Lean design of Spare Part Kit Production Cell

A Case Study from a Sperre Industri AS

K. K. Vijayan
Student
Norwegian University of Science and Technology - NTNU
Ålesund, Norway
E-mail: kavinkathiresh@hotmail.com

O.J. Mork
Associate Professor
Norwegian University of Science and Technology - NTNU
Ålesund, Norway
E-mail: ola.j.mork@ntnu.no

S. komandur
Associate Professor
Norwegian University of Science and Technology - NTNU
Gjøvik, Norway
E-mail: sashidharan.komandur@hig.no

I. E. Hansen
Scientific assistant
Norwegian University of Science and Technology - NTNU
Ålesund, Norway
E-mail: irina-emily.hansen@ntnu.no

1 Introduction

Eye tracking is the process of measuring either the point of gaze (where one is looking) or the motion of an eye relative to the head. An eye tracker is a device which captures real-time video of eye positions and eye movement [1]. The output of the eye tracker is a video with gaze point. This video with gaze point can be analyzed to see the challenges faced by the employee during human-machine interaction. This data can be seen from two perspectives; from business the organization can understand the problem faced by employees while the students can educate themselves or they can come up with a solution which can actually benefit industry.

Lean is a concept of elimination of waste and adding value to customer. It is an approach which is growing fast in and around all industries. The birth of eye tracking and idea of using it in industry have given new dimension for Human-machine interaction. So the direct benefit for the industry is during the implementation of lean as it can easily identify all the wasteful act and problem during this video analysis. The same video can educate students as a real-time example for lean courses as problem based education and they can come up with a solution which create a synergy between industry and university.

This paper has been written in interest of improving education system in university. This approach give opportunity for students, lean specialist or anyone to access these videos from any location, any time and at their own pace to educate themselves or suggest solution for problems. This can bring interaction between lean community, industry and students.

1.1 Background

This case study was conducted at ABC industry (changed on industry request) at Norway in collaboration with NTNU I Aalesund, Norway. The author is a student at NTNU I Aalesund and this paper is a part of the thesis work (master degree). This paper is developed with the aim of bring problem based learning and bringing both industry and university together. This approach was to improve the teaching technique at the university for future.

1.2 Theoretical Basis

After exhaustive research it is evident that there is no study in relation to using eye tracker as a tool for analyzing problem based learning. There are certain cases where eye tracker is used for understanding human-computer interaction and usability testing related to that but not on human-machine interaction in manufacturing environment. Problem based learning have been discussed by the researcher [2]. In that the researcher have dealt with how increasing student activity and reducing lecturing will improve the learning outcomes. Lean Design concerns itself with methods and techniques to create a lean solution from the start, resulting in more value and fewer wastes across the value stream. [3]

Lean design seeks to optimize the development process through rapid learning cycles to build and test multiple concepts early [4]. Managing the knowledge value stream, systematic problem solving with analysis of the trade-offs between various options [5], and solutions generated from ideas filtered by systematic innovation methods [6] are viewed as methods within the lean design process. Implementation of lean manufacturing system in various organization and analyzes of the result was conducted by [7]. They have explained about implementation methods and time period taken for that. So the implementation method has been adapted from their guidelines.

1.3 Objective:

1.3.1 Business

- To improve production capacity by eliminating wasteful and to integrating lean in their work culture.

1.3.2 Research objective

- Applicability of eye tracking as a tool for problem based learning in manufacturing sector

1.4 Research Methods

Kolb's learning circle defines people's learning method which is either from their own experience or from theories [2]. This helps both employee and student learn through group dynamics. A hybrid of both quantitative (controlled experiment) and qualitative method such as interview, observation, Pep talk, workshop, lean games, kaizen activity & brainstorming was followed regarding lean application.
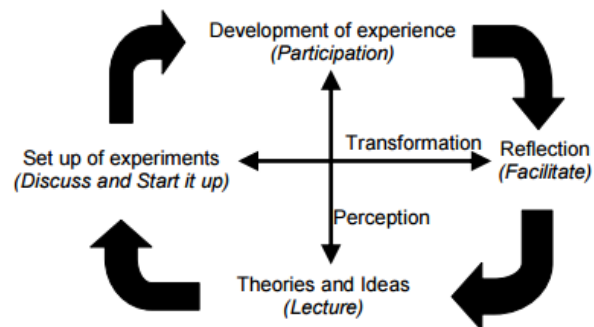

Figure 2.1: Kolb's learning circle

1.5 Participants:

The participants are the regular employees and 4 student researchers. This part of the experiment help's students to bring up their problem solving skills, team work and project management. The picture below shows the use of eye tracker by the participant during actual work environment.

Figure 2.2: Participant using eye tracker

1.6 Equipment:

The equipment which is used in this experiments are Eye tracker, Go-Pro, Timer, etc. to name a few.

Figure 2.3: Eye tracker

In this project, it is used as a tool for understanding point of gaze and to understand its usability in lean design. This will provide us workers view, their struggle, understanding of the process and time taken.

1.6.1 Eye tracking technology in lean design

So the employees are educated with lean principles and implementation of lean tools was performed. During implementation eye trackers were used to record videos of pupil movement. The following picture represent one of the movement of recording data. The red dot represents the pupil movement from one place to another. This helps us to see how the employee do certain activities. Finally, these activities can be questioned step by step to the employee who performed the task and prepare a table of value added and non-value added activity.
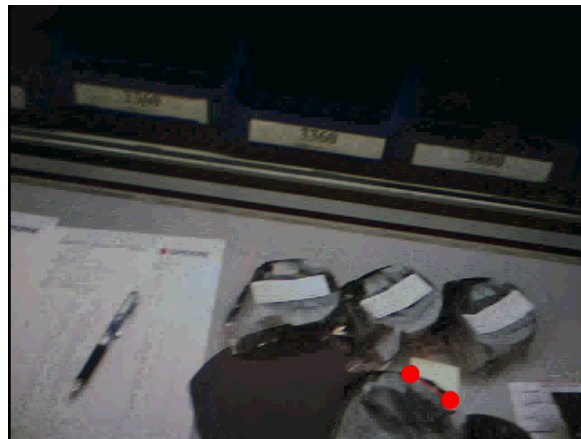

Figure 2.4: Eye tracking during time study

So, the questioning section helps the employee, students, etc. to evaluate whether those tasks are resourceful or not. This is a problem based for both students and employees of the organization. One such fine example is when the employee was trying to find a reference number which is a wasteful activity performed several times during an operation which consumes a lot of time.

This operation is not value added from customer point of view as in this case students acted as customer and explained why it not valuable step. The employee understood it is a wasteful act and the reason why it took so long to identify a number is because the text is small which needs more attention. The above picture shows the actual struggle of the employee to spot the reference number.
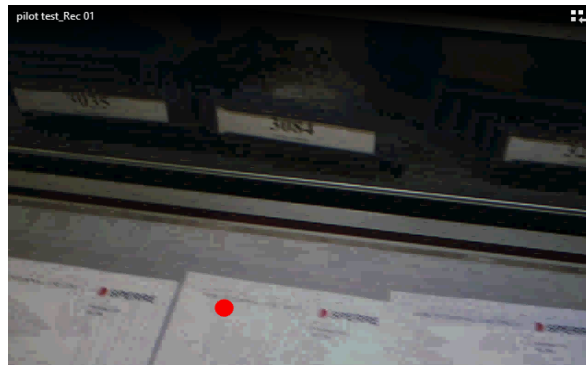
Figure 2.5: Gaze point during reference number

This is one such example where even minute details were able to be noted. Elimination of that step have saved a lot of production time and given the organization to analyses whether their approach of right or wrong.

1.7 Procedure & Preparation:

The preparation and procedure is a simple task as a team from university (6 students) and the industry (employees who performed all activity during data collection) was formed.

1. The data is analyzed step by step with employees and students acting as a customer to evaluate value and non-value added activity. This helps the employees to see from customer perception.

2. A common ground has been reached on all non-value added activity. As we are not interested in value added activity.

3. Third step is to eliminate or minimize those operations which is performed by both students and employee which gives them problem based learning.

4. Finally, students were asked to answer a yes or no questionnaire to see whether it is useful or not. The questionnaire consists of 10 question and it was accessible at appendix.

2 Lean & eye tracker Applicability

This section is used to further explain where it has been used to solve problems in the industry using eye tracker.
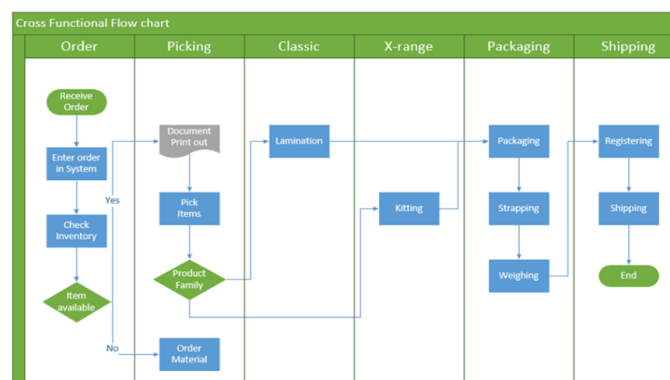
2.1 Work flow mapping

Figure 2.1: Process flow

Eye tracker is used to visually map the flow of production and shows the current state of processes. Since the eye tracker have the ability to record both the audio and video this can be used to demonstrate all the process to the participant by walking through the process. The following picture is the prepared as the employee explains the process flow in the video.

2.2   Plant layout design & spaghetti diagram

Plant layout design is one of the important lean tool in process improvement. The entire outline of the layout of the production unit has been drawn using the video of eye tracker. Then the discussion helped to change the layout according to operation flow. The present layout and proposed layout as follows,
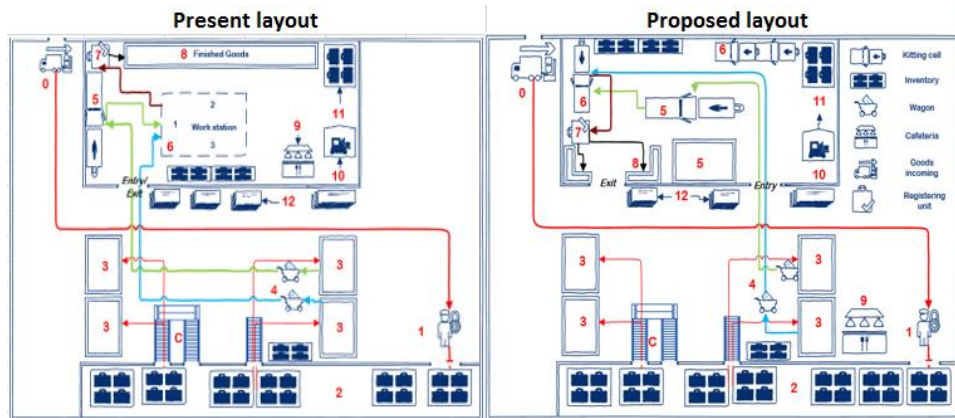

Figure 2.2: layout modification

The proposed layout has been modified in the plant and the new layout is validated using Spaghetti diagram which is another lean tool. The walking distance of old layout and new layout has been compared in the picture. From the after result we can conclude that the motion has been reduced considerably. The entire idea was performed just by using video and audio from the data collection.
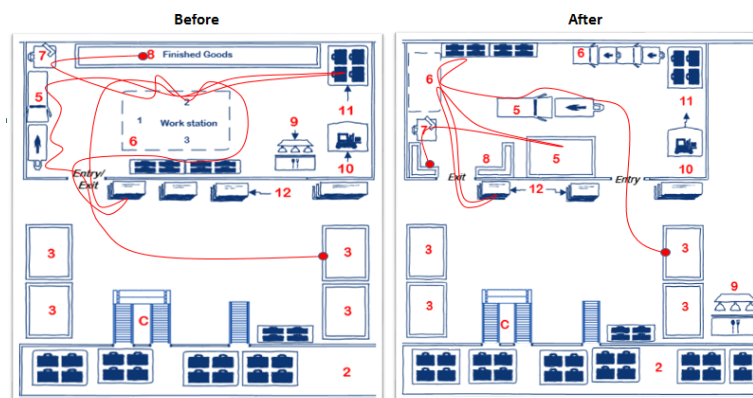

Figure 2.3: Spaghetti diagram

3   Results

The results are demonstrated in two ways from business and education perspective. From the business perspective, the overall performance has been improved just by eliminating waste. This does not involve any capital investment from the industry which proves the benefit for the industry. So the outcome has been compared as time taken for producing a particular product in before and after case scenario.
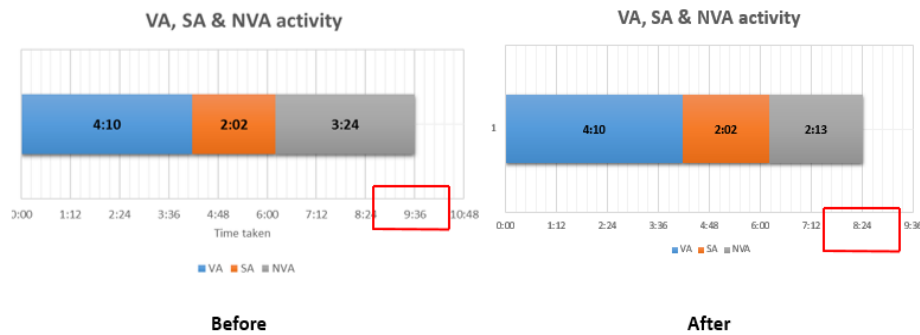
Figure 3.1: Business outcomes (Blue[1], Orange[2] and grey[3])

From the figure we can see that it took 9:36 mins to produce a product while after case scenario show it has reduced to 8:24 mins. This has reduced production time by 13%.

From education perspective, this pilot test does not provide any empirical data which can directly tie to students' academic performance. On other hand, the qualitative result i.e. feedback from the students shows the approach has a positive effect on them. This feedback from the questionnaire was used to evaluate the success of the new approach. The primary responds from the students are, it helped them in team work and real life example makes it easier for learnings. But the most of their concern is with the software (Tobii) and hardware (Tobii eye tracker) as it is costly, bit difficult to use and not accessible for general purpose of learning.

4 Conclusion & future work

To ensure the delivery and attainment of quality educational programs are the major outcomes of any learning system and enhanced learning system is necessary for any discipline [8].

In this paper, author tried to detail a new approach of problem based learning through smart class environment using eye tracker as a tool. This is the pilot test was performed with students who has already completed the lean course and used them to evaluate the old and new approach to improve the course at the university.

The difficulties faced by the student due to lack of real time examples can be reduced by this approach. Students should be given a detailed project to improve their knowledge of designing and implementation [9]. This detailed project of real time examples can improve their understanding on the subject and it can prepare them for industrial projects. In addition, the feedbacks from the students shows a positive outcome and motivating. The industry also benefited by implementing lean principles in their work culture by educating their employees. Moreover, this teamwork between students and employee have helped to increase the productivity by applying the learned theory. This verifies eye tracker can also be useful in manufacturing sector where their application has not been studied widely.

Thus author concludes that the new approach is useful and applicable but there are several shortcomings such as expensive equipment and its usability, location of the company and mobility of the employees and students, other cost factors, etc. In future we aim to implement the new approach in the classroom and will further investigate student's results, feedback to enhance the learning outcomes.

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[1] Represent value added activity
[2] Represent supporting activity
[3] Represent non-value added activity

5   Bibliography

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6   Appendix

Questionnaire

1. Did the approach developed your capability to understand the theory?

2. Did the approach assisted you to envision the concept to be learned?

3. Did you gain as much content as from a lecture?

4. Was there satisfactory level of interaction with videos from eye tracker?

5. Do you feel that industry interaction through eye tracker is enough?

6. Do you consider this remote virtual experiment helpful?

7. Was the new approach easy to understand?

8. Is the ideas and concepts were presented clearly and follow-able?

9. Did the technology work correctly and usable?

10. Did the software requirements pose a problem for you?