Change Over Time Reduction Using SMED: An Industrial Case Study

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Abstract—In this era of globalization, the market condition changes by every second, to stay and compete in such market condition it is essential for the manufactures to find a way to reduce the production runtime and cost as low as possible. In this global industry, there are various tools available for reduction in setup time. Single minute exchange of die (SMED) is one technique that helps us to reduce the setup time by segregating internal and external activities with greater flexibility.

In this study, a press shop which uses different types of presses for the production of chassis, which requires setup time reduction and improvement in the overall process. The main objective is to reduce the set up time so as to increase the productivity.

Index Terms—External Activities, Internal Activities, Set up time reduction, SMED (Single Minute Exchange of Dies)

1. INTRODUCTION

The scenario of the present production system involves a high variety and low production of parts that too in batch production. However, this type of production tends to increase setup time thus by reducing the productivity. To overcome such type of situation lean manufacturing plays an important role. Nowadays manufacturing companies are adopting lean manufacturing techniques because it is capable of satisfying customer's demand with less change over time, thus by increasing the productivity with greater flexibility. Quick changeover time is also referred as setup time which mainly focuses on elimination of non-value added activities from the process, so as to change the tool/die easily.

KLT Automotive & Tubular product Ltd (KLT) is a Flagship Company of KLT group. It is located at Palghar in Mumbai, Maharashtra. It requires lean manufacturing in press shop in order to reduce the lead time during operating hours. Using SMED technique can bring a lot of change in overall process and increase in productivity.

Changeover time is the total elapsed time between the last unit of good production of the previous run, to the first unit of good production of the succeeding run.

Single minute exchange of die (SMED) is a lean manufacturing technique introduced by Shiego Shingo that emphasizes on reducing the setup to less than 10 minutes or more specifically in a single digit time. SMED provides greater flexibility in die changing, by reducing changeover time. This is achieved by separation of internal and external activities. It involves analyzing all activities performed during changeover so that non-value added activity can be eliminated or can be converted into external activity.

Internal activity is an activity which is performed after the machine is stopped.

External activity is an activity which can be done without stopping the machine.

Non-value added activities are the activities whose removal will not affect the process as it generates zero or negative return on investment on resources.

SMED also focuses on standardization of each step and also checks for the scope of improvement for future purpose i.e. continuous improvement.

2. LITERATURE REVIEW

SMED is a lean manufacturing technique was developed by Shiego Shingo of Japan in 1985, so as to increase the overall productivity of the process when a smaller lot size is produced. The aim of the SMED is to reduce the setup time to a single digit minute, though every time it's not easy to achieve the same. It is a process based innovation technique that reduces the setup time by converting internal activities

into external activities. The productivity of the company can also be increased by elimination of waste. [8]

Arun Abraham, Ganapathi K.N and Kailash Motwani founded out that carrying out SMED on BMS machine reduces the setup time by 75%.This was achieved by identifying the bottleneck machines and elimination of non-value added activities from the process leading to great improvement in productivity.[3]

Pablo Guzmán Ferradás and Konstantinos Salonitis suggested a tailored SMED approach when they carried out the work in welding cell. This new tailored process is a inclusion of conventional SMED method with the implementation of Manufacturing Execution System (MES) for a better production system. On successful completion of the work, it was found that there was overall 33% reduction of change over time, while with the implementation of improved hardware system more than 35% can be achieved. [5]

Vipin Kumar and Amit Bajaj implemented their project work at Gill Agro-Industry. Their work includes SMED with 5'S machining process for the reduction in setup time for three mechanical press machines. After completion, they found that on the implementation of SMED, they were able to reduce setup time from 265 minutes to 169 minutes. [6]

SMED is one of the ideal methods to strengthen the output and minimize the quality loss in any manufacturing process as said by Prof. Nagaraj A Raikar. He carried out his project of reducing cycle time by using SMED technique in an automotive industry and as a result, he managed to reduce the overall changeover time by 24.5% thus by increasing the productivity. Also, great results can be achieved by proper planning, better coordination between team members and a slight modification in process. [7]

3. Problem Definition

In the process of chassis manufacturing at KLT Automotive & Tubular product Ltd, it was observed that the die setup time of the presses was not as per the expectation of press shop department of KLT, there was a delay of about 1.5-2.5 minutes for Average Die setup time. This was result of the decreased stroke per minutes (SPM) of the presses in the press shop.

4 Methodology

The proposed SMED methodology is based on McIntosh et al overall, methodology for changeover improvements and Shingo's methodology. It consists of four stages:

Stage 1: Understanding the current process

- During this stage, all the activities were observed at the place of work and also video recording of the same was done for future purpose.
- Reviewed literature on SMED which includes journal, technical paper, etc. to understand the process in a better way.
- In this stage no effort is invested in differentiating external and internal setup, so external setup is often performed while the machine is stopped.

Stage 2: Separation of internal and external activities

- We defined setup time as the total elapsed time between the last unit of good production of the previous run, to the first unit of good production of the succeeding run.
- It becomes clear now that setup time cannot be less than the internal setup, and should not be more than the internal setup.
- Therefore, care should be taken to perform all external setup while the machine is running (either before or after the changeover).

Stage 3: Conversion of internal activities into external activities

In this stage, two significant methods are involved:

- Detailed analysis of internal activities to determine the flaws in the operation.
- Once no external setups are performed while the machine is waiting, a good way to reduce the setup further is to analyze the internal setup carefully and see which activities can be transformed into the external setup.

Stage 4: Streamlining of all the operations

- This process basically emphasizes on optimizing all the activities with the help of above three stages.
- Streamlining of the operations is necessary in order to reduce internal work time and to improve the productivity of the desired operation.

Also, the third and fourth stage can actually be done in parallel. That is, it is not necessary to transform internal setup to external setup before streamlining some setup activities. Nevertheless, the conceptual order implied by the stages as

presented above is good. First, shift as much work to times when the machine is running (stages 2 and 3), then, when we have a more rational process, we can concentrate on detailed small improvements.

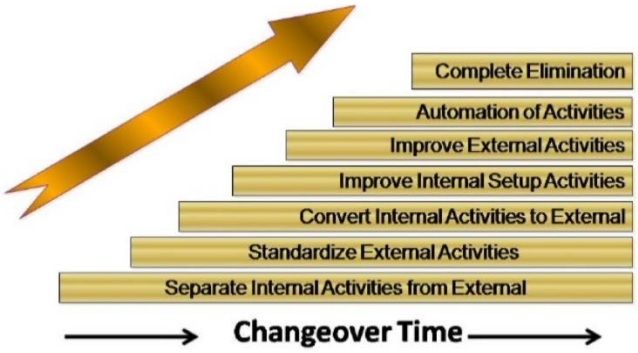

Fig.1

5. Data Collection and Analysis

As per the data collected from the planning department of KLT Automotive and Tubular Products Ltd. regarding the presses available, their capability and different operations being performed on them, Detailed analysis of the press shop carried out at different stages enabled us to:-

- Identify the bottleneck machine,(i.e. TAPP01(250T) calculated in 5.4)
- Detailed time study and attributes contributing for setup
- Selection of major areas of focus

Further detailed study for press TAPP01 250T is carried out :-

5.1 Tool Set Up Details of Press Machine

The table 1 shows the data of the different activities during set up and their average time in minutes respectively. The table also shows the steps that can be converted from internal activities to externals, and are marked as green.

The process analysis shows that around 11 mins. of Die setup time can be saved if properly planned setup is executed. It should also be noted that maximum time is taken for Die positioning and clamping.

Different steps involved Die setup	Past	Planned	Current all activities Internal (in minimum mins)
Die Dismantling time	I	I	4
Trolley Levelling	I	E	1
Loading of Die on trolley from the press bed	I	I	3.5
Die bringing time from Die-shop	I	E	5
Loading of Die From Crane to trolley bed	I	E	5
Fitting time	I	I	9
Clamping time	I	I	8
	Total Time		35.5

Table 1

5.2 Externalizing Internal Activities

The conversion of Internal to External Activities could save up to 11 minutes in Die setup time. The resultant graph is shown in Fig.2

The Fig.2. indicates that there would be decrease in the die-setup time, and time saved will be as high as 31% approximately.

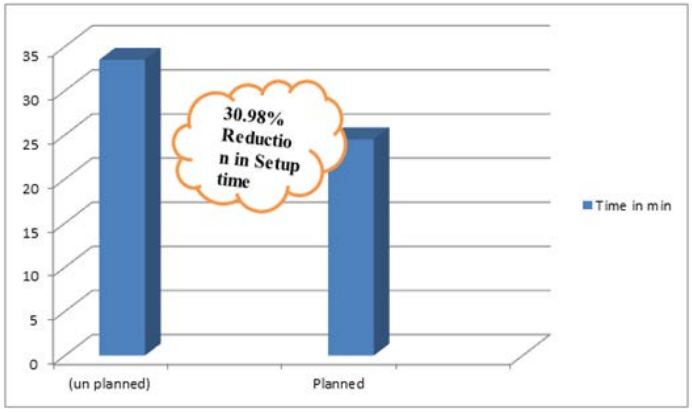

Fig.2

The external activities have to be standardized and implemented properly to get effective results. This can be achieved by providing proper training to the workers and implementing 5S on shop floor

5.3 Improve Internal Activity

To improve the Internal activities firstly cause of delay has to be known. To find out the possible causes which were leading to the inefficiency of internal activities a Fish Bone diagram is plotted. The figure 3 shows the cause and effect diagram.

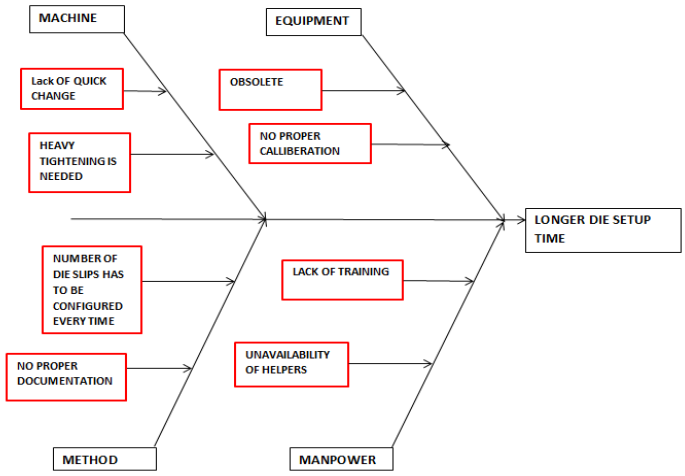

Fig.3

It should be noted that the Die fitting time for Die can be reduced significantly from 9 minutes if the slip blocks(used for adjusting the Shut Height) for individual dies are proper documented and kept.

Fig.4

5.4 Calculation

Bottleneck machine is identified by calculating the SPM of all the machines. The formula for SPM (excluding the human interference and human factor for performing a given operation) is :

$$SPM = \frac{(TOTAL\ NUMBER\ OF\ STROKES\ IN\ A\ SHIFT)}{(TOTAL\ WORKING\ HOURS\ IN\ A\ DAY)}$$

The table 2 shown below contains total number of strokes in a day including both the shifts for 7 different days:

Machines	Total strokes in day1	Total strokes in day2	Total strokes in day3	Total strokes in day4	Total strokes in day5	Total strokes in day6	Total strokes in day7
TAPP01	2101	2213	2390	2285	2575	1287	2213
TAPP02	3024	2825	3075	2469	3727	2379	1885
TAPP04	4137	2953	4108	3791	3692	3002	3001
TAPP05	2282	3367	5968	4115	3338	3385	3508

Table 2

SPM with the help of above data and formulae is calculated and tabulated in table 3 :

M/C / Days	TAPP01	TAPP02	TAPP04	TAPP05
1	2.1885	3.15	4.30	2.377
2	2.31	1.9	3.07	3.509
3	2.49	3.203	4.27	6.235
4	2.38	2.57	3.94	4.28
5	2.68	3.98	3.84	3.477
6	1.34	2.47	3.13	3.53
7	1.67	3.49	4.79	5.05
Average for seven days	2.15	2.97	3.9	4.07

Table 3

With the help of the above calculation for different machines are calculated and it is found that the SPM is lowest for M/C 1 i.e. TAPP01 250T.

Fig.5

6 Conclusion

As a result of implementing SMED the Die change time has been reduced from 35.5 minutes to 24.5 minutes in overall. 45% of updated Die change time is saved by classifying processes as shown in table1 above.

Implementing Lean principles in any process will bring huge results to organizations. This study has proved that eliminating Non Value Adding in any process can bring huge results. The payback achieved in this study indicates that if the lean concepts area horizontally organized in all departments they would generate very significant organizational benefits. As a result of this project, the Strokes per minute of the overall shop must increase thus increasing the production capacity of presses.

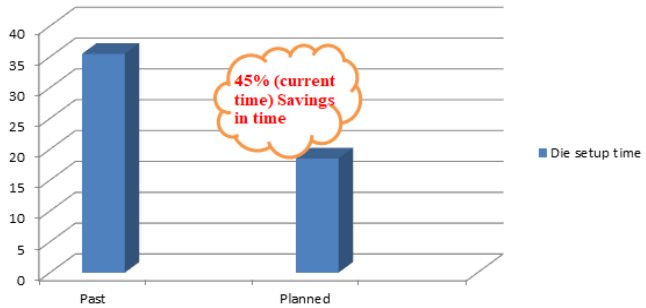

Fig. 6 : Graph showing total time saved

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