jakubowski et al., 1984; Pamukcu & Pruett, 1985; Cano & Saenz, 2003; Prisk & Dunn, 2002). Others such as Klassen and Willoughby (2003) and Hood and Hood (2006) report about a classroom-based simulation game using other artifacts than computers. Commercially there are several well-known simulation games for management. Elgood (1997) provides an extended list of several management simulation games including Babel Tower, Bridge the Gap, The Puzzle and others. He summarizes the advantages and disadvantages of using simulation games as compared to ordinary lectures, as follows:

Disadvantages

- Simulation requires more time to cover the same amount of material.
- They are less rigidly programmed than a lecture, so there is no guarantee that all material will get sufficient emphasize.

Advantages

- Games can have considerable subject knowledge built into them. They can pose a problem, demand an answer, and respond to the answer providing an excellent device for learning by experience rather than by hearsay.
- Massive difference in student motivation. Participants are actively involved in the game. They are interested and are 'doing' rather than listening.
- Games provide an opportunity for group discussions and debates.

The effectiveness of simulation games for management education and training as compared to other instructional methods is still unclear. Chuda (1996) argues that despite the lack of consensus regarding the teaching and grading methods to be used in conjunction with such games, it is clear that well-conducted simulation games can provide excellent experiential atmospheres for students of management. He raises a number of questions, such as: Are games valid as educational tools? How effective and efficient are simulations for educational purposes?
Pfahl et al. (2003 & 2004) conducted several experiments in order to evaluate the learning effectiveness of using simulations in software project management education. They concluded that a simulation-based role-play scenario is a very useful approach for learning about issues in software project management.
Randel et al. (1992) conclude that subject matter areas where very specific content such as mathematics can be targeted, are more likely to show beneficial effects for gaming. That is unfortunately not the case in project management. The skills required to perform project management can be generally divided into two main categories:

1. Soft skills: Answering the when's and why's in the management context. Topics like leadership, team alignment, negotiation, communication and stakeholders' management form the heart of soft skills project management. The problems that stretch out under this domain are highly ill defined and are strongly dependent on project's context.
2. The second domain of project management answers mainly the *how's*?. It is concerned with planning and control aspect of management. In the planning and control domain, project managers deal largely with problems related to trade off between time, cost and quality (Kerzner, 2006). The two domains are indeed hard to separate since any effort to understand, the more so to plan, organize and control resources in any project must rely upon a realistic description of the dynamics in and around such projects.

Cano and Saenz (2003) point out that despite widespread use of simulation games it is still not clear what conditions have to be provided in order to obtain optimal learning through simulation games. They presented the concept of project management simulation laboratory where users share their knowledge and get some insight on project management practice through the simulator.
In their frequently cited paper, Keys and Wolfe (1990) take a broad look at the management gaming movement and summarize how the field has evolved to its current state. Several models of experiential learning applicable to gaming are explained.

Included are studies on the educational value of management games and a review of the literature that deals with management games and simulations as research laboratories. The paper also provides a classification of simulation games in management. They classified management games into the following categories:

- Epigrammatic: Short time, and not computer-scored, single-concept exercises, generally referred to as experimental exercises.
- Simulations that deal with the entire organization and provide a balanced number of decision variables from different subunits in the organization is called top management games.
- Functional games concentrate on a single subunit in the firm such as marketing or accounting.

Simulation games in project management

Project management is defined as the application of skills, tools, knowledge and techniques to project work activities to meet project requirements (PMI, 2004). Project management is accomplished through the use of processes such as initiating, planning, executing, controlling and closing. A project is a temporarily effort undertaken to attain a unique goal under the constraints of time, resources and costs.
Although the literature on project management field is vast and enormous (see for example Kerzner, 2006) the literature about simulation games in project management is limited. Most of the research studies in the field of simulation games focus on business games. Little evidence of this kind of research has been found in project-management simulation games (Cano and Saenz, 2003).
Reviewing the current literature on simulation games shows that we can distinguish broadly between two categories of simulation games: 1) Functional simulation games; 2) Project leadership simulation games.

1. Functional simulation games

The vast majority of simulation games reviewed fall under this category. These exercises usually deal with isolated concepts (single or multiple.) Decision making in this kind of games is based on mathematical models and are mainly applied in order to balance or trade-off between multiple project objectives such cost, time, performance and so on. This kind of simulation games also include experiential exercises (epigrammatic) for well defined problems such as forecasting project durations, resource usage and leveling, cost estimation, cash flow control, and logical relations between project activities or combination.
The first reported simulation game that falls under this category is the 'Gremmex game' (Rowe et al., 1968). Gremex is a Research & Development (R&D) management simulation exercise designed to provide a simulated project-management environment for instruction of R&D project management techniques. The target group is R&D executives. The exercise was designed as both a training device and also as a management research vehicle. Training objective was to provide a synthetic experience illustrating the types of problems that can come up in an R&D project, what lead time is necessary to make certain that a balanced, coordinated effort is achieved, and how Technical, Cost and Time objectives must be properly coordinated in the planning and control facets of project management.
Estes and Herring (1974) describes a Project Activity Management Simulator (PAMSIM). The purpose of PAMSIM is to provide new means of teaching project analysis and management. The author emphasizes that the simulation game is a

supplement but not a replacement of the traditional textbook-lecture-homework approach by permitting the student to interact with a dynamic simulated project environment. The events in the simulation game takes place randomly. The simulation covers topics like duration estimates and resource leveling in the presence of random events such as weather delays.
Baird and Flavell (1981) present a game that simulates a project which is described in terms of a network. The player is presented with a sequence of 'project meetings' at which he must make certain decisions. The outcome of each decision will affect the total cost of the project. Pamukcu and Pruett (1985) present a game called Interactive Project Management game (IPM). The game focuses on scheduling, resource leveling, risk assessment and response. The simulation is done on a weekly basis under the assumption that once a simulation has been started it can not be stopped.
Rounds et al. (1986) describe an interactive game which objective is to strengthen project management progress reporting skills. The program is set up by the player to specify the desired type, frequency, and detail of reports as well as the intensity of predefined problems that the program introduces to disturb the project. Once established, the program begins to cycle through the project, typically on a monthly basis. As reports are produced, the player attempts to identify when a problem has occurred and selects appropriate solutions from among alternatives provided by the program.

Simulation games at NTNU

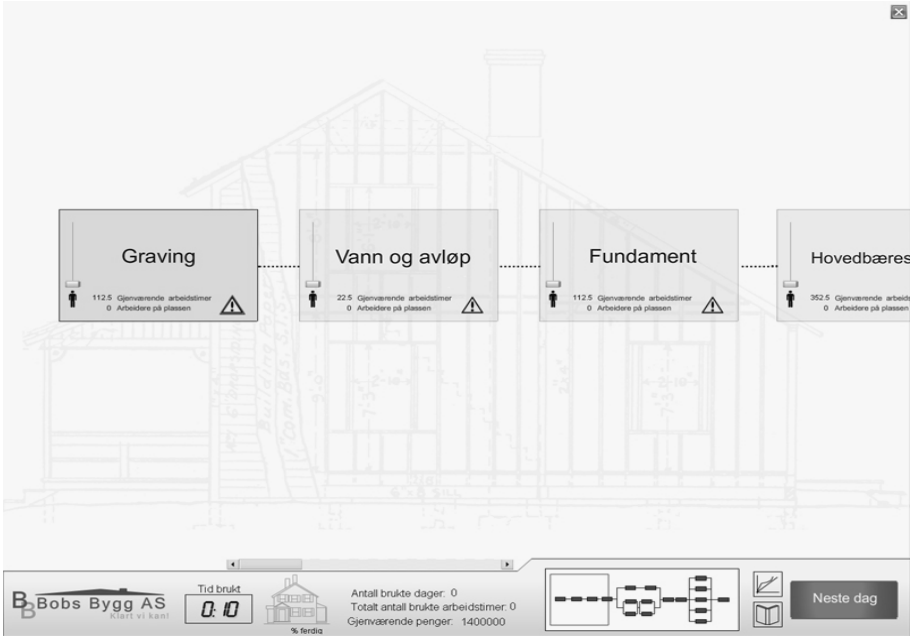
I present here a game, called 'BoBs building' that was developed by students from the Norwegian University of Science and Technology (NTNU) under the supervision of the author with the intention to teach fundamentals of project management. The game is currently used in education and training. The game covers several subjects in planning and control including, network analysis, risk management, earned value and recourse usages. 'Bobs Building' was developed as a computer game where most of it is done automatically (Hussein, 2006).
The game is organized as a competitive game, in which students take on the roles of project members in the same project. All groups are given the same project and are instructed to complete it within the specified time and budget constraints. The group who completes the project first wins. However, players must balance several competing concerns as they work, including their budget, to identify and mitigate the risks associated with project execution as well as the overall quality of the product. In essence, they must strive to follow proper project planning and control practices in order to avoid any undesirable consequences that might cause them to fall behind their opponent in the race to complete the project.

Game scenario

Detailed project planning is not part of the game. The game rather focuses on decision making during project execution in order to deliver the project plan within the specified constraints. The decision making is facilitated by providing feedback about productivity, earned value and volume variance while running the game.
These are indicators that are usually used in real-world application in control process (PMI, 2004). Students are provided with a collection of work packages and a network diagram (Activity On Node) that symbolizes the work packages that must be completed for a family residence building project (Figure 1). The students must perform risk-assessments on all packages and distribute the available resources on the work packages. Collaborative learning is facilitated during the risk-assessment and the re-

source allocation phase. This phase of the game begins before starting the simulation. This will help the students to exchange knowledge and will facilitate group learning in project management.

Figure 1: Game navigation bar



Challenges

The Work Breakdown Structure (WBS) of the project is given. It comprises 18 work packages and the total workload of the entire project is 2500 hours distributed on these work packages. The first challenge the group should resolve is to allocate the available resources on these work packages so that the project is completed within 85 days. The team has only 5 persons to assign to the different work packages, but two extra workers can be transferred from other projects within the firm, but then the cost is twice that of a normal worker.

After having completed planning the project - that is to try to allocate resources so that the project finishes within 85 days - the second challenge is encountered during executing the work. The groups should assess certain risk elements and mitigate these risks by buying themselves free from the impacts of these risk elements. Here again it is a question of risk impact analysis while considering the major project objectives. The idea generation phase here will be about finding the best ideas to allocate resources and calculations of risk impacts on both the time and project objectives.

Interestingly the game had also a research objective or rather research opportunity to study or to investigate what information is most useful, what new information and what format would be desirable in the project management operation.

The game provides a meaningful framework for solving, mainly well-defined problems; networking, resources allocation and follow up. The game provides as well a framework for ill-defined problem, risk assessment and decision making. However the depth of risk assessment part is not comprehensive and need to be redesigned to allow

the students to practice problem solving for ill-defined problems or for testing hypothesis and constructing new ideas.

2. Project leadership simulation games

This category cover simulation of the issues rising at the leadership level of project management, e.g. those concerning identification and selection of project execution strategy, optimal project work breakdown structure, optimal project organization structure and contract strategy. Unfortunately there has been very little reported research into simulation of these types of issues.

Exman and Rauch (1990) present the Σigma game. This work focuses on measurement of the player's performance, with the aim of increasing productivity and providing meaningful comparison of different projects. A term named the PERT surprise is defined and measured which expresses the discrepancy between actual behavior and previous planning along the project history. The winner is the player who is least surprised. Wessex Training (2006) describes a simulation game that can be run in a variety of ways depending on the objectives developing leadership, management and team working, project management, performance management, negotiation, delegation, risk management and team-coaching.

Martin (2000) presents a simulation game called C&C where in addition to the three critical elements of time, cost and quality, further elements of morale and safety were introduced, representing the less tangible aspects of management. The participant in the simulation (the player) takes the role of project manager. The simulation is in two phases. Phase 1 involves the selection of contractors for the 18 activities of the project. Phase 2 then runs the project from start to completion. During the running of the project in phase 2 several events occur, some planned, others not. The project manager must make decisions about how to deal with these events. The decisions taken will affect the cost, duration, quality, morale or safety of the project and the participant's performance in these areas is assessed.

Conclusion

The unique characteristic of simulation games is the inclusion of a time-line in addition to having the competitive elements of games. Simulation games are not about the direct application of skills to solve a particular case or a problem. This characteristic makes the use of simulation games solving or simulating well defined problems - such as network calculations, resource leveling or cost estimation- superfluous.

There are a number of simulation games and software tools that are currently used in training and education of project management. With variable degrees they are used as a tool for: 1) Exploring and understanding concepts and problems of project management; 2) Experimenting with factual information. Current simulation games can be classified broadly into two main categories. This classification is consistent with the actual practice in the field of project management:

1. Functional simulation games targeting functional project management problems such as balancing cost, time and scope.
2. Leadership simulation games dealing with softer issues such as developing project strategy, negotiation and decision making in pursuit of several objectives.

Most of the existing games which are used in education primarily fall under functional simulation games and usually are insensitive to the dynamics of actual project contexts. Another reported shortcoming of these games is ‘oversimplification’.

Oversimplification is manifested in the type, timing and range of events that occur during the game. Indeed, oversimplification is intended to make the simulation possible since any simulation requires a reference model and this model is usually an abstraction of reality. However, the players may simply keep experimenting with actions and settings until their scores or results improve. Such behavior, based only on trial and error, does not enhance learning. This is especially true in case of computer-supported simulation games.

There is very little evidence in the literature that simulation games have been used as a research vehicle during planning phase of projects for validating or testing a strategy or a scenario. The reported research opportunities in the presented games were about investigating the usefulness of the information provided, their types and format. Further research should be conducted on the possibility of using simulation games as a generic tool during project planning for conducting trade-offs and to investigate or test the outcome of a given decision, action or scenario in the real world. Simulation games in such case should be combined with role-plays scenarios in order to make this happen.

DeFreitas and Griffiths (2007) indicate that multiplayer online role-play games have also been used to support military training in a number of areas. For instance, StrikeCOM a multiplayer online strategy game was designed to research and teach group interactions, dynamics and processes. The game was developed in order to investigate deception detection within large groups of people, by examining group performance and perceptions of deception in face-to-face communications and real-time text chat. It has also been used to research leadership and deception in collaborative group decision making.

There are already some efforts to use simulation games to investigate the would-be behavior of team members under simulated working conditions in order to reveal how these persons would react under certain conditions. Simulations games in combination with role-plays scenarios are also used as a training vehicle for increasing group effectiveness.

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