Increase of the Productive Capacity due to the Setup Reduction: Case Study in the Industry of Medical Products

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Abstract. The reduction of set up, among others things, increases flexibility, diminishes the inventory and increases the productive capacity. So the reduction of setup is important and something desirable, but this is far of being enough to implement a program of setup reduction, because all the improvement initiatives must be evaluated as a strategical investment, based on the evaluation of the necessities of the business. It must be understood what improvement level is being searched and why. In this work a methodology was presented that calculates the gains of setup reduction considering that the technological improvements implemented to reduce the setup will affect the downtime apart from setup and will change the necessity of workmanship qualification (not necessity of specialists). At the end it was gotten a goal of setup reduction and a economic reason (transference of 25 employees) to implement a program of setup reduction.

Keywords*: Setup, OEE, Productive capacity*

1. Introduction

As commented by Correa (1996), nowadays there has been an increasing movement of valuing the role of the manufacture to achieve the strategical objectives of a manufacturing organization. A great reason for this comes from the observation of the Japanese industry. One notices that in the sectors where it stood out: motorcycles, household-electric, cameras, devices of sound and steel production, had already well-established leaders. In these markets the Japanese companies would have had success mainly for the low price and high quality of their products, obtained through an excellence in manufacturing. The best Japanese companies were using innovative industrial practices, as its main competitive weapon, in opposition to the occidental companies who would have considered the production "a problem already solved". Correa (1996) also comments that there are five main competitive priorities, based in which the manufacture can contribute for the competitiveness of the organization:

- To make the products spending less than the competitors, getting advantage in costs.
- To make better products that the competitors, getting advantage in quality.
- To make the products faster than the competitors, getting advantage in delivery speed.
- To deliver the products in the promised stated period, getting advantage in delivery trustworthiness.
- To be capable of changing fast, getting advantage in flexibility.

A good example of highly competitive Japanese company is Toyota, that is a company that developed practices of excellency in the management of its manufacture having the reduction of setup as an essential support. Womack (1992) describing the beginning of lean manufacturing at Toyota explains that in 1950 the time necessary to change molds of presses was reduced from one day to three minutes generating the unexpected discovery that the cost for pressed part was lesser in the production of small lots than in the process of immense lots.

These gains in the setup reduction are grouped by McIntosh et al. (2001), in 5 main areas of benefit:

- Reduced equipment downtime.
- Reduced inventory.
- Reduced resource.
- Enhanced flexibility.
- Enhanced process control.

Comparing the lists of Correa and Mcintosh (above) it is concluded that to work in setup generates gains that improve the competitiveness of the company. But to spend energy and money in a project it is desirable the quantification of the profit. McIntosh et al (2001) comments that changeover improvement initiatives should be assessed as strategical investiments and that should be understood what level of improvement is being targeted and why.

Company ESA, focus of this study, has the intention of making projects to reduce the setup of some machines to become more flexible, diminish the inventory and increase the production capacity. At the beginning of the project the following questions appeared:

- "What is the goal of the work"?

- "How much will be saved"?
- "How much will be expended"?

The objective of this paper is to answer the first and second questions above, a goal of setup will be determined and it will be calculated the gain of a project of setup reduction considering only the increase of the productive capacity that is measured by the index OEE (Overall Equipment Effectiveness).

It is important to stand out that it was not considered the other areas of gains (e.g.: inventory) not because they are less important, but due to the necessity of focusing an area of setup gain one at a time in a so ample subject.

This work is divided in eight sections. In Section 2 it is shown the relation between lean manufacturing and setup reduction. In Section 3 it is presented the case study. In Section 4 it is explained what is the index OEE. In Section 5 it is shown the gain calculations. In Section 6 it is shown the discussion. In section 7it is presented the conclusion and in section 8 the references.

2. Lean Manufacturing and Setup Reduction

Lean manufacturing says that we must eliminate seven sources of waste that are: excess production, movement, waits, inventory, rework, defects, transport.

Among the above sources of waste, Rother and Shook (1999) focus on the excess production. They say that the most important source of waste is the production excess because it causes all type of waste.

But a reason to produce in excess is due to the lowering of costs when the machines are used as most as possible or the necessity to increase the capacity to attend all the orders requested by the customers. So the industry is tended to make big lots to diminish the number of setups. A support for this politics is the adoption of the production of economic lots.

In relation to this Shingo (1985, p.18) comments: "there is no doubt that the concept of economic lot size is entirely correct in theory. Yet this concept conceals an enormous blind spot: the unspoken assumption that drastic reductions in setup time are impossible ". Shingo (1985) then shows that the setup reduction from 4 hours to 3 minutes, in a process that makes 1 part per minute, practically makes meaningless the calculation of economic lot size.

3. Case Study

In order to find out how the products flow in the company ESA, it was made a stream map value (fig. 1).

Through its analyses it can be seen that the stage named "stamping" has a bigger setup time that any another productive stage. At the stamping the setup is of approximately 10 hours, while the second bigger time of setup is of approximately 25 minutes (at the machine polinix).

Due to this bigger time of setup at the stamping, it is determined a minimum production for the lots so that the productive capacity does not diminish. This politics restricts flexibility and generates an impact in the inventory.

So the reduction of setup at the stamping is the point to increase capacity, increase flexibility and reduce inventory.

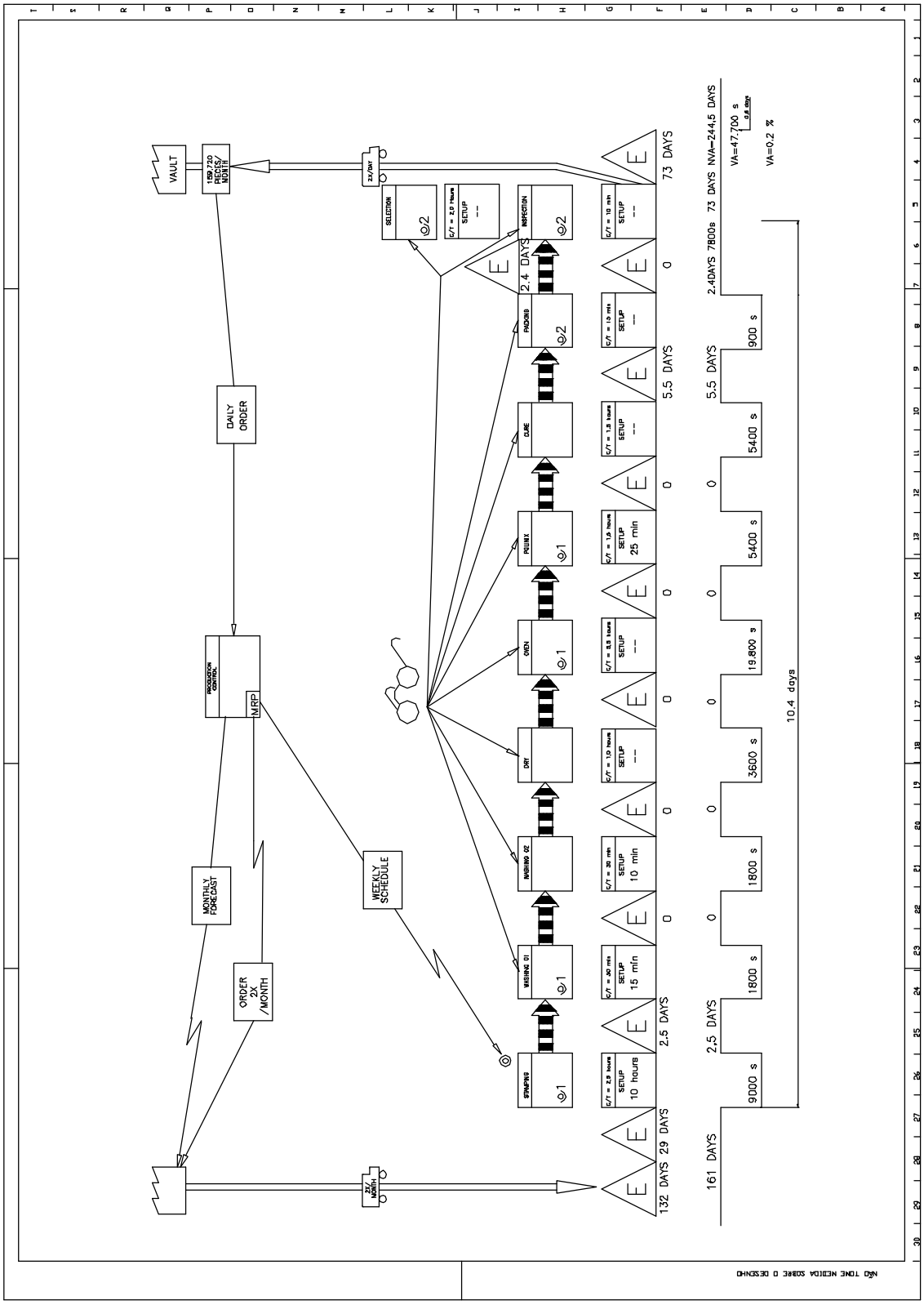

Figure 1. Stream Map Value

4. Overall Equipment Effectiveness - OEE

OEE is an index that shows the areas of opportunity to increase the productive capacity through its break into basic reasons.

It is defined by eq. (1).

$$OEE = GP/(SS * AT) \quad (1)$$

It can be broken into the following parts:

$$OEE = Availability * Production\ Efficiency * \%\ good\ products \quad (2)$$

Where:

$$Availability = (WT/AT) \quad (3)$$
$$Production\ Efficiency = (MP/(SS*WT)) \quad (4)$$
$$\%\ good\ products = (GP/MP) \quad (5)$$

Where:
GP = Good Products
SS = Standard Speed
AT = Available Time
WT = Worked Time
MP = Manufactured Products

It is important to stand out that:

- Availability is related to long breakdowns, (e.g.: longer than 10 minutes).
- Production Efficiency is related to short breakdowns (e.g.: shorter than 10 minutes) and reduction of speed below a standard value.
- % good products is related to the losses of good products

5. Calculation of the gain

Through the data collection of approximately 4 months it was gotten a stratification of the OEE (fig. 2).

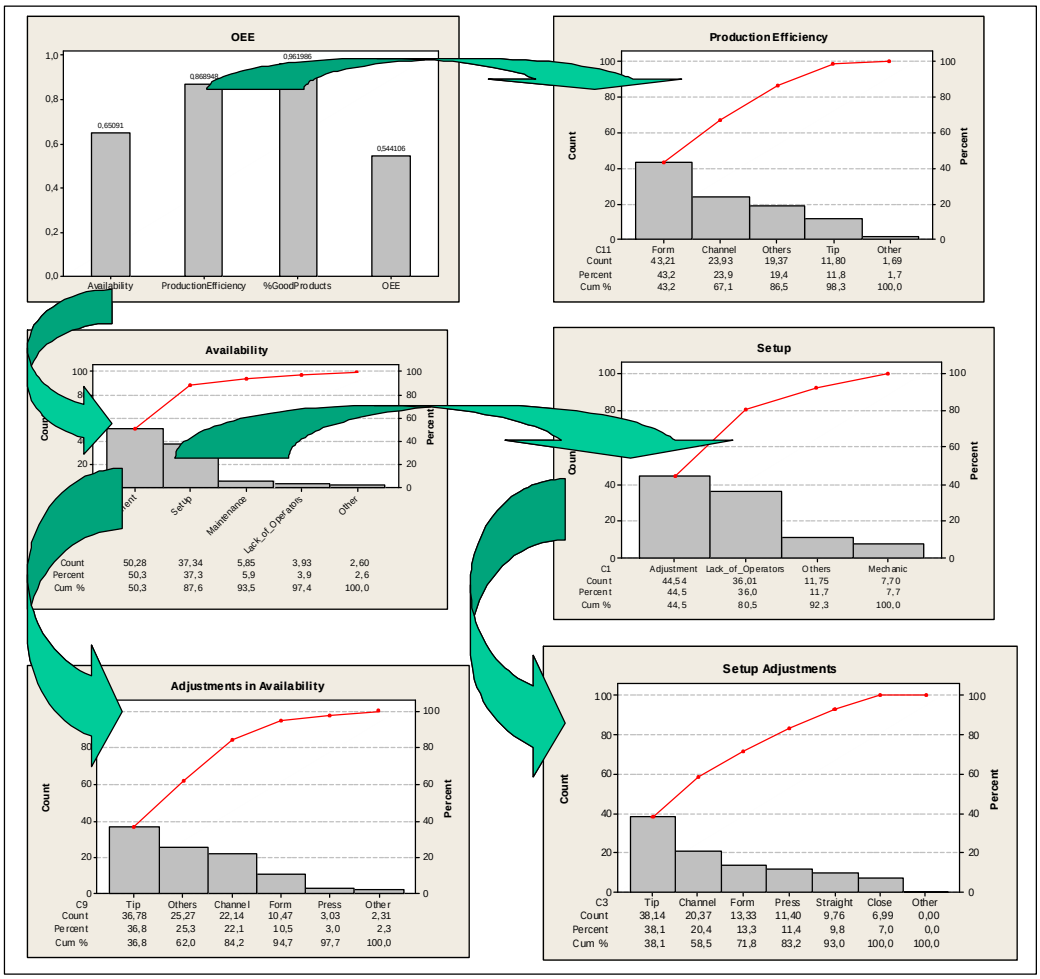

Figure 2. Stratification of the OEE.

In fig. 2 it is noted:

- A break of OEE into “Availability”, “Production Efficiency” and “% Good Products”.
- A break of Production Efficiency into basic reasons, considering that the machines speed were always the “standard speed”.
- A break of availability into basic reasons (that was done with four paretos).

It is important to stand out that Van Goubergen and Van Landeghem (2001), break the setup activities into preparation/aftercare, exchanging parts, setting/adjusting and readjusting , but in the present text when it is used the word adjustment means the set of activities above. It was then simulated the impact in OEE of setup adjustments, of “tip”, “channel” and “form” with values, each one, of one minute.

This value of one minute was adopted by two reasons: due to the claims that this is a goal that was already gotten in works of setup reduction and because a substantial reduction in setup would facilitate the calculations of the gain.

5.1. Reasons to have the goal of one minute - feasible by the literature

Shingo (1985), created a methodology of setup reduction that challenges the exchange of tools in less than ten minutes and cites some cases of substantial reductions, some examples:

- In a press of 1000 tons setup was diminished from 4 hours to 3 minutes.
- In a bolt-maker setup was diminished from 8 hours to 58 seconds.

- In a six-arbor boring machine setup was diminished from 24 hours to 2 minutes and 40 seconds.

Hay (1987) quotes a methodology that diminishes in 75% the time of setup, not mattering if it is a setup that takes 24 hours or 12 minutes, that means, if the current setup is of 10 hours, in 4 phases of reduction we would reach the value of 2,3 minutes. This approach of reducing setup in phases is quoted by Sepehri (1987) when analyzing the manufacturing revitalization at Harley-Davidson Motor Co.. He comments that there are three phases in the reduction of setup. In the first phase little effort is expended, getting a reduction of setup between 20 and 30%. In the second phase some expenses are necessary, with benefits between 30 and 50%, and in the third phase great expenses of capital are necessary generating reductions between 10 and 40%.

5.2. Reasons to have the goal of one minute - easiness in the calculation

The objective at this moment is to calculate the OEE for a scenario where the adjustments during setup for the channel, the tip and the form is of 1 minute each.

In this scenario, in the pareto of setup adjustments(fig. 2), it will be changed the percentages of time expended doing adjustments on the the tip, channel and form, respectively from 38,1%,20,4% and 13,3% to 0%. What is a close estimate. Example: Since the setup takes 10 hours and 44% of the time is expended in adjustments, as it is seen on figure 2 ("pareto of setup"), and 13% of the setup adjustments are expended on the form, as it is seen on figure 2 ("pareto of setup adjustments"). It can be concluded that the setup adjustments for the “form” take 34 minutes (600 minutes X 0,44 X 0,13), diminishing it to one minute, the setup adjustment of the form would change from 13.3% to 13,3%/34 = 0,4% that is close to 0%, that means that the estimation of 0% is reasonable.

5.3. OEE Calculation

In order to simulate the OEE of the new scenario, besides changing the percentage of time expended on adjustments on the tip, channel and form to 0%, We will also change the lack of operators to 0%, because in the new scenario since setup will be simple, there will not be lack of operators, because this lack of operators that stop the production are caused by the lack of setup specialists who work in setups and complicated adjustments, that simply will not exist in the new scenario.

Since the setup adjustments of the tip, channel and form will be of one minute, the adjustments during the production will be at most 1 minute, because setup is the most complicated adjustment. So it will be considered that the adjustments of the tip, channel and form during long breakdowns (availability) or short breakdowns (production efficiency) will also be of 0%.

Applying this vision of future (fig. 3), an increase of OEE of 50,4% is obtained, that means that it is possible to eliminate a shift, so it is possible to transfer all the operators of one shit and all the setup specialists of the three shifts to other activities. In this case this would mean the transference of 25 operators, or the saving of approximately 250,000 US$/year.

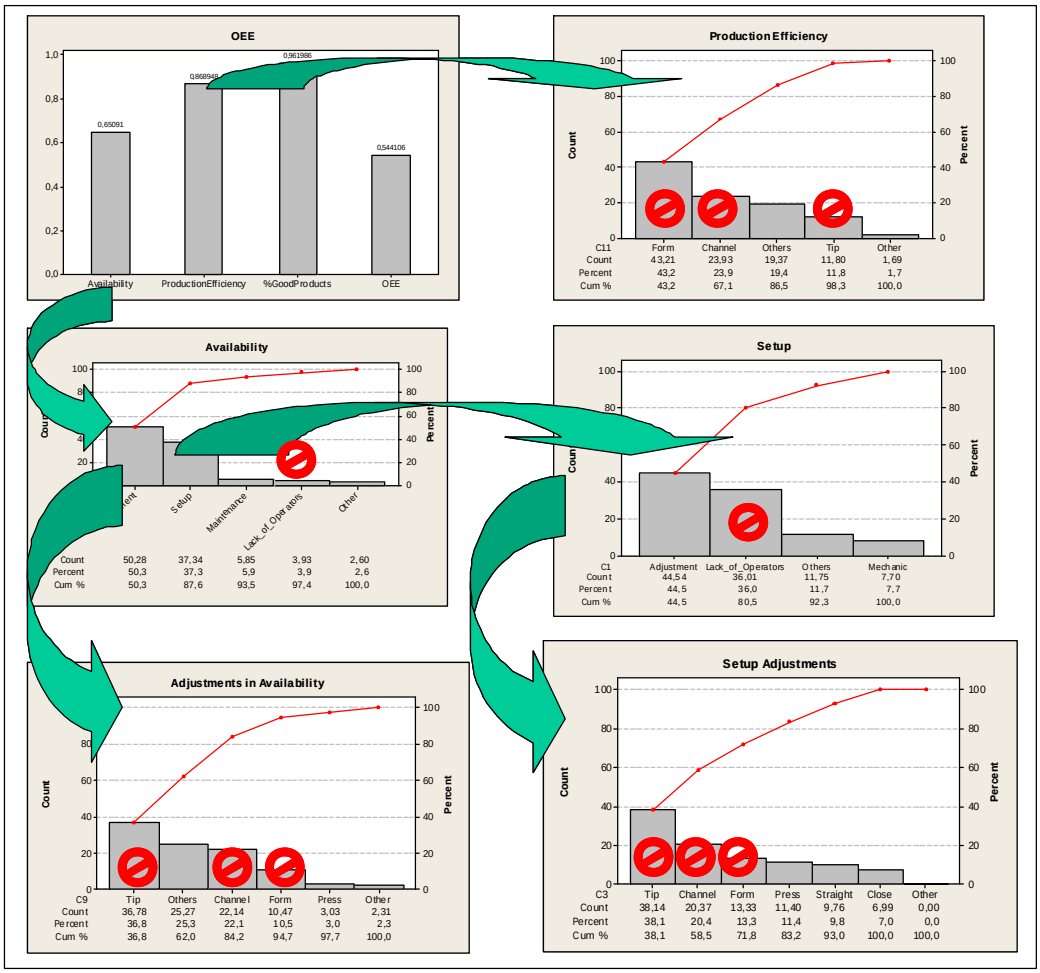

Figure 3. Scenario of the future .

6. Discussion

In order to have a program of setup reduction it is necessary a economic justification. In this work a methodology was presented that calculates the gains of setup reduction considering that the technological improvements implemented to reduce the setup will affect the downtime apart from setup and also will change the necessity of operator skills (it will not be necessary setup specialists). That means that it was used a methodology that creates a new scenery.

The methodology of scenery construction showed to be a very useful tool, through it we can see a situation where the OEE would increase 50.4% generating a gain of US$ 250.000,00/year .

It is interesting to observe that if a new scenery was not created and if we analyzed the impact on OEE only of reductions of adjustments inside setup, we would have a total different situation. The elimination of the adjustments of the tip, channel and form, inside setup, would generate an increase in OEE of only 6.4% and with this increase it would not be possible to imagine the transference of workmanship, that means, we would not have gains and so we would not have justification to ask for investments to develop and to implement new technologies.

We must remember, that in the present article, the scenery for the new situation still is not complete. It was not shown the impact on the inventory, on the reduction of the price, on the increase of flexibility and consequently on the increase of sales.

7. Conclusion

A very important tool to construct the future scenery was the use of stratifications gotten in the index OEE.

The construction of a scenery that considers the impact of improvements in the setup on other activities showed to be a tool necessary to get a economic reason to implement a project of setup improvement.

The future scenery not only showed "the reason" to improve (economy of US$250.000/year), but also defined the goals for the setup reduction : setup of tip, channel and form each one of one minute.

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9. Responsibility notice

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