Simulation Based Training (SBT) – the Next Generation of Project Management Training

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Abstract

Teaching project management is not an easy task. Part of the difficulty is the one-of-a-kind nature of projects. Being one-of-a-kind and focusing on a unique product, service or result means that in teaching project management we must consider a very wide array of possible situations (scenarios) with which the project manager and his team should learn to cope.

Traditional project management teaching is based mostly on textbooks, articles and case studies. Textbooks present a body of knowledge in the project management area including best practices that proved to work well for a variety of projects. Many textbooks integrate some case studies with which the reader has an opportunity to implement the material learned. These case studies are valuable and widely used but they suffer from an inherent shortcoming — they are static in nature. Simulation Based Training (SBT) offers a solution to this problem.

This paper discusses the use of SBT for training and educating in project management, and presents a specific example of SBT platform.

Introduction

Traditional teaching and training of project management is based on lectures, reading materials and case studies. The advantage of case studies is that they can represent a real project and provide the lessons learned from it. A case study presents a snapshot of a situation at a specific time point. It is hard to understand the dynamic nature of projects by analyzing static case studies. Dealing with the dynamics of projects is most important throughout the project life cycle. During the planning, monitoring and control stages of the project, managers must take into account the fact that changes are an inherent part of project management due to uncertainty. Change management as part of the monitoring and control processes is vital to the success of modern projects.

Uncertainty is typical to most projects. This uncertainty leads to project risks (and opportunities) and to the need for proper risk management. Most textbooks on project management deal with risk management in the planning phase focusing on how to identify and how to mitigate risks. Some books go a step further and discuss the issue of residual risks and ways to buffer against such risks. The art and science of risk monitoring and control is very difficult to teach and even more difficult to practice using only books, articles and static case studies.
Simulated Based Training (SBT) presents a unique approach to the teaching and training of project management. In the following sections the need for SBT in the project management training arena is discussed. Next the use of simulation in training is discussed and finally a specific tool for SBT in project management is presented.

The Need

The need for experienced, well-trained project managers is growing fast. The number of new PMI (Project Management Institute) members and the number of new PMPs (Project Management Professionals) is an indication that project management is a fast-growing discipline. Another indication is the growing number of undergraduate and graduate programs mainly in Engineering, Business and Management of Technology that offer project management courses or even a degree in Project management. The traditional approach for training new project managers is to teach the appropriate body of knowledge and to train the new project managers on the job. The number of books on project management is growing very fast. Since classroom education may not be enough in this area, the PMP accreditation requires the accumulation of enough on-the-job experience (e.g. working hours) in project management in addition to passing an exam based on the best practices listed in the Project Management Body of Knowledge. On-the-job training is expensive and time consuming.

Most expensive is the cost of errors made by the trainees. In some fields sophisticated simulators replace on-the-job training or reduce it to a minimum while ensuring that the quality of training is the highest possible. This is common, for example, in training pilots who spend many hours on advanced simulators to save the high cost of actual flights. The cost of on-the-job training in this case should also include the cost of risks associated with mistakes frequently made by inexperienced pilots. In a similar way, training project managers on the job is expensive due to the high cost of mistakes made by inexperienced project managers.

Modern project management systems combine models (in a model base) and data (in a database). These systems are based on an enterprise-wide approach that supports comprehensive management of projects in a stochastic dynamic environment across the enterprise. Extensive use of the Web enables group decision-making and collaboration. In order to utilize these capabilities managers have to understand the models and best practices discussed in the Body of Knowledge, to learn how to implement the methodologies and to gain some hands-on experience in doing it as individuals and as team members.

This fast development of new methodologies, tools, techniques and software packages for project management was not accompanied by a similar progress in developing teaching and training tools. Traditional teaching based on textbooks, articles and case studies is still the backbone of most training programs in the area of project management.
The use of simulation in the learning process

Confucius said: "I hear and I forget. I see and I remember. I do and I understand."

This is the essence of Simulation Based Training. We must do things ourselves in order to really understand them. In his article, James I. Grieshop [Grieshop 1987] stated that: "Games and simulations (ranging from role playing to case studies, from guided fantasy to problem solving) have become widely recognized methods for instruction and learning. Since the early work in the United States in the late 1950s and in Europe in the late 1960s, gaming/simulation has become increasingly important to training and decision-making processes in academic settings as well as in business, the military, and the social sciences."

More than twenty years later it seems that the same trend persists and games and simulations are recognized as important facilitators of the learning and training processes in many fields.

Grieshop (1987) listed some of the benefits of games and simulations:

1. Emphasize questioning over answering on the part of players.
2. Provide opportunities to examine critically the assumptions and implications that underlie various decisions.
3. Expose the nature of problems and possible solution paths.
5. Promote skills in communicating, role-taking, problem solving, leading, and decision-making.
6. Increase the motivation and interest in a subject matter.

Grieshop (1987) states that evidence is offered for:

1. increased retention,
2. energizing the learning process,
3. facilitation of understanding the relationships between areas within a subject matter.


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1. learning from content — the dissemination of new ideas, principles, or concepts.
2. learning from experience — an opportunity to apply content.
3. learning from feedback — the results of actions taken and the relationship between the actions and performance.

A well designed simulator supports a process of action-based learning. Instead of talking about different ways of doing things, simulators offer an opportunity to try different ways of doing things without risking the consequences of doing so in the real world.

Simulators create an environment that requires the participant to be involved in a meaningful task. The source of learning is what the participants do rather than what they are told by the trainer.

Thompson, Purdy & Fandt (1997) list the advantages of using simulations as a learning tool:

1. Simulators are characterized as tools enabling the acquisition of practical experience and acceptance of an immediate response of the learned system to the user’s decisions and actions.
2. Simulators offer a realistic model of the interdependence of decisions that the trainee makes.
3. Simulation-based training reduces the gaps between the learning environment and the "real" environment.
4. Simulators facilitate training in situations that are difficult to obtain in the "real world".
5. Simulations promote active learning, especially at the stage of debates that arise because of the complexity, interconnectedness, and novelty of decision-making.

Wolfe (1993) notes that simulations develop critical and strategic thinking skills. He claims that the skills of strategic planning and thinking are not easy to develop and that the advantage of simulators is that they provide a strong tool for dealing with this problem.

An important development in the design of training simulators is to provide the learners with automatic or semi-automatic feedback on their progress. A learning history mechanism was used in several simulation-based teaching tools. The user of these systems obtains access to past states and decisions and to the consequences of these decisions. Learning histories encourage the users to monitor their behavior and reflect on their progress [Beyerlein et al. 1996, Guzdial et al. 1996]. Learning histories enables analysis of the decision-making process as opposed to analysis of results only and therefore it is very effective because the direct influence on the user's actions can be seen. For example, learning history is used as a quality improvement tool for programmers [Prechelt 2001].
The most basic view of history recording and inquiry is the temporal sequence of actions and events. In its simplest form, user actions are logged and recorded, and are then accessible in various ways for recovery and backtracking purposes [Vargo et al. 1992]. Such a mechanism is used as "undo". Several recovery mechanisms have been developed using the simple undo/undo or undo/redo [e.g., Archer et al. 1984].

Parush et al. [2002] described simulation-based teaching of the order fulfillment process in a manufacturing context, using the Operations Trainer [Shtub 1999, Shtub 2001] with a built-in learning history recording and inquiry mechanism. The study addressed two basic questions:

1. Can history recording and inquiry affect the learning curve during the training phase with the simulator?
2. Can history recording and inquiry affect the transfer of what was learnt with the simulator onto different contexts?

The findings showed that with the learning history recording and inquiry available to users, better performance was obtained during the learning process itself. In addition, the performance of learners with the history mechanism was better transferred to a different context, compared to learners without the history mechanism.

The studies reviewed above demonstrated that having an opportunity to review learning history had a positive impact on learning. However, these studies did not examine whether the mode of history recording could have an impact on learning. History recording can be done either by automatic mechanism or by learner control. In automatic history recording, the training system such as the simulator determines when to record a given state in the learning process. These recording points are predetermined by the simulator designer or the instructor that prepares the training program. In such a situation, the learner is not involved in the decision when to keep a specific state in the learning process. In contrast, in a learner-controlled mode, the learner determines if and when to keep a specific state in the learning process. It was shown however that giving the learners some control over the learning environment by letting them actively construct the acquired knowledge produces better learning [Cuevas et al. 2004].

The successful use of a simulator for teaching project management was reported in several studies [Davidovitch et al. 2006, 2008, 2009]. The simulator called the Project Management Trainer (PMT) was used in those studies as a teaching aid designed to facilitate the learning of project management in a dynamic, stochastic environment. The research focused on the effect of history recording mechanism on the learning process. Two types of history mechanisms were tested: the automatic history mechanism, in which predefined scenario’s states are always saved, and the manual history mechanism, in which the trainee had to show an active involvement and to save selected states manually. In [Davidovitch et al. 2006] the study focused on how project managers’ decisions to record the history affected the learning process and on the effects of history inquiry when the ability to restart the simulation
from a past state is not enabled. In [Davidovitch et al. 2008] the study focused on the forgetting phenomenon and on how the length of a break period and history mode affected the learning, forgetting, and relearning (LFR) process. Both studies revealed that history recording improved learning; furthermore, with the manual history mechanism learners achieved the best results.

The issue of a simulator’s functional fidelity is also of great interest. The fidelity of a simulator is a measure of its deviation from the real situation; it has three dimensions: perceptual, functional and model fidelity. Perceptual fidelity refers to the level of realism it evokes in terms of its look and feel relative to the real system. Functional fidelity refers to the way users or trainees use and control the simulation, its behavior and responses to user actions. Finally, model fidelity refers to the extent to which the mathematical or logical model underlying the simulation is close to the real processes and phenomena.

The fidelity of the simulator has been recognized as a critical factor influencing the transfer of learning [Alessi 1988]. In order to provide a higher level of functional fidelity, the PTB simulator includes two functionalities: the ability to control the level of human resources and the ability to control the execution of the tasks. These functionalities are made available to trainees as part of the scenario development.

The ability to control the level of human resources refers to the decision to hire or fire employees in accordance with the changing demand for resources during the project execution; the project manager can control the number of employees in the project in order to match availability to needs. The ability to control the execution of the tasks refers to the decision to split tasks during execution - a task can begin, stop for a while and continue later.

Davidovitch et al. (2009) found that higher fidelity improved performances in the learning phase and in the transfer phase to a different scenario.

Specific Example - The Project Team Builder (PTB)

The Project Team Builder (PTB) is a training aid designed to facilitate the training of project management in a dynamic, stochastic environment. The design of PTB is based on the research findings described in the previous sections. Thus, for example PTB provides high fidelity by supporting the simulation of any (real or imaginary) project. Another example is the history mechanism built into the PTB that allows the user to go back in simulation time to review past decisions and to restart the simulation from any past simulation time. A student version of PTB is the basis of the book "Project Management Simulation with PTB Project Team Builder," Springer (2012) and information on the full version of PTB is available at sandboxmodel website: ..., http://www.sandboxmodel.com/content/ptb%E2%84%A2-training
The PTB is based on the following principles:

- A simulation approach — the PTB simulates one or more projects or several work packages of the same project. The simulation is controlled by a simple user interface and no knowledge of simulation or simulation languages is required.

- A case study approach — the PTB is based on a simulation of case studies called scenarios. Each case study is a project or a collection of projects performed in a dynamic stochastic environment. In some scenarios the projects are performed under schedule, budget and resource constraints. The details of these case studies are built into the simulation while all the data required for analysis and decision-making is easily accessed by the user interface.

- A dynamic approach — the case studies built into the PTB are dynamic in the sense that the situation changes over time. A random effect is introduced to simulate the uncertainty in the environment, and decisions made by the user cause changes in the state of the system simulated.

- A model-based approach — a decision support system is built into the PTB. This system is based on project management concepts. The model base contains well-known models for scheduling, budgeting, resource management and monitoring and control. These models can be consulted at any time.

- To support decision-making further, a database is built into the PTB. Data on the current state of the simulated system is readily available to the users; it is possible to use the data as input to the models in the model base to support decision-making. Furthermore, by using special history mechanisms the user can access data on his past decisions and their consequences.

- User friendliness and GUI — the PTB is designed as a teaching and training tool. As such, its Graphic User Interface (GUI) is friendly and easy to learn. Although quite complicated scenarios can be simulated, and the decision support tools are sophisticated, a typical user can learn how to use the PTB within an hour.

- An integrated approach — several projects can be managed simultaneously on the PTB. These projects can share the same resources and a common cash flow.

- Integration of processes: planning processes, executing processes and monitoring and controlling processes. All these processes are performed simultaneously in a dynamic stochastic environment.

- Integration with commercial project management tools — the PTB is integrated with Microsoft Project so that the users can export the data to Microsoft Project in order to analyze the scenario and to support its decisions with tools that are commercially available.

**Summary**

Many project managers claim that project management is a combination of art and science. It is the art of dealing with people in a dynamic, frequently uncertain environment and the art of riding the learning curve in a non-repetitive environment. It is the science of solving hard combinatorial, stochastic problems of project
planning, monitoring and control under resource and budget constraints. SBT can support training in both aspects of project management. By using the PTB in team settings the art of project management can be practiced, by using SBT to plan monitor and control projects with an increasing level of difficulty, the science of project management is mastered.

References


Sandboxmodel http://www.sandboxmodel.com/content/ptb%E2%84%A2-training


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