HUMAN LIMITATIONS ON WASTE DETECTION: AN EXPERIMENT

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ABSTRACT

Waste, or in other words, the search to its elimination, has been the target on most important production philosophies. Mass production success was based on the drastic cost reduction caused by elimination of many forms of waste. Lean production went even deeper on pursuing the elimination of more forms of waste. Waste elimination plays a key role in production performance and this paper intends to be a contribution to the deeper understanding of waste as well as on the natural human limitation on detecting it. Waste detection can be performed from two different angles, either from the search for non-value adding activities, or from the focus on value adding activities. Aligned with what some experts say and from the experiment presented on this paper we tend to believe that when we focus our attention on value adding activities and eliminate everything else the results are better. This paper also shows that people are normally "contaminated" from existing production practices and therefore their ability to detecting waste is conditioned.

INTRODUCTION

The impact of Lean Production in world's economy during the end of the twentieth century can be easily compared with the impact obtained from Mass Production during the beginning of the same century. Both lean production and mass production are, without any shadow of doubt, the major milestones in the history of industrial management. Both concepts were created in the car industry; the mass production associated with the assembly line concept was developed in the Ford Company while lean production was developed by Toyota Motor Company. The concept of lean production was originally developed by Taichi Ohno during the decade of 1950 under the name of Toyota Production System [1]. This way of organizing and managing production was later coined as Lean Production by a research group from the Massachusetts Institute of Technology [2]. This research group was involved in a 5 million dollars and 5 years project studying the car industry throughout the world during the 1980s.

Lean production can be seen as an evolution of mass production and one of the similarities is the focus on waste reduction. Lean manufacturing puts its main focus on clarifying the difference between activities contributing to adding value to the product and activities that do not add value to the product. Any effort, time our resource used in activities that does not add value to the product is considered waste ("Muda" in Japanese). The continuous identification of waste and its elimination is the mechanism for continuous improvement, being a key factor in lean production environments. The idea is that any waste that is eliminated results in production performance improvements and therefore a step towards higher competitiveness.

Factories as well as offices are fulfilled with waste everywhere but not always easy to be identified or eliminated. Many forms of waste are not identified as waste for everybody and to make things even more complicated, some authors and experts classify some waste as "necessary waste". People with different experiences, backgrounds, and production culture, do not always agree on labeling some activities as waste and also is true that some waste would never be identified at all for some people just because they wouldn't see it. Even the same person, looking at the same production problem in different angles would identify different forms of waste.

This paper intends to show that the same people when analyzing the same production problem with different information would identify different forms of waste. Another interesting feature shown is that different results are obtained when we focus our attention on non-adding value activities or on value adding activities.

WASTE

Waste is typically defined as anything that does not add value to the product, in other words, anything that adds cost to the product but your customer will not pay for. The value of a product

can then only be defined by the ultimate customer [3]. Waste is therefore intimately connected to value and a good way of identifying waste is though the recognition of which part of the process is actually adding value to the products.

Another way of understanding waste is through the nature of the operations that are preformed in production systems. Anything that is performed on a product that does not result in any physical our chemical changes can be considered waste. Any operation that does not change anything on the product is not adding value (Some may not agree but under this definition inspection is waste). On the other hand some operations resulting in real changes on the product may not add value to the product and therefore being waste.

The forms of waste are classically classified in seven types [1]: waste of overproduction, waste of time on hand (waiting), waste of transportation, waste of processing it self (over-processing), waste of stock on hand (inventory), waste of movement, and waste of making defective products. It is important to point out that the waste of overproduction plays a key role in waste since it leads to all those other types of waste [4].

All these forms of waste are in some degree presented in general industries and offices. Only about 5% of the time that products spend in a production system is actually used in operations that are adding value to the products [5] but in offices that percentage decreases to about 1% [6]. Most time products are doing operations that are not increasing their value or waiting for something.

When I try to make people understand waste a list of typical questions normally arise: "how can I consider transport as waste if I really need to move the products from one machine to the next or from the warehouse to the assembly line?"; "how come the time I spend on setting up the machine is waste?"; "when I inspect the quality of the product I am actually adding value to the product since that product is declared as good, how can that work be waste?". Apart form this type of questions there are other problems even more complicated. The idea of production in batches is difficult to be identified as waste since producing in batches is so natural and obvious that most people would never look at it as waste.

All forms of waste can be divided in two types: necessary waste and non-necessary waste [6]. According to the authors, the difference is that the not necessary waste is the one that is possible to remove under present circumstances while the necessary waste cannot be removed unless the existing supply process is radically changed. Although I understand the reason for that distinction, many managers feel comfortable when

most of their waste is considered as necessary, I do not think it is necessary and I am quite confident that it does not make things easier.

The important issue in this paper is, since waste is everywhere in the factory, from where should we start? How can we be effective in identifying and reducing waste? We can say that there are two main approaches: (1) approaches centered of non-value adding activities detection and (2) approaches centered on value adding activities.

The approaches centered on non-value adding activities put all effort on identifying, on the shop floor, activities that do not add value to products. One straight forward way of doing so is going around the factory or around the office trying to find forms of waste and then trying to eliminate it. This is not a very effective way to go lean. A more systematic and effective technique for waste identification is the technique known as "Treasure map" [4]. This technique uses the principles of work sampling studies to identify the areas on the shop floor where more waste occurs. The first area to be focused to waste reduction actions would be the area where more waste was identified. Detecting areas with large quantities of waste is like finding treasures because of the money you can save once that waste is eliminated.

The approaches centered on value adding activities go around the problem from a complete different angle. Instead of trying to find waste and eliminating it, what is proposed by many experts is that you should identify the necessary adding value operation for a product or family of products and then eliminate all the remaining operations. A technique that can be successfully used for that purpose is the Value Stream Mapping [7]. This technique although with some limitation, makes a clear distinction between adding value and not-adding value operation as well as the time spent on each one of them throughout the production system.

We can say that the improvements on waste reduction go through three steps: (1) understanding the concept of waste; (2) identifying forms of waste on the shop floor; and (3) eliminating or reducing waste. The identification of waste can be sometimes complicated but even more complicated is frequently its elimination. In some cases, the way of eliminating the waste is known but its financial viability is not clear.

This paper intends to shown that people can easily be conditioned by the existing practices on the shop floor and therefore being unable to see several forms of waste. On the experience reported here, we can also see the two approaches for waste identification: (1) the

approach centered of non-value adding activities detection and (2) the approach centered on value adding activities.

THE EXPERIMENT

The ability of a person in perceiving production waste is strongly dependent on which production culture the person is involved with as well as on how the person is informed or experienced on the concept of waste. Workers, supervisors and managers in traditional production environments are so used to their production practices that they loose the ability to see many forms of waste present everyday around them.

The experience presented here is the result of an interesting finding occurred during de introduction of Lean Production principles to engineering students at School of Engineering of Minho University. A common behavior pattern has being perceived during a production game that is taking place every semester for the last 5 years. These finding made me understand some of our limitation on understanding production waste as well as understanding how much we are conditioned by our own intuition.

Description of the production game

One of the first lecturers on lean production a basic production system is set up in the class room showing two alternative production approaches for the same production problem: the traditional mass production approach and the lean production approach. We start with the traditional mass production approach (see figure 1), setting up the warehouses, workplaces, buffers, and so

on and make the students participate actively in the operations of that almost real production environment during some time to feel its dynamics. The students are then asked to measure the performance of the system, identify forms of waste, and to propose improvements. The production system is then modified into a lean production form and once again students are involved in the operations for the same amount of time they did before so they can fell the differences in both approaches.

Most of the times, because I normally have more students than the students needed to run this "factory" some students are just observing the production run while some others are being really involved: two acting as suppliers, six as workers, one as quality controller, one as production manager, and a last one acting as customer.

In this production system, four different types of products can be assembled and a Takt Time of 20 seconds is assumed for market demand. Once the production is set, the person acting as customer places an order every 20 seconds. The order can be on one of the available four types of products chosen randomly. If that product exists already assembled it is considered to be on time, otherwise it is considered a late delivery. We normally perform a production run for 5 minutes which is the same as saying that the customer actually places 15 orders. The production is managed based on production orders, using batches of 5 products in a push production manner. The "factory" is full of inventory everywhere and everybody is quite busy. At least one workplace is clearly identified as bottleneck and sometimes the student acting as production manager puts somebody or himself helping that "worker".
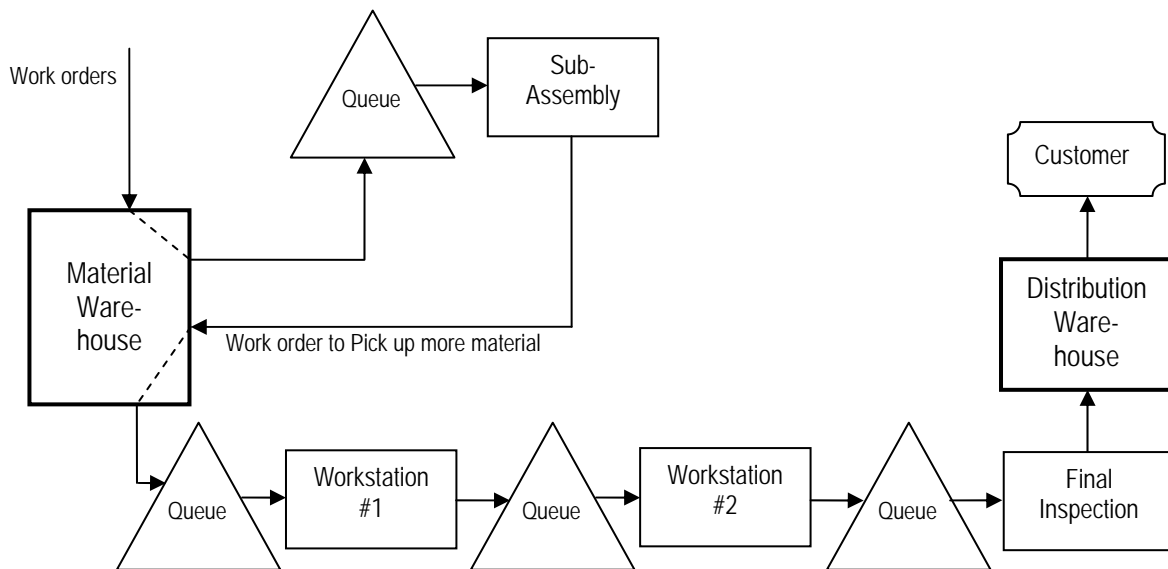

Fig. 1. Production Systems Flow Overview.

Then the students are asked to stop anything they were doing and asked to measure the performance of the existing system. The performance indicators are: Productivity, Labor Utilization, WIP, throughput time, number of tables utilized, as well as others. The students are then asked to identify waste and propose improvements. They identify some forms of waste such as transport, inventory, and waiting. As solutions they vary from class to class but a typical proposal is to put more workers under the idea that the worker on the bottleneck is not able to deal with queue that is piling up just before its workplace. I explain that this solution is not a good solution because it only makes performance to get even worse.

After some discussion I divide the class in groups of 4 or 5 students and I give them the task of proposing improvements to the existing production system and come up with a proposal with less waste. Once they finish their proposals, each group runs the system and we measure its performance. Most groups end up with some improvements on production performance typically solutions such as improving the layout, reducing transport, and reducing one or two workers. Curiously students normally do not recognize that:

- Batches may not be necessary,

- Quality controllers may not be necessary,

- Overproduction is avoidable,

- Most transportation can be eliminated,

- The supervisor may not be necessary,

- The production may be pulled by demand requests,

- And so on.

The students were just looking at the problem as anybody else, as most workers in our traditional factories and offices.

The production system is then modified into a lean production oriented approach where we can see many lean production practices applied: one piece-flow, pull production with kanban, milk run, cellular production, new relationship with suppliers, etc. The students are also involved in a 15 customer order production cycle and at the end they are also asked to measure its performance and compare with the performance obtained on the previous production approach. With this approach we only use 3 workers and the WIP and Throughput time is drastically reduced.

The Interesting finding

In one of lectures, because the number of students was quite large (a bit more than 60 students) and because I know that if there are too many students just observing they get a bit noise and distracted, I decide to do something different. I divided the class into two groups in two separate class rooms. With one of the groups (lets call them as group A) I performed the production game as described earlier in this article, but with the other group (lets call them as group B) I just gave them the type of products they had to assemble and the type of demand as in the game. The job of students from group B, working in teams of 5 or 6 members, was to build from scratch a production system able to respond to the Takt Time of 20 seconds with random customer orders as in the game. They had to test different ways of assembling the products, they had to measure assembly operation times, assume inventory policies, number of workstations, batch sizes, etc. in order to meet customer demand, and present a solution to be tested in the class room.

Group A (the group that was involved in the production run of the traditional factory) as in previous experiments came up with the same type of comments and solutions. Very little performance improvements were achieved with their proposals. Although detecting several forms of waste, solutions to eliminate it were in most cases not achieved. We consider that the student teams from this group actually approached the problem form the identification of waste angle, focusing their attention on non-value adding activities and trying to find solution to eliminate it.

Amazingly the teams from group B came up with solutions a lot more efficient than the solutions developed by teams from group A. Since they were not "contaminated" by any existing production practice, they had their focus on value adding activities and the result of their production system design was a lot less messy and with a lo less waste than the solution of the group A teams.

Table 1 shows the production performance values obtained from the traditional factory production run compared with the solutions typically achieved by teams from Group A and Group B production runs. We believe that the students that were not exposed to any existing production solution would concentrate on value adding activities resulting in better solutions. The students exposed to an existing production solution became conditioned by it and therefore tending to focus the improvements on non-value adding activities, resulting in poorer solutions.

Tab. 1. Comparison of production performance results.

Perform. Indicators	Tradit. Factory	Group A (Typical values)	Group B (Typical values)
Production time	5 min	5 min	5 min
Products sold	15	15	15
Cycle time	20 sec	20 sec	20 sec
People involved	8	6	3
Throughput (p/h)	180	180	180
Productivity (p/man.h)	22	30	60
WIP	90	35	10
Throughput time	30 min	11.6 min	3.3 min

Legend:
(p/h) – products per hour;
(p/man.h) – products per person per hour;
WIP – (Work In Process) – Number of products being processed.

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CONCLUSIONS

Improving production performance through waste reduction or elimination can be done either with focus on value adding or with focus on non-value adding activities. If we are improving an existing production solution we tend to be conditioned by the existing practices and some forms of waste cannot be detected. Even when some forms of waste are detected, solutions to its elimination are harder to be found since we are conditioned by existing practices. In these cases we tend to focus our attention on non-value adding activities. On the other hand, if we are not exposed to any existing production solution we tend to focus our attention on value adding activities and achieve better production performance. This paper shows an experiment where some teams of students were exposed to an existing production solution while some other groups were not. All teams had the task of developing the best solution in terms of production performance. The teams not exposed to existing solution performed a lot better than the other ones. In my believe the reason for these results is that the teams exposed to existing solution focused their attention on non-value adding activities while the other teams put their focus on value adding activities.