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A DIGITAL SIMULATION GAME AIDING LEAN LEARNING AND TRAINING

GRY KOMPUTEROWE WSPOMAGAJĄCE METODY DOSKONALENIA PRODUKCJI

A b s t r a c t

This paper presents challenges when developing a digital simulation game to aid Lean learning and training for engineering students and others responsible for quality management. Lean emphasizes an integrated philosophy embracing the whole culture and as a never-ending story of improvements. A digital simulation game faces the importance of reality resembles and involvement, as well as illuminating how Lean tools and techniques could be valuable. Teamwork and facilitators are needed to ensure Lean learning outcomes. With the assistance of Stormfjord[1] a prototype is nearly finished and challenges ahead involves testing and refinements to enhance inspiration to "play" again and again! The prototype is source coded to enable producing simulation games covering a broader variety of workplaces and companies.

Keywords: lean, simulation game

S t r e s z c z e n i e

Artykuł przedstawia próbę wykorzystania gier symulacyjnych wspomagających procesy nauczania metod zarządzania i jakości studentów jak również personelu odpowiadającego za zarządzanie produkcją. Metoda doskonalenia produkcji „Lean manufacturing" kładzie nacisk na filozofię obejmującą niekończący się proces udoskonalania. Gry symulacyjne mogą być wykorzystane do odzwierciedlenia sposobu wykorzystania technik „Lean manufacturing". W ramach eksperymentu zaimplementowano gry symulacyjne w planowaniu produkcji w firmie Stormfjord.

Słowa kluczowe: *metody doskonalenia produkcji, gry symulacyjne*

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[1] A company employing 10 coworkers, located in Oslo, Bergen and Stavanger (http://stormfjord.com).

1. Introduction

Lean philosophy is founded in "Toyotaisme", but as concept from USA, crowned by Liker (2006). The last 5-10 years a spread over the Western World has enhanced continuous change based on the philosophy and techniques embedded in Lean. A breakthrough in Norway appeared with the first National Conference in Lean in November 2010[2]. A variety of approaches in introducing and adapting Lean has been chosen partly depending on previous traditions in a business and partly depending on who represents the advocates for implementing Lean. On the other hand, many companies and business – private as well as public – have had sessions playing Lean Games. The games mostly used, seems to have been real simulation games building a product, a kind of board games. Among them is found, with the need of somewhat minor equipment, a famous torch factory game and a sticker brick game. In this last one a product is constructed which has some resembles to a boat[3]. Other, larger simulations exist such as Lean Lab factories, i.e. at big car producers in Sweden, and also in Norway in a special designed Lean lab producing houses. Only in a very few instances digital games has been found as a mean to enhance Lean learning and training. From Legosity there is a Lean Bicycle Game and at Brigham Young University a digital simulation has been part of an educational program[4].

At Bergen University College we are now developing a digital game enabling interactive learning and training in Lean concepts and philosophy. The project is financed by Norgesuniversitetet and has a final deadline in December 2012. In collaboration with a creative company in Bergen: Stormfjord, a first prototype will appear in April 2011. Making a digital game we are interested in getting more knowledge about the value of such an approach in Lean learning and training, how an interactive digital simulation game challenge learning approaches in board games and show shortcomings, and last but not least the possibilities of transformation from one simulation setting to several others. So far we are very optimistic and are convinced that a digital simulation game opens up to a more realistic and exciting Lean learning arena. Obtaining a breakthrough for Lean in businesses has been symbolized as "making a new path in the woods"[5]. This paper focus on some challenges in making a digital Lean Simulation Game so far in the process.

2. Motivating a digital solution

Learning Lean through traditional board game simulations has many advantages, not least that the learning involves a direct physical experience when learning. People bump into one another, actual moving around is necessary and fingertip sensitivity; heart beating rises and the atmosphere can be very high tempered. Some of their emotional let outs can be experienced when playing digital games as well, but the actual physical contact is impossible to replicate other than on screen. On the other hand, board games have some

[2] There is a Norwegian tradition from around 1930 of industrial collaboration making Lean one of many suitable perspectives on involving employees in continuous improvement.

[3] On Youtube several video's show such games being played. http://www.youtube.com/results?search_query=lean+games&aq=0sx.

[4] Luoding Paul Wang (2005).

[5] Bjarne Berg Wig (2010).

drawbacks[6]. It is required rather long sessions. A short run could take from 2 hours up to several days or if divided in sections: several semesters. Length depends on frame and circumstances of how to approach the more successful teaching and learning objectives. The equipment kits are often large. Setup time can be tedious, so also breakdown and transportation. It may also be a problem keeping kits complete in a school or university environment.

Some elements have previously not been incorporated such as poke-yoke, TPM and TQM. Today there are simulations that incorporate them, such as poka-yoke. In the Lean Lab constructing houses, a poka-yoke is made possible by preventing which direction to set up a window panel. TPM ensures that every machine is set so that production processes are not interrupted. In simulations man-power is used, there is no machinery – at best a few tools. TQM requires statistical tools as basis for manufacturing decisions. The statistical material gathered is often on a very simple analysis level. Improving personal abilities and focusing on "respect for people" (B. Emiliani) are, on the other hand, often underestimated in lean simulations.

The most important question is however, do computer simulations enable a learner to reach comparable educational objectives as live simulations – and preferably reach an acceptable level compared to real life experience?

3. Digital simulation game

Nicola Whitton (2010:23) lists ten different characteristics of games in a presentation based on a range of different contributions in game and simulation literature. These ten characteristics all apply to the simulation in question here (listed alphabetically): challenge, competition, exploration, fantasy, goals, interaction, outcomes, people, rules and safety. Klabbers (2006) has given a systematized overview of categorizing games, but main elements are: participants, equipment and rules, while some also include "chance" (i.e. when using a dice). In our simulation game it is constructed as to meet these requirements.

Digital games offers the participant a bird-view of the whole process, this compared to board simulations where everyone is confined to their own workstation and tasks. It can also provide immediate feedback and allows a more self-paced learning. Visualizing consequences of choices, of economic input and results – not just as sheets to be filled in (excel) – will be essential parts in the game. In accordance with lean thinking it is important that the game gives priority to collaborate playing.

In the initiating phases we spend some time discussing whether a touch screen should constitute the platform technology or if we should use a traditional computer with a mouse-pointer. Discussions with competent informatics designers at Bergen University resulted in a choice of computer. Even though they could construct a touch-screen platform there still had to be done some further research before it could be implanted in our simulation game.

With a digital simulation combined with a scholar facilitator there will be no need for external consultants. Such Lean learning seems very promising! It will be cost-effective, time-effective and promote learning by getting to know cross-operational procedures among colleagues.

[6] Wang (2005:16) has pointed out several of these disadvantages in applying a traditional lean simulation.

4. Learning Lean

Bob Emiliani (2001)[7] makes a distinction between "Real Lean" and "Fake Lean", implying a disregard of "respect for people" and a reduction of lean into at set of tools and techniques. People are all stakeholders who are effected either by being employees or employers, as well as shareholders, customers or suppliers. Techniques and tools applied to achieve improvements are of course very important, but the frame and overall intention with Lean is a cultural change embracing everyone in a business. Many games focus primarily on the tools: 5 S, six sigma, kanban, poka-yoke, A3, kaizen, SMED, tact time and so forth. Not reducing Lean to such tools put great importance to the facilitator of the game. This is as vital with digital games as with board games.

5. Constructing a simulation – step wise approach

A digital simulation game gives great opportunities of creating a scenario which is quite realistic. We have chosen a simple maintenance production relevant for a cluster of companies in the oil sector (like Shell and Statoil): tools, equipment and services industry. After having made a first game, scenario may be changed allowing a range of different work places to find resemblance to own processes and challenges. After a short introduction by a facilitator, the participants are first introduced to a screen picture showing the whole factory layout. Important information is made available and visible through time-lines and display of KPI's (Key Performance Indicators), Lean tools and operating status. A poor status report is then presented while participants can view an short period of an ongoing production (From Magnus Reigstad and Henning Erlandsen, February 2011 Stormfjord.com).

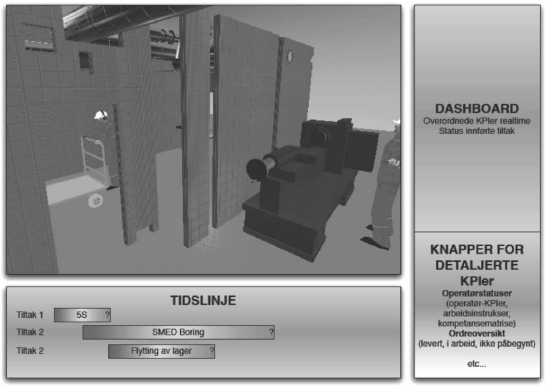

Fig. 1. Visualization of a screen picture showing one work station and related areas for information gathering, registration and processing

Rys. 1. Widok ekranu przedstawiającego miejsce pracy i odpowiednie obszary zbierania, przetwarzania i zapisywania informacji

[7] http://www.isixsigma.com/index.php?option=com_kunena&func=view&id=31042&catid=5&Itemid=151 (Sept. 2010).

The whole factory layout is presented below in a sketch (drawing by bachelor students Sverre Holmberg, Kenneth Svendsen and Lasse Eriksen, HiB 2011).

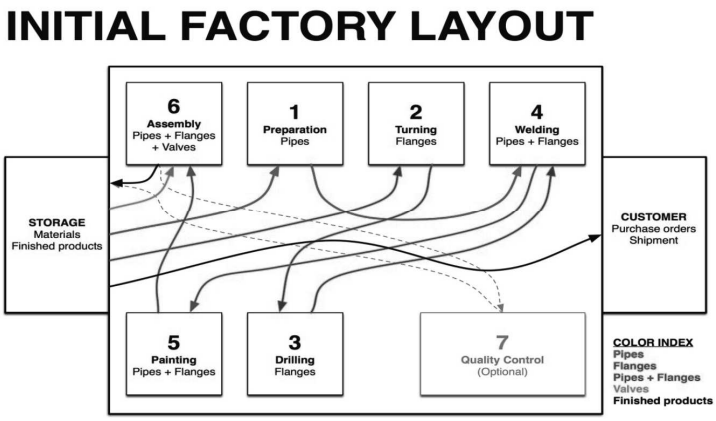

Fig. 2. A lists of possible Lean actions to be chosen in each round combined with a duration time line for each action
Rys. 2. Lista możliwych czynności, które mogą być wybrane w każdej rundzie w odpowiednim czasie

Our simulation game is set up as a traditional batch production of joining together a flange, a screw and a pipe. They produce batches of 3 before sending them off to the next workstation. The batch production is a push process. New work is created when the next worker in line receives a new batch to fulfill, and thereafter the batch is passed on to the next in line.

The product to be made is a result of joining together flange, pipe and valves (Stormfjord.com).

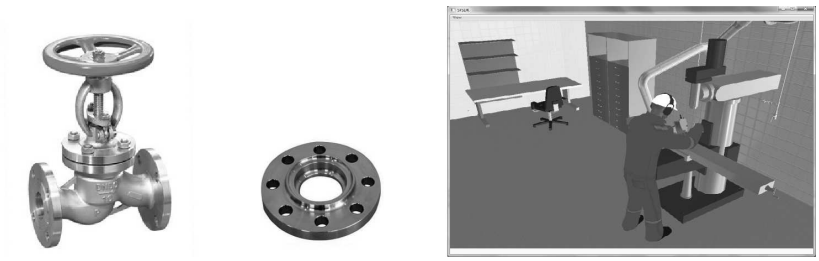

Fig. 3. To the left is shown the product to be made, and in more detail a picture of a flange to be drilled. To the right is shown a worker operating a welding machine producing a defined batch of pipes and flanges
Rys. 3. Rysunek po lewej przedstawia Obiekt, który ma być wykonany wraz z jednym z detali. Po prawej przedstawiono pracownika obsługującego stanowisko do spawania rur i kołnierzy

The simulation game enables participants to make use of, and create new, written work procedures essential to improve any process by using the PDSA or PDCA (Plan – Do –

Study – Act or Plan – Do – Check – Act) wheel of analysis and sustain new work performances.

In the simulation game we have created a range of problems and mishaps: quality problems, tools dysfunction, pace and time problems, orders not fulfilled, information problems, losing money etc. In addition inventory and queuing can be changed in the simulation game.

Muda (waste) is to be experienced as well as far from an optimal value stream and. Players are to experience waiting, inconveniences, frustrations and red numbers. As a result many "workers" will feel bored and/or discouraged or even get stressed by a too high pace. Such experiences emphasize the urgency of making improvements and will give everyone an incentive to act.

In a performance matrix the participants will be able to check out their improvements on run-through time. Profit, fulfilling of orders, HES and quality indicators are marked. The screen set-up, help, results, resources, time-line etc will be displayed either as fixed columns or searchable links. Worker's experience like "bad days", are also possible to simulate. The digital simulation game will offer contestant possibilities of "looking-up" relevant concepts and tools made available during the game to find better solutions to register and solve problems.

The simulation game is divided into rounds and after each round concepts and tools from lean-thinking are discussed and choices of which to use as their own application is made available. Often only two or three changes can be made between each round. Techniques and concepts from lean-thinking are to be put into practice. Groups of 2-3. Evaluate different future scenarios which will appear as consequences of choices made during the game. Several rounds are to be played with increasing level of difficulty. It is very important aligning the simulation with the learning objectives.

Effects of choices made, if i.e. this implies adding or removing workstations, they to be displayed in economic and productivity figures as well as flow and tact time.

The simulation will contend an online access that can transfer data and animations to the participants. This also will allow them to access other websites in search for information. Every user will need a log-in name and password.

6. Learning by mistakes?

In Lean learning detecting and defining mistakes are decisive in the learning process. Every game or simulation encompasses various faults in a production line, tools or inappropriate use of resources: hard core as well as human. Such faults must be constructed as challenges in the simulation, and not self-evidently observed in a first run-through. Inconvenience in a production line layout and in the presented standard operational procedures are often detected, but quality problems, HES consequences and lack of ability to fulfil a production requirement is more seldom detected.

Calling Lean learning a learning perspective implying learning by mistakes is a misconception, the mistakes and deviances are necessary observational data to instigate measures and means to reduce and prevent inappropriate use of resources. Deviances could be measured statistically (six sigma) or on report sheets defining what to measure (standards). Such learning is in accordance with learning theories emphasizing reflection (Schön) and experiential learning (Kolb).

The faults in lean simulation training must be directed to make lean concepts and tools relevant. Encourage critical thinking, finding alternative explanations, foster search for cause-effect relationships and hidden problems, and last but not least contribute to a systematic data gathering and focused analysis.

7. Challenges ahead

The simulation game is to be programmed as a "real" simulator by programming real observed characteristics of each workstation. Putting them together, the total work may be optimized by the simulation game. Similarly, a variety of companies and workplace may be modelled. Thereby, the initial simulation game may be transformed and made relevant to a variety of different occupations.

When the prototype is ready to be tested in mid April a systematized approach of evaluation will be carried out. Performance will be registered as well as suggestions of improvements from participants. Both selected students as well as future facilitators will participate in the testing. The evaluations will enable us to make adjustments and improvements of the simulation game, but not only will be interested in evaluating ability to reach Lean learning goals we will also focus on opinions on how to make the simulation game an opportunity of training. In Lean philosophy sustaining improvements are very dependent on continuous training. An important challenge is the wish to play again and again! Lean – as the never ending story!

Three students in mechanical production engineering at HiB are this spring writing their bachelor thesis rooted in developing the simulation game. They contribute in the development and conduct continuous evaluations and comparisons with other learning approaches to Lean learning and training. Their previous experiences and work is a valuable contribution in the project.

We are also, as yet, in search of a good name. One idea has been: The Wesselsim Game, drawing on associations to a Norwegian poet and with a vessel, which any company can be symbolized by.

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