SET-UP TIME ELIMINATION IN AN AGRICULTURAL EQUIPMENT INDUSTRY

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Abstract. *Firms are embedded in a context where losses by transport, inadequate processes, among other wastes are no longer tolerated. The scenario where companies are included demands efficiency and effectiveness in production processes. Lean process has been the watchword among competitive companies. In this scenario of waste elimination and continuous improvement, set-ups times are losses that should be minimized or even eliminated when possible. Many companies which adopted the Lean philosophy are becoming agile by reducing machines set-up times. This article describes a study of production process improvement by reducing the set-up time of a welding process, to manufactured agricultural equipments, by 30 minutes to zero. To achieve this result it was necessary to change the project of welding jigs and also the layout of manufacturing sector. Some of the results achieved by the company after the elimination of the set-up of the welding jigs were the reduction of production batches and increasing flexibility.*

Keywords: *set-up, lean production.*

1 INTRODUCTION

Both the developed Western Europe as the emerging countries of Eastern Europe are facing enormous problems to meet rising customer expectations, and provide quality in a world where the old formula of mass production are no longer applicable. Applying old theories and practices to the new realities of current production can be dangerous and unwise. (Banas Quality, 2002).

The globalization process has led to the extinction of the comfort zones of businesses worldwide. The customer loyalty, achieved often by lack of choice that they had, it is most common in the business. Advances in information technology and improvements in transport systems have customers submerged in a wave of options never seen before. The many choices, and ease of access to products from different companies located anywhere in the world have driven organizations to become competitive.

And to be able to compete in this new universe of information and offers companies has sought to maintain a process of continuous improvement of your production system. Among the many problems they face on a daily basis, reducing the set-up routine practice has been a constant among the companies that are able to excel. The reduction of the set-up is one of the pillars of the reduction of production batches, thereby reducing waste and inventory and numerous delays in the process.

According to Singh and Khanduja (2010), set-up time is a vital parameters used in any manufacturing industry and is a form of necessary input to every machine or workstation. Because set-ups are a collection of sequence dependent changeover activities which are carried out before starting the production of any product, so productive time for machine can be increased by reducing its set-up time.

2 CHARACTERISTIC OF SET-UP

Slack et. al. (1999) defines the set-up time as the elapsed time in exchange for the production of a batch to the production of the first good part of the next batch. This time directly affects the size of production batches. The longer the set-up time higher the tendency to produce in large batches. For example, if two different parts A and B have a processing time of 1 hour and the set-up time is 30 minutes, hardly able to flow with small batch production. There will always be a tendency to produce large batches of A and B. So the set-up time ends up being diluted in the processing of batches.

The problem is that the production in large batches generates losses and less flexibility to the company production's system. An ideal system of production would be one that includes a continuous flow as shown in Fig. 1. But to approach the continuous flow is necessary among other things reducing the machines set-up times.

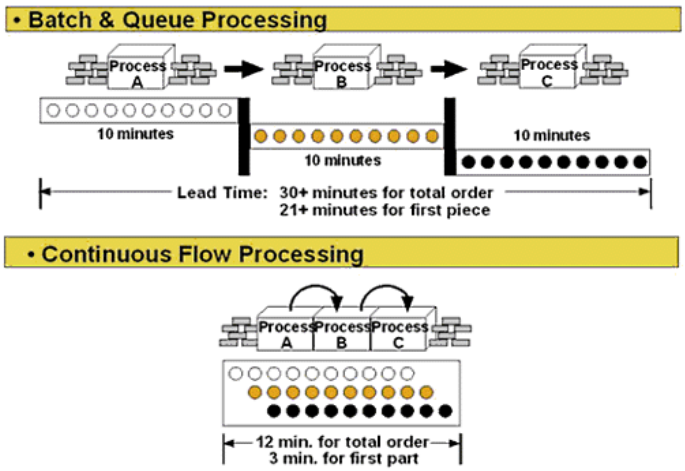

Figure 1. Comparison between batch processing and continuous flow processing
Font: MAMTC (2010)

Observing the figure above, is possible to see that an continuous flow has a smaller work in process and lead time. According to Pannesi (1995), shorter set-ups bring the following impacts to any type of production system:

- Make feasible the production of smaller lots;
- Reduce set-up scrap;
- Decrease set-up labour cost;
- Make production system flexible;
- Reduce product lead time;
- Enhance productivity and utilization of assets;
- Reduce manufacturing cost.

There are some methods and common practices in reducing machines set-up times. Following is described the Shingo's method to reduction set-up time: Single Minute Exchange of Die.

2.1 Single Minute Exchange of Die (SMED)

The SMED method can be applied in any factory, to any machine. Figure 2 shows the SMED method and the steps of the method are (Shingo, 1985):

Separation of internal and external operations set-up. Moxham and Greatbanks (2001) mentioning that an important step in Shingo's method is to clarify set-up activities into two distinct categories: internal set-up, which can only be perform when a machine is stop, and external set-up, which can be conducted while a machine is in operation. Reis and Alves (2010) noted in this phase achieve an economy of 30% until 50% of set-up time.

Convert internal to external set-up: this is the most powerful principle in the system of quick tool changing. Doing this conversion involves the operations review to see if any of the steps was mistakenly taken as internal and find ways to convert these setups in internal external. Slack et. al. (1999) highlights three main methods to convert internal setup to external setup:

a. Use pre-assembled tools. In this way a complete unit is fixed to the machine instead of having to assemble various components while the machine is stopped.
b. Assemble the tools or different die in a standard device. This allows the internal set-up consist of an simple and standardized assembly operation.
c. Making it easy to load and unload tools and dies. The use of devices such as conveyors and rollers generate good results.

Streamlining all aspects of the set-up operation. There are some forms to streamlining the activities that make part of the set-up operation:

a. Standardize the function, not form: The form standardization is a loss, because all dies would have to fit the largest size used, which would increase costs unnecessarily. The function standardization requires only uniformity of parts required for operation set-up.
b. Use clamps or eliminate functional staples: Screws are the most common mechanism of fixation, but their use can consuming excessive time. Screws are not the only way to fix objects. Nor should we assume that fasteners are always needed. Methods One-Touch, which use wedges, cams or springs, greatly reduces set-up time, and

any binding mechanisms that fit, and to unite both parties.

c. Adopt parallel operations: When the set-up requires that transactions be made on both sides of the machine is necessary that the operations are done in parallel. When two people perform parallel operations simultaneously, the set-up time is typically reduced by over 50% due to economy of motion. An operation that takes 30 minutes to be performed by an operator can take only 10 minutes with two operators. When these parallel operations are employed, the number of man hours used in the preparation is equal to or less than the number of man-hours with only one worker. Thus rises the rate of machine operation.
d. Eliminate adjustments: Typically, adjustments and testing pilots are responsible for 50 to 70% of the internal set-up time. The elimination of these times greatly reduces set-up time. And the elimination of adjustment begins with the recognition that the preparation and adjustment are two distinct functions. The preparation takes place in changing the position of a limit switch. The adjustment occurs when the limit switch is tested repeatedly and set on a new position.

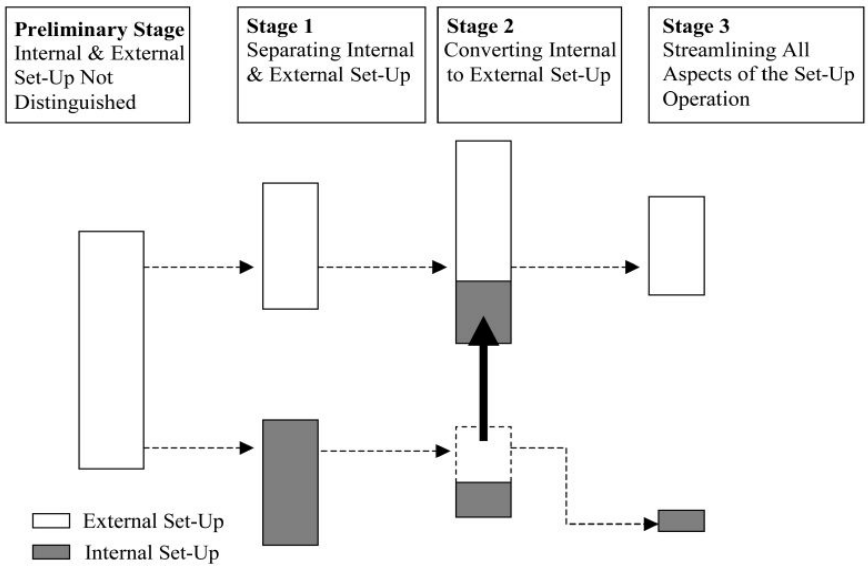

Figure 2. SMED method
Font: Shingo (1985)

Next section is presented a case study held in Agricultural Industry, located in the Sao Paulo State. Specifically, is examined of set-up reduction based on the construction of a new welding device.

3 CASE STUDY

This study of reducing set-up time was held in a company in the agribusiness sector in the state of São Paulo. This is a medium-sized company, mainly focused on the manufacture farming equipment of no-till.

The steps in the process of set-up reduction are described below:

– **Step 1: Identify the problem**

Through the construction of value stream map of the current situation was identified that the welding sector had very high times, becoming a production bottleneck. A more detailed analysis showed that the set-up time, preparation of weld fixtures, was the bottleneck operation in the welding sector. Therefore, reducing the set-up of assembly jigs became necessary to eliminate the production bottleneck. At this stage was used the Ishikawa diagram, in order to identify possible causes of the high set-up time. Figure 3 shows the Ishikawa diagram constructed.

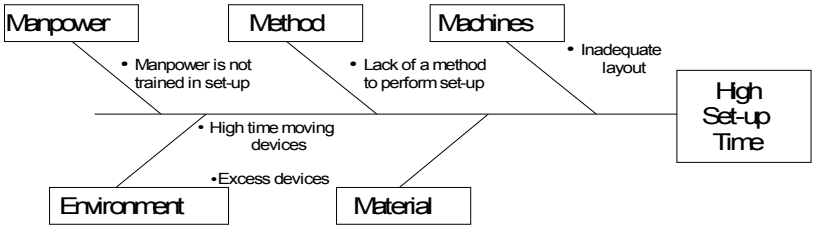

Figure 3. Ishikawa's diagram about high set-up time

– **Step 2: Checking the process of preparing jigs**

After identifying the problem was analyzed the completing process set-up. To this have been raised all the activities that made this process work. Figure 4 shows the activities identified and analyzed, as well as a schematic layout of the workplace.

As can be seen, there is a defined area to welding the machines structure. Before start, the welding structure is necessary to perform the set-up. The set-up involves changes and the repositioning of devices and tools in the jigs. Furthermore is necessary to move the jigs to the welding area. This movement involves the use of a overhead crane, which, in addition to encumber the operation in terms of time can also cause accidents, since the movement of feedbacks depends on largely the operators ability to operate the overhead crane. Two jigs were used for machines with greater output. The welding jigs 1 was utilized to structure machines with 12 and 15 lines for the planting. The welding jigs 2 was utilized to structure machines with 8 and 10 lines for the planting. The others were utilized for the more machines.

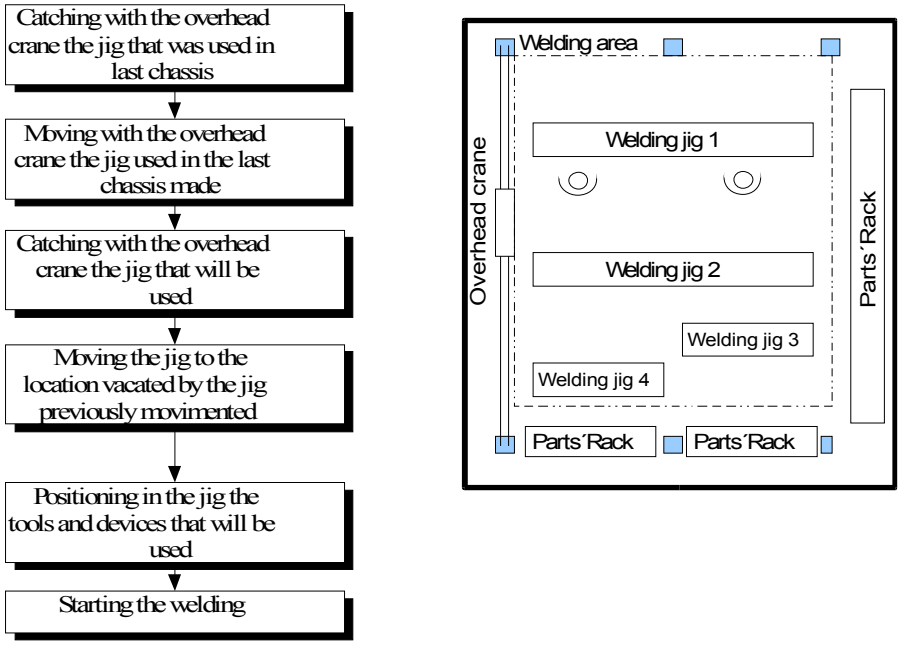

Figure 4. Sequence of activities and layout of the welding area

– **Step 3: Improvements made**

Based on the activities described above and with worker suggestion's were proposed the following improvements:

a. Jigs time moving elimination: the layout was restructured so no longer need to move the jigs. The welding of the chassis have to be carried out on site where the templates were. Figure 5 shows the layout reorganized.
b. Elimination of the internal set-up of welding jigs: two new welding devices were built under the concept of elimination of preparation time

The jigs were designed as follows:

Welding jig 1: machines of 8 and 12 lines
Welding jig 2: machines of 10 and 15 lines.

This separation allowed that was no longer necessary to perform internal set-up in the jigs. Before the changes in the

jigs, tools and devices utilized in the jigs for welding machine´s chassis with 8 lines for planting clashed with the tools and devices of a machine with 10 lines for the planting. Therefore it was necessary to perform the set-up. This reorganization allowed that both the tools of machine as 8 lines and 12 lines could be assembled on full-time in welding jigs, because no one in position clashed with each other. This change in the welding jigs and the layout restructuring allowed that the set-up time was reduced from 30 minutes to zero. For the structure machines with 10 and 15 lines for the planting was constructed a new jig with the same concept. Figure 6 shows the initial situation of the jigs used in the welding process and Fig. 7 shows the new welding jigs designed with the new combinations of tools.

With the new configuration of welding jigs, it became no longer necessary to prepare the tools to perform set-up. This set-up elimination allows the company to produce in small batches and a large mix of products, managing more efficiently fluctuations in demand. Figure 8 shows the new jigs constructed.

In the new jigs the position of the each tool are checked. As can be seen, marked in yellow are the positions of the tools for machines with 12 lines and in red the position´s tools for machines with 8 lines for planting. This tag makes it easy and visual to the operator know which device to use.

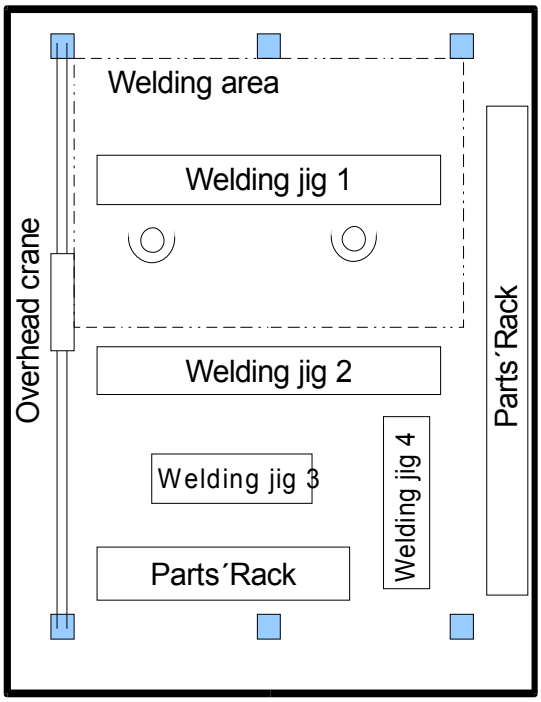

Figure 5. New layout reorganized of industry

Figure 6. Welding jigs before the changes

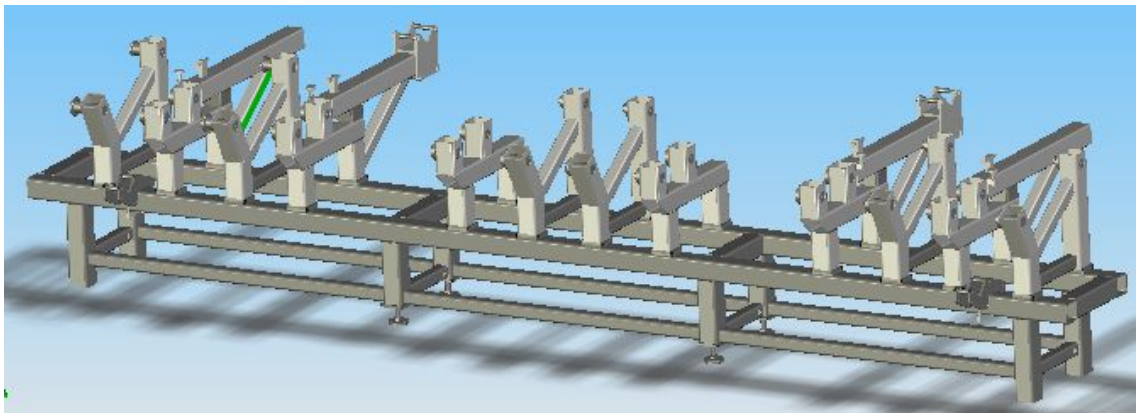

Figure 7. Schematic figure of welding jig for the machine with 8 and 12 lines with all the tools assembled

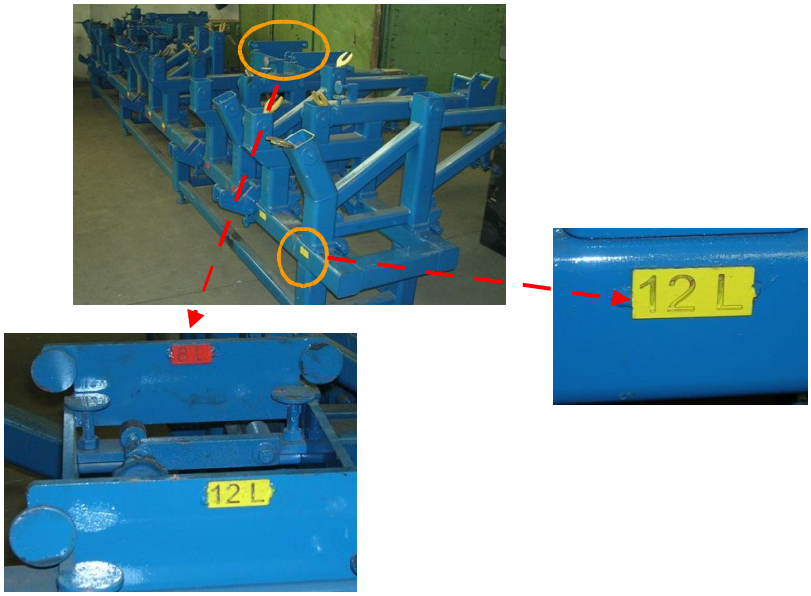

Figure 8. Pictures of the new jigs

– **Step 4: Defining methodology and training manpower**

After to change the jigs was established a standard method to welding the chassis. Furthermore the workers were trained in concepts as 5S to maintain the work place organized, because the space to make the weldings was restricts due restriction of the building and of overhead crane.

4 ACHIEVED RESULTS

The main results achieved were:

– Elimination of the need for set-up. In this case, the reduction time was 30 min. In other words, the set-up was eliminated.
– Possibility of producing a range of different models of chassis. Before the operator, due to lost time with set-up, welded all models of the same chassis to start only after the production of another model. The aim was to prevent the operator perform set-up operations.
– The welding sector was a "bottleneck" of production. With this new concept of zero set-up that was supplying the assembly line as needed.
– The production of different models enabled the assembly of a range of different designs on the finish line. Because different models are welded the line can produce different types of machines. Unlike what occurred, because the frames were welded into lots and forced the line to produce a large batch of the same type of machine.
– Reducing the possibility of accidents at work since there is no need to move the fixtures.

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5 CONCLUSIONS

The deployment of lean manufacturing has demanded, among other things, reducing set-up times. Making internal set-up on external set-up, eliminating time-handling tools, etc. has been the mission of many companies in search of a production process more flexible and agile. Shingo (2002) points out that the set-up time typically comprises four functions, whether internal or external set-up:

- Preparation of raw material, mounting devices, and accessories. - 30%.
- Fixation and removal of tools and dies – 5%.
- Centering and dimensions of the tools – 15%.
- Initial processing and adjustments - 50%.

Many authors have described the advantages of reducing set-up. Among these, perhaps the greatest gain, is the tcompany's ability to pass on to produce in small batch. As described and confirmed by Toyota, small production lots minimize waste and inventory. In addition, if a defect is detected, only a few defective items are produced, as opposed to a process in large batches, normally when a defect becomes apparent several parts or products have been manufactured. With this, the company suffers losses with rework or even entire batches of production qre lost.

In this context, reducing set-up time is a critical variable in the pursuit of lean manufacturing. Simple actions to reduce set-up time can bring big gains to companies. Therefore, it is important that companies realize the importance in the set-up reduction and starting actions to minimize their times spent with machines set-ups.

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