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DEMONSTRATING THE A3 TECHNIQUE USING A LEAN PRODUCTION MODEL

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Abstract

Structured problem solving has become one of the key important skills in every industry as problems are a daily occurrence, mastering a structured problem solving technique can greatly increase one's chances of employment but unfortunately structured problem-solving techniques are underrepresented in education. This paper aims to provide a way of demonstrating the A3 technique with a model of a Lean production system thus providing a simple way of teaching the A3 method in educational circumstances while linking together industrial problems.

Keywords: A3; Lean; Problem Solving; Teaching; Jidoka

1. Introduction

Structured problem solving represent an integral part of everyday work in industry, but is not often taught or represented in education therefore there is a gap in young individuals about the proper usage of problem-solving tools such as the A3, 8D, Why-Why techniques etc. The reason behind this might lie in the illusion that to demonstrate the proper usage of a structured problem technique you need a real-life situation or an industrial related problem [1].

But this is not the case as for example Toyota uses movies such as Apollo 13 to teach structured problem solving, also simulations and games can be used for teaching and demonstrating different techniques [2]. With problem solving being not a need but a requirement of industry there is need of adjusting to the needs of the industry be educational institutions [3].

This paper aims to use a physical Lean model of a production system do demonstrate the usage of the A3 technique, showing that problem solving can be taught with using modelling and a simulation of production processes by applying the A3 technique to a problem achieving production targets and number of Jidoka stoppages on an assembly line.

2. A3 technique

A3 represents a structured problems solving technique which follows a series of steps such as (1) establish the business context and importance of a specific problem or issue; (2) describe the current conditions of the problem; (3) identify the desired outcome; (4) analyse the situation to establish causality; (5) propose countermeasures; (6) prescribe an action plan for getting it done; and (7) map out the follow-up process [4]. When trying to understand a process fully the A3 method could be helpful perhaps even when mining a process [5], the method has been used for several different applications such as quality improvement [6] and product development [7].

Although the number of steps which an A3 report contains varies [8] the structure remains the same from problem definition to root cause analysis, defining countermeasures/actions and validating the results, other than for problem solving the technique can be used for projects as a structured approach to give an overview of the goal, status, and timeline of the project as well as a summarization of a project. The technique represents a very powerful tool when applied correctly for productive dialogue and helping people learn from one another, as it involves a cross functional team [4].

When the technique is applied correctly it can lead to several benefits such as process improvement [9] [10], and environmental development [11], but further applications of A3 are possible, perhaps it is possible to apply it event protocol development [12]. In this paper the technique will be applied to a model of assembly line which is one more way of the application of the technique [13].

Demonstrating the A3 techniques using models of production systems allows the demonstrator the freedom to not only show problem solving in a way that best suits the needs of the students but also allows the actual problem to be customized to the needs of the audience and allows the audience to interact with the model and problem. One of the key advantages of using models, more specifically physical models is that they allow reusability, meaning that the same model could be used to demonstrate the same problem multiple times or even to demonstrate a different problem each time, depending on the size and parts of the model.

With the usage of models problem solving could be taught in a structured way providing a clear understanding of what structured problem solving is to the students and thus preparing them for the challenges they will face in industry. The negative side of using models is the problems that will demonstrated will often be simplistic and therefore might lead to the understanding the structured problem solving only works on simple problems which are rapidly solved and don't require detailed analysis, also physical models are that they are inactive meaning they are not systems with continuously moving parts and while they can simulate real life problems they are not as complicated as real-life problems.

The limitations of using models to demonstrate problem solving are that building the model requires a lot of time and effort for the model to be as similar to a real system which would require the model to be prepared beforehand the demonstration of the problem solving. Another limitation of using models for problem solving is that it heavily relies on the creativity and experience of the demonstrator as the demonstrator needs to create the situation or problem where the problem solving can be applied, these issues could be solved using augmented reality and building a models which is interactive [14].

3. Demonstrating the A3 technique

The A3 technique which will be used for the demonstration represents a modified version which consists of four parts:

A. Problem definition – in this part the problem is clearly defined, all historical data is represented if available as well as countermeasures performed. In this part of the technique there the key questions which should be answered are:
   a. What is the problem?
   b. Where is it?
   c. What has been done to solve it?
   d. What are the effects of the problem?

B. Root cause analysis – when the problem is clearly defined possible causes which lead to the consequences of the problem must be listed and evaluated to define possible countermeasures.

C. Countermeasures – for the causes which are deemed most likely to cause the problem countermeasures must be defined and evaluated, the measures which provide the most effect with the least amount of effort should be prioritized.

D. Validation – the countermeasures which have been applied must be validated be comparing the starting state to the current one, if the problem is solved and there have been no reoccurrence of the problem it will be deemed that the problem is solved.

The model which is used has five stations on the final assembly line which perform the following processes (1) setting the bodywork, (2) positioning the steering wheel, (3) positioning the front bumper, (4) setting the wheels right side, (5) setting the wheels left side (Fig. 1).

Fig. 1. Assembly line layout

In the next part of the paper the A3 technique is applied to a problem on the assembly line. The A3 technique has been split into four tables, with each table representing one of the steps of the technique, problem definition is shown in Table 1 where the problem and its trends are described, in Table 2 the root cause analysis is demonstrated using the Ishikawa technique and the Why-Why method, Table 3 shows the proposed countermeasure developed based on the root cause analysis, while Table 4 validates that the given countermeasure solved the defined problem and that the root cause was eliminated therefore an improvement of performance is achieved which is shown in the results.

A. Problem definition
For the past four days the production target has not been achieved, also there has been at least one Jidoka stop in each day, also the average cycle time has gone up due to the frequent stops (Fig. 2). Also, all the Jidoka stops have been on station number 2 (Fig.3).

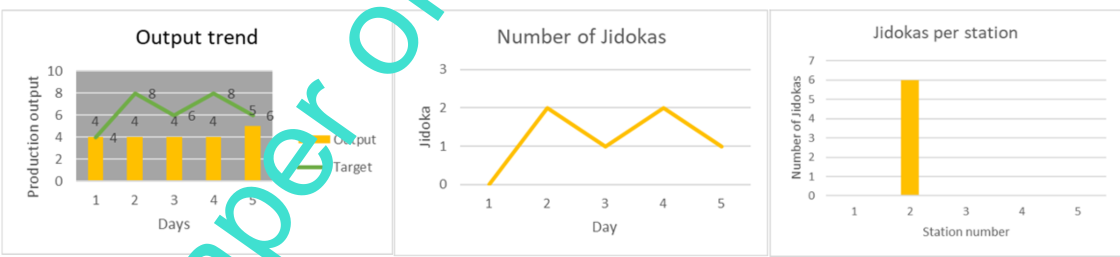


Fig. 2. Problem trends

Fig. 3. Jidoka stops

Containment action: Each time the Andon cord has been pulled the production supervisor has assisted the assembly worker the error has been corrected and the process was continued (Fig. 4).

Fig. 4. Containment action

Table 1. Problem definition

B. Root Cause analysis

Since the issue is on station 2 possible root causes to the problem are analysed using the Ishikawa diagram (Fig. 5) and Why-Why method (Fig. 6). This part demonstrates one of the possible ways of performing root cause analysis, where possible causes regarding the machine, man, material and method are tested.

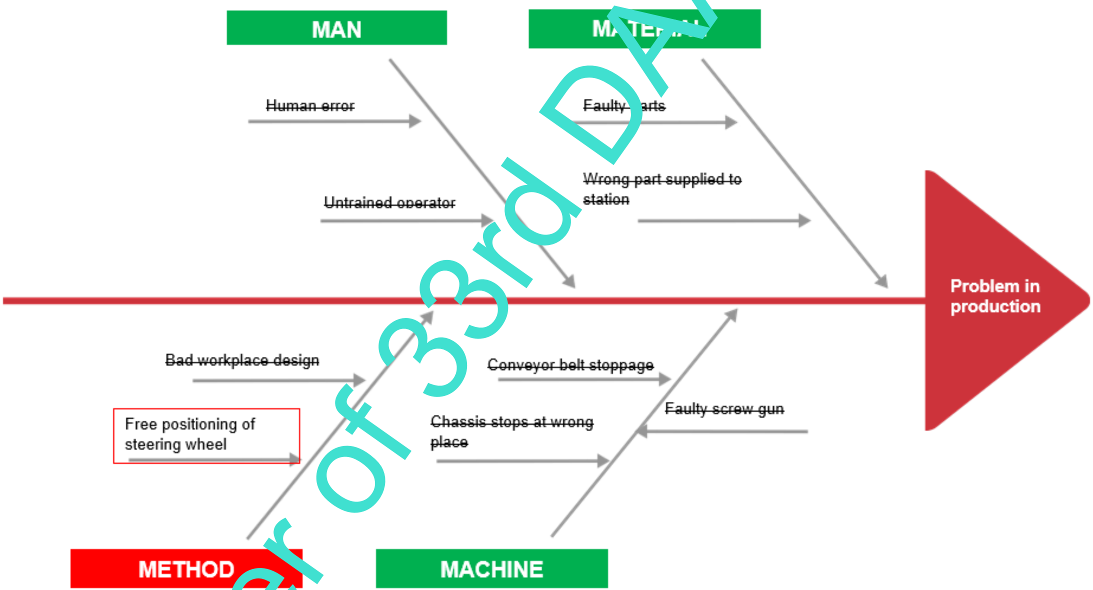


Fig. 5. Ishikawa diagram

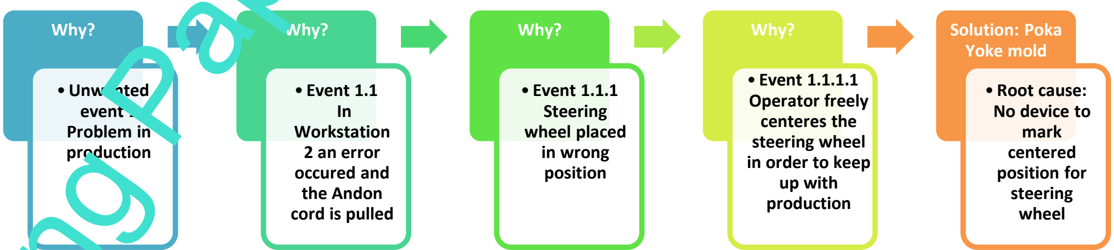


Fig. 6. Why-Why analysis

The result of the Ishikawa diagram and Why-Why analysis is that the root cause to the issue was that the worker has no marks or tool to help him centre the steering wheel in the right place.

Table 2. Root cause analysis

C. Countermeasures
As the proposed countermeasure a Poka Yoke device which reveals the position where the steering wheel should be placed is built and placed on the station.  Fig. 7. Poka Yoke device

Table 3. Countermeasures

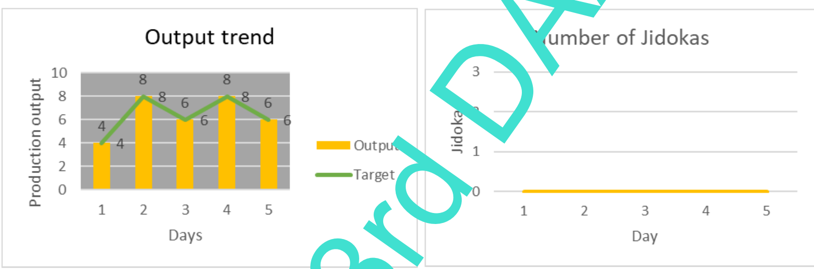
D. Validation
Since the implementation of the Poka Yoke device the production targets have been reached each day for the past five days and there have been no Jidoka stops on the assembly line (Fig. 8).  Fig. 8. Validation

Table 4. Validation

The result of the A3 technique which was applied to the problem is the elimination of the error which was causing multiple stops on workstation 2 and in turn reducing the production output and putting the customer at risk, the result of the A3 method is a Poka Yoke device which shows the worker the exact position where to assemble the steering wheel, the solution proved effective as shown in Table 4 and alleviated the deviation at the start of the method.

With the demonstration all the basic elements of structured problem solving were demonstrated from problem description to the validation of the proposed solution showing that by using a model of a Lean production system to set up a problem the A3 technique can be applied to it and demonstrated in a simple but effective way, showing that teaching can be done through games [2] [15], as well as simulations which have shown to have a positive trend with students especially when it comes to Lean methods [16] and coincides with the evolving role which teachers will have in the future [17].

4. Conclusion

Through this paper it has been shown that the A3 method can be demonstrated using simple problems and techniques without the need of problems directly from the industry, and that using models of Lean production systems can be used to not only show the A3 technique but also promote creativity especially when the technique is taught. The way the technique demonstrated in the paper is simplistic and therefore surpasses some of the problems of teaching structured problem solving such as missing real problems from the industry. While the demonstration is simple it can be effective, but in the future using methods such as augmented reality for problem solving can be effective and can show that problem solving can be applied even out of the physical world.

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