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# IMPLEMENTATION OF QUICK SETUP IN A THREE-DIMENSIONAL MACHINE

# CASE STUDY IN AN AEROSPACE METALLURGY INDUSTRY

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**ABSTRACT**

*The reduction of the time in the Rapid Tool Exchange (TRF) aims beyond the objective of reducing the preparation time (or setup) of the equipment, reducing non productive periods inside the factory floor. Bringing as a consequence, the reduction of the size of the production batches in the manufacture. The rapid exchange of tools is based on techniques where cooperative team work is of paramount importance to develop suggestions for creative ways of improving processes. This article presents a methodological proposal for the rapid exchange of tools, where the following steps are available: Define which project will be introduced; Planning of the activities to be developed; Training of the deployment team, monitoring, consolidation on the deployment itself. About the case study was developed in the aerospace metallurgy industry and illustrates the proposed methodology.*

**Keyword***: Fast Change, Lean Manufacturing, Continuous Improvement, Planning.*

## 1. INTRODUCTION

According to Terra (2003), with the competitiveness of today's world, companies are adopting methods that were previously neglected. They saw that a company that does not adopt improvements in its production and management to grow and remain strong in the market, ends up not following the evolution that comes every moment, falling behind in this dispute for the market. New methods are emerging that help companies to perform, so they have to adapt to these changes in the short term so that they can become even more competitive in the medium and long term.

According to ONNO apud Silva (1997), there are several types of waste that can be classified as waste: overproduction waste, available time (waiting), transportation, processing itself, inventory and producing defective products. Complete disposal of these wastes increases the efficiency of operations over a wide margin.

For SLACK (2002), the ability to continuously improve is not something that occurs naturally in companies, there are specific skills, behaviors and actions that need to be consciously developed and managed to achieve continuous sustainable improvement in the long run.

According to SHINGO (2000), the use of rapid tool change helps reduce lead times, allowing the company to respond quickly to market changes.

Another advantage of rapid tool change is the economical production of small manufacturing lots, which usually requires low investment in the production process.

The KAIZEN methodology has its principles linked to the reduction of expenses and gain in productivity without losing the main item of a product that is quality.

This methodology is one of the quality tools that today are more present in the company's processes.

The companies have been adopting a new methodology focused on lean production, applying the lean manufacturing system. The implementation of the process of continuous improvement in companies aims to contemplate precisely the application of this new mentality.

## 2. LEAN MANUFACTURING

Lean manufacturing, better known as Lean manufacturing, was developed in Japan in the 1950s by Eiji Toyoda and Onho, and aims to develop the best possible way of working in order to efficiently add greater values to the products requested by the customer, Meeting exactly what the customer wants and transforming, in the best possible way, the waste in value.

When Eiji Toyoda and Onho started the concept of lean manufacturing. Both realized that in attempting to imitate the American system that Henry Ford (1880-1940) had developed mass production could be dangerous because of the territorial dimensions and consumer market that required a wide variety of products.

Knowing the Ford method, Eiji and Onho deployed with a differential, where others tried to imitate the method and made a mistake. Eiji and Onho were able to verify that there was no point in setting up a production line, in which the employees were not trained and experienced this not only in the work but in all their life. As a result, a new production system model known as Lean Manufacturing System (Lean Manufacturing / Lean Production) has emerged.

According to Toledo apud Dias (2006), lean thinking can be understood as the way to produce more and more with fewer resources and, at the same time, to approach the clients and offer what they really want, making the work more satisfactory and Offering immediate return on the efforts of transforming waste into value. Its main objective is to align the best possible sequence of work in order to effectively add value to the products requested by the client.

## 2.1 JUST IN TIME

Just in time appeared in Japan in the 70's, in the Toyota Production System. They were looking for an administration system that would coordinate production with the specific demand of different vehicle models and colors with the least possible delay.

It is a system that dictates that nothing should be produced, transported or purchased ahead of time. The raw material is only bought after the effective sale of the product. The Just in Time concept is related to demand-based production.

For Ballou (2006) JIT is "a planning philosophy in which the entire supply channel is synchronized to respond to customer operations needs." While there is a strong likelihood that you will need to work much harder on supply chain management under a JIT philosophy than under a supply-from-inventory philosophy, your benefit is to operate the pipeline with as little inventory as possible and the savings and / or improvements in the services thereof.

The main objective of Just in time is the continuous improvement of productive processes, with reduction of inventories, allowing the problems to be visible.

"JIT aims to identify, locate and eliminate losses, ensuring a continuous flow of production. The feasibility of JIT depends on three intrinsically related factors: continuous flow, takt time and pull production. "

According to Ghinato (2000), the continuous flow is about the need to reduce the lead time of production.

Takt time is the time required to produce a component or a complete product based on customer demand.

The concept of pulled production is based on the system in which it is only produced when one has product information (product sold).

In addition to the inventory reduction, Just in time makes it possible to reduce product manufacturing times, reduce machine setups, improve productivity, quality, less waste (rework) and quick response to problems.

## 2.2 JIDOKA

It is defined by the Toyota Production System as "automation with a human mind," meaning to create processes free of defects.

Jidoka allows the operator to have the autonomy to interrupt the operation whenever any irregularities in production are detected, such as defective parts, generating immediate corrective action. In this way, the process can have its own quality self-control, reducing waste and improving product quality.

According to Silveira (2013), the Jidoka consists of 4 important steps:

- Detect the fault or abnormality;
- Stop;
- Correct or immediately repair abnormal condition;
- Investigate the root cause (using, for example, the "5 whys") and establish effective actions so that the problem no longer occurs.

The benefits of Jidoka are:

- It maintains productive, continuous and stable flows, avoiding defects;
- Identifies and eliminates the causes of waste due to lack of quality;
- It frees man to perform multiple tasks that add value;
- It improves productivity and establishes actions that avoid recurrence of problems, through definitive solutions at a systemic level, incorporating elements that ensure quality at source. (Silveira 2013).

## 2.3 KAIZEN

KAIZEN is a practice of continuous improvement and its origin comes from the Japanese model of production. And it is based on concepts of changes and actions in which it presents improvements in its current structure making the activity more efficient.

KAIZEN follows some basic principles essential for its implementation and are demonstrated below:

- Throw away all fixed ideas of how to do things;
- Think about how the new method will work, not how it will not work;
- Do not accept excuses. Fully deny the status quo;
- Do not seek perfection. A 50 percent implementation rate is good if done in the act;
- Correct mistakes when they are found;
- Do not spend a lot of money on improvements;
- Problems give the chance to use the brain;
- Ask "Why?" At least five times until you find the root cause;
- The ideas of ten people are better than those of a person;
- Improvements have no limits.

The principles of KAIZEN are intended to follow the steps that must be followed and followed exactly.

For the KAIZEN method the concept of improvement has to have every day, something can always be improved and it does not matter if it is a high impact or small impact improvement, improvement is improvement.

The KAIZEN methodology, which means continuous improvement. This practice is aimed at the good not only of the company but also of its employees, revealing concrete results, qualitatively or quantitatively, in a short time and at a low cost, supported by the combination of values that the Kaizen methodology brings and is formed by a Team of all sectors, seeking the goals set by the management of the company.

The key elements of Kaizen are: quality, effort, participation of all employees and communication. To implement such a philosophy, the organization must have in-depth knowledge of its processes.

The word itself denotes the meaning of this philosophy: "kai" in Japanese means change and "zen" for the better.

## 2.4 QUICK SETUP

For Shigeo Shingo (1996), the application of a rapid set-up system aims to act in an organized way on the actions that do not add value to the product from the consumer's point of view.

Setup is an operation that needs to be performed when there is a need to replace the item being produced with another item that we have to produce.

It serves to reduce in an organized way actions that do not add value to the product, when we change the item that we are producing in the machines, the concept setup fast does consists in the survey of the current data, to identify the wastes in the process, to plan the quick setup and the work Standardized, guaranteeing the stability and efficiency of the process.

ADVANTAGES

- Reduction of batch size - faster delivery;
- Flexibility - production of a greater variety of products;
- Simplification of preparation - reduction of occurrence of errors;
- Better quality - consequence of inventory reduction;
- Increased productivity - reduction of idleness.

This rapid setup tool is paramount in companies, with this tool implemented correctly and organized allows the company to have flexibility in the manufacture of different products.

For Ferreira apud Dias (2006), the delayed exchanges result in excessive inventory, large batch size and poor product quality. In this way, you should try to reduce this exchange time as much as possible to make the plant as flexible as possible to schedule customer changes.

Setup consumes production time, and conceptually the total setup time is defined as the interval from the last 'good part' of the previous lot to the first 'good part' of the current lot.

The activities are divided into:

Internal Setup, activities that can only be done while the machine is stopped.

External Setup, activities that must be done with the producing machine.

## 3. METHOD

This article aims to optimize the setup of tool change in an automated measuring machine (CNC) in company XX, where the operators perform several actions until the end of setup, resulting in bottlenecks in production.

The use of the KAIZEN methodology to reduce bottlenecks uses its systematic approach to improve productivity and reduce tool change time.

The implementation of this system is based on the engagement of teams and groups. Employees play a key role in achieving the stated goals and the success of the project. It is worth mentioning that the improvement only happens with the involvement of all, starting with management, employees and suppliers.

According to IMAI apud Hornburg, Will and Gargioni (1994, 1996) in KAIZEN, this is highly stimulated, and has one of the positive consequences, people more willing to follow the new standards proposed by themselves.

For companies, products and processes must always be constantly changing, seeking to achieve the goals; however the product or service is at the highest level there is always room for improvement and the pursuit of excellence.

## 4. DEVELOPMENT

In order to reach the desired reduction target and consequently the increase of the indicator, we took as a basis the data collection in the metrology laboratory in a three-dimensional machine. And for this was created a statistical database in conjunction with other sectors of the company, such as PCP, financial, logistics, in order to have more complete data, to the development of the process to be deployed in the company.

The three-dimensional machine has a fundamental role in the area of metrology of the company, in the measurement of parts that are part of aeronautical components, because its process is slow and makes the process bottleneck in the release of the reports that must be approved, after the measurement.

After the process of measuring a part in the machine has been completed, the operator (Quality Inspector) starts the machine setup job, starts the machine in safe mode and starts taking the part out of the device, all parts before being Measures are set in the device for the machine to take the measurement. The machine makes this measurement according to the part programming, this programming is done in a lean way. The operator after the machine stops taking the necessary keys and unscrew four screws to release the device from the machine, thereby removing the device from the machine and removing the part from the device outside the machine by changing it, with that process the company loses Minutes that lead to low productivity.

We were able to identify that the best solution for this time loss in setup would be solved by preparing the setup outside the machine that performs the measurement. This preparation would be done on a bench next to the measuring machine that would facilitate the assembly of the part. With this the preparation would be done on the outside of the machine while it is performing the measurement of another item, ie, to perform most of the setup outside the machine having a gain of time in minutes. The machine was chosen because it has higher demand or higher value added parts. The case study has been divided into several stages, making it clear and easy to understand how the designation works, which is external and internal setup. To start applying the improvement we use the procedure below.

To enter the quick setup method it was necessary to know what is internal and external setup.

The company did not have the knowledge of what was external or internal setup, then it was identified what was internal setup and external setup, where a great problem was found, the internal setup time was very high. The operator of the three-dimensional machine only started the setup of the next Part Numbers when the machine finished measuring the item being measured, because we used devices that could only be set up in the machine, generating a great waste of time, the only one Setup was to get the device that would fix the next item. With the data collected it was identified that there was a great loss of time with the internal setup (machine stopped).

We work in search of a tool that could reduce this time lost with the internal setup.

Data collected before fast setup application.

| | PNs | Year Volume | Measurement Volume Approximate Production | Set Up Time per Piece Currently Production (Min) | Set up time Current Annual Production (Min) |
|---|---|---|---|---|---|
| 3D measuring devices | 830-0108 | 9760 | 976 | 3 | 2928 |
| | 67xx_ Body regulator | 2800 | 280 | 3 | 840 |
| | 829 - 0108 | 2560 | 256 | 4 | 1024 |
| | 1806 - 0800 | 1400 | 140 | 5 | 700 |
| | 1386 - 2201 | 1300 | 65 | 4 | 260 |
| | 926 - 0102 | 1260 | 126 | 3 | 378 |
| | 786 - 0701 | 1140 | 114 | 6 | 684 |
| | 4775 - 0002 | 936 | 94 | 3 | 282 |
| | 4774 - 0002 | 888 | 89 | 3 | 267 |
| | 920 - 0201 | 450 | 45 | 7 | 315 |
| | 1642 - 0401 | 270 | 27 | 7 | 189 |
| | 918 - 0701 | 208 | 20 | 4 | 80 |

| | |
|---|---|
| | 7947 |
| Lost time with internal setup (Machine stopped) during the year | 132,5 |

Table1: Setup times
Source: Author

After application of the kaizen suggested by the operators to perform the setup, externally in a quick coupling device, with this application was created devices for several PNs where the fixation of the part is performed outside the machine avoiding machine down time. It can be seen in Figure 6A that the machine is measuring an item and there are already three items ready to be measured, they are already with external setup performed as shown in Figure 6A / 6B.

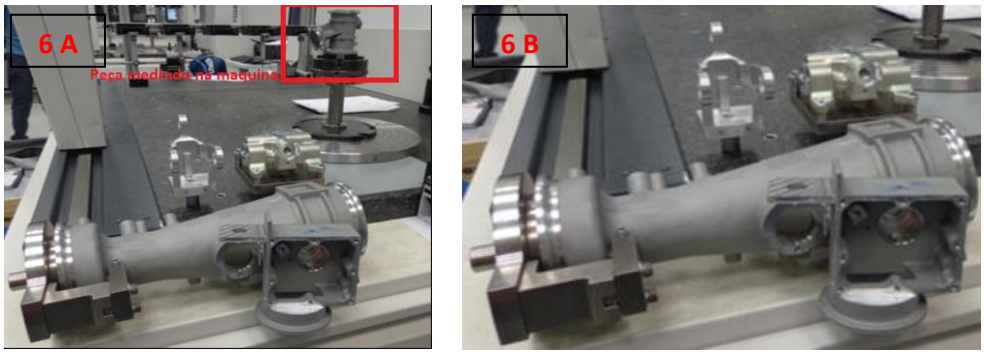



Figure 1 - Device
Source: Company XX

### 4.1 QUICK SETUP DEVICE FOR METROLOGY ROOM

A universal base with quick coupling was designed to leave fixed by definitive in the machine aligned with the machine zero axis. As shown below.


Figure 2 – Device
Source: Company XX

Devices for each PN were designed and manufactured to fit into the universal base with the rapid setup system, always aiming to use the longer time of the setup externally. For all items, work instructions have been created so that the operator can identify which device to use and also how it will fix the part in the device. Example below.

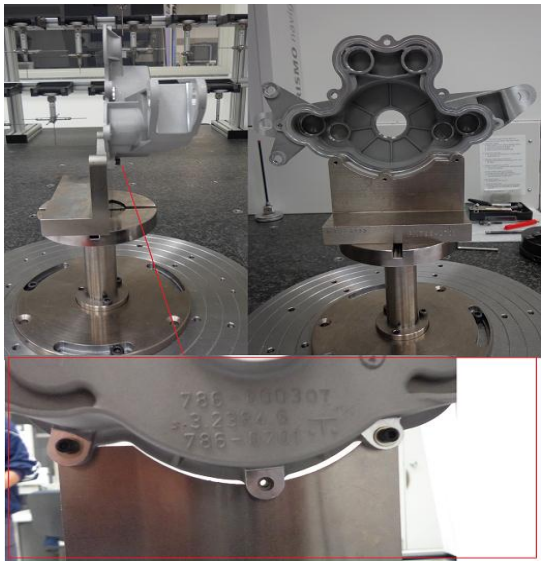


Figure 3 – Device
Source: Company XX

In order for the operator to execute the tool correctly the standardized work was created, the operators were trained so that they would carry out their activities in order to perfect and facilitate the activities carried out in the work routine.

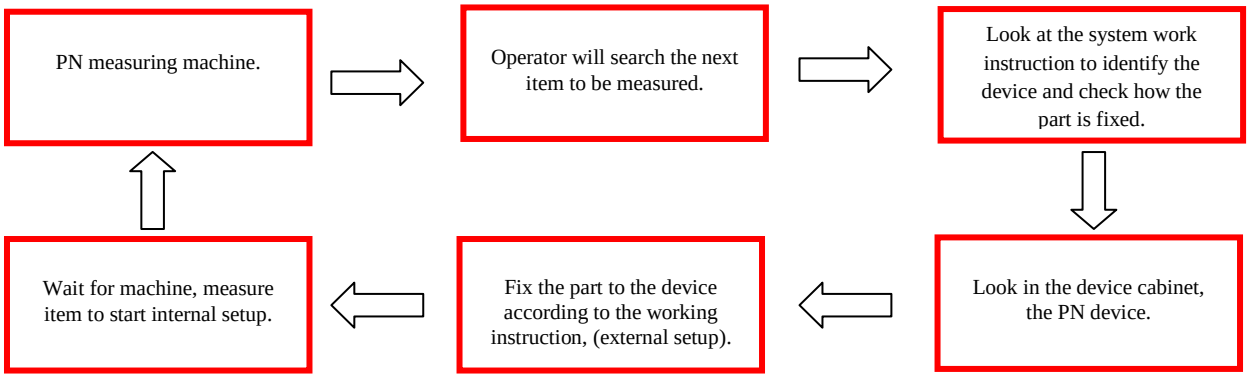
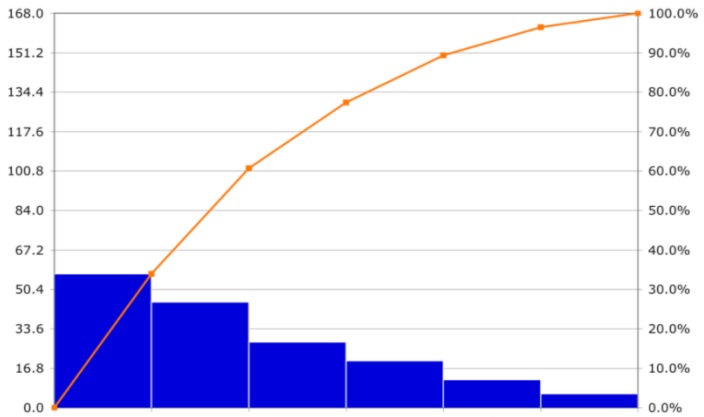



Figure 4 - Duty Cycle
Source: Author

To define which PNs (Part numbers) will be introduced the quick set up method, the Pareto chart was used to verify which were the most produced items in the company during the year seeking to insert this method for 60% of the items that are most produced during the year.



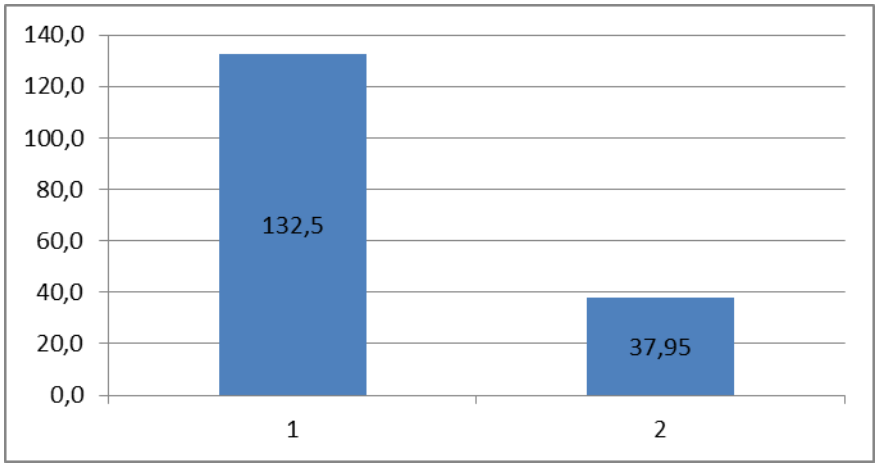

Graph1: Pareto
Source: Author

After the introduction of the quick setup for the most produced PNs in the year 2015, the graph below shows the time gain of the setup, identifying how it was and how it was.

| 3D measuring device | PNs | Part volume / steel | Approximate production measurement volume | Fast Setup Time per Piece in Production in (Min.) | Fast setup time per part in annual output in (Min.) |
|---|---|---|---|---|---|
| | 830-0108 | 9760 | 976 | 1 | 976 |
| | 67xx_Corpo regulador | 2800 | 280 | 1 | 280 |
| | 829-0108 | 2560 | 256 | 1 | 256 |
| | 1806A0800 | 1400 | 140 | 1 | 140 |
| | 1386-2201 | 1300 | 65 | 1 | 65 |
| | 926-0102 | 1260 | 126 | 1 | 126 |
| | 786-0701 | 1140 | 114 | 1 | 114 |
| | 4775-0002 | 936 | 94 | 1 | 94 |
| | 4774-0002 | 888 | 89 | 1 | 89 |
| | 920-0201 | 450 | 45 | 2 | 90 |
| | 1642-0401 | 270 | 27 | 1 | 27 |
| | 918-0701 | 208 | 20 | 1 | 20 |
| Lost time with internal setup (Machine stopped) yearly, after the introduction of the fast setup. | | | | | 2277 |
| | | | | | 37,95 |

Table 2: Time comparison
Source: Author

Graphical comparison of the time gained after the quick setup was introduced in the figure below.
1. Before applying the quick setup method.
2. After applying the quick setup method.




Graph 2: Comparison of gain
Source: Author

## 5. CONCLUSION

This article provides a methodology for the rapid exchange of tools. Where, they are clearly shown to the difference between the steps of planning, preparation and deployment.

The methodology can be applied in a generic way, in different industrial sectors. The objective of the proposal is to emphasize the creation of favorable environments for the implantation and formation of teams of continuous process improvement.

The methodology offered is applied in the analysis of the setup of an operation in an aerospace industry. Where the main results obtained, the reduction of the setup time of the studied operation of 71.35% and consequently reduction in the time of stops between manufacturing batches of the analyzed product stand out.

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