Reduction in Setup Time by SMED Methodology: An Industrial Case Study

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Abstract - *Machining operations play a vital role in giving the cast components accurate dimensions, profile, and surface finish to match the customer requirements. In the past few years due to technological advancement and industry 4.0 machine shops have tremendously developed and boomed in the manufacturing market. To have a stupendous outcome, Manufacturers need to attain optimum production time and cost. The major problem a manufacturer faces during the actual manufacturing process is the idle time, which further reflects the commitment of a manufacturer to his customers and also has a diminishing effect on the overall equipment efficiency of the assets. Idle time is not just a loss in the manufacturing time (run time) but also has a great impact on the cost of poor quality. Different types of idle conditions that sum up the total idle time are No load, quality problem, Machine Breakdown, less work, Tool change & Tool problem, Power off, Inspection, setting, and no operator. This paper presents the analysis of idle time data especially focused on setting idle time over a period, occurred in the machine shop. Detailed analysis is done with help of the concepts like SMED, and 7Qc tools to reduce the setup time.*

***Key words**:* SMED, setup time, kaizen, lean, internal and external setting.

1.Introduction

India ranks third globally in the manufacturing sector [1] and fulfills major demand of market order. Due to market Competitiveness, many Manufacturing Organizations are doomed to produce and dispatch products in shorter delivery times. Many manufacturers produce a high variety of products that too in batch quantity. This leads to an increase in the setup time and reduces productivity. Setup time is a part of idle time which contributes to the non-value addition in the manufacturing process. To overcome such an uneconomical situation Manufacturing techniques capable of reducing setup time for change over time and thus increase productivity.

Following are important motives for reducing setup time

Flexibility: To be able to respond in no time to the market demand, so that one can be able to produce a small number of quantities in economic manner.

Bottleneck Capacities: Reducing setup time increases machine availability, which enables installing an extra shift in situations when the market demand rises. [2]

Cost Reduction: especially on idle time reduction, the manufacturing prices are directly associated with machine performance, increase in OEE (Overall Equipment Effectiveness) can indicate the effect of setup time moderation. [2]

2. SMED Literature

Setup time or setting time is defined as whenever there is a change in component type the first component of next batch needs to be setup which includes many activities like cleaning of bed, mounting of jig/fixtures, making fixture true, orientation and mounting of master job, measuring tool offset, checking of the program and finally inspection. So setting time can also be defined as the time required for setting up a new job on a machine after the completion of the last job of the current batch till the completion of a non-defective job from the next batch. [3] Setup time contributes to idle time which is controlled by SMED.

Due to production demand and increase in batch type production method which increases the setting time, SMED (Single-Minute Exchange of Die) a Lean manufacturing technique was developed by Japanese engineer Shigeo Shingo in 1985. [5] The technique helps to increase productivity by reducing the setup time to a single digit minute. 'Single digit minute' means the changeover process must be accomplished within less than 10 minutes, and this is achieved by converting internal settings to external settings followed by streamlining all the operations. [4] SMED is ideal for boosting the output by minimizing the setting time in the manufacturing process. This method can be also used in other applications and different purposes.

- Internal setting - Setting that can be done only when the spindle is off or the Process has stopped.
- External settings - Settings that can be done when the spindle is on or operations are going on.

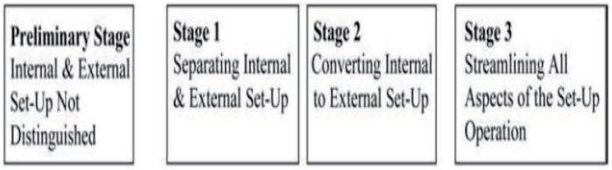

Figure 1 – SMED process mapping

3. Problem definition

MMPL industry produces a variety of automobile, transmission, agro-based components, and machining of these components is done at their machine shop. Through observations, it was found that the machine shop needed a lean change especially regarding the setup time which was far greater than the expected setup time. This case study contains a detailed analysis of setting time occurring at the machine floor and taking required action to gain control over the setting time.

4. Methodology

4.1 Stage 1 – Study of the current process.

The machine shop contains a total of 21 machines which are CNC turning, VMC, and HMC. These machines are marked as assets and are numbered. As per the availability of raw material, schedule, and type of operation being performed the casted components are setup. During the setting operation, keen observations were made of the various setting activities and video recording was also taken. The initial study helped in gathering information such as:- The timings of the different activities and operations; The organization of workers during the setting process; The identification of critical points that reduce the effectiveness and increase time for the setting, as well as its causes.[5] A setting operation is not complete unless and until the 1st component is ok in the inspection process.

4.2 Stage 2 - Identifying target for SMED application

Among the present 10 VMC machines in the machine shop, a single machine is selected for the SMED application. For this following steps were followed.

1. Collection of 2 months (February & March) idle time data from the system.
2. Arranging the collected data in a flexible manner in sheets so as to carry analysis efficiently.
3. Identifying a particular machine that contributes the most to the setting idle time by plotting graphs.

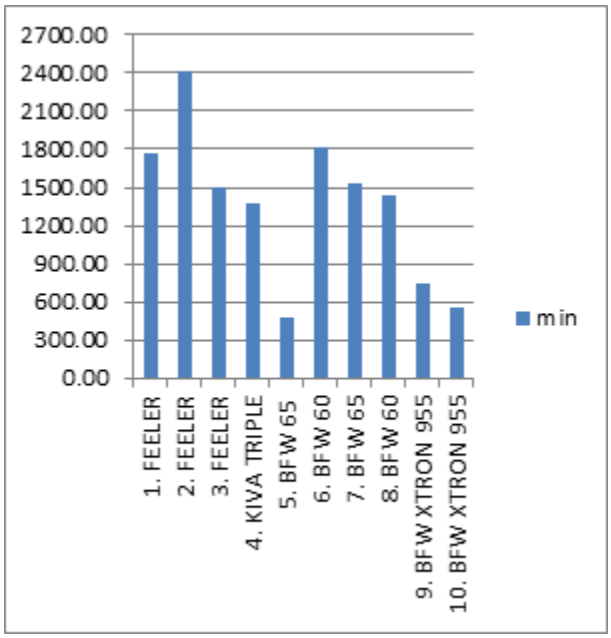

Chart -1: setting time distribution

Above graph explains that machine no. 2 is the topmost contributor of change over time i.e. 2409min

4.3 Stage 3 – change overtime data analysis.

For further analysis among the various components machined on machine no. 2 one critical component is selected. The data led to segregating various setting activities.

Table -1: setting activities

activity	description	Tools required	Time (sec)
1	Cleaning of the bed	Pneumatic blower	50
2	Mounting and clamping of fixture	Fasteners, spanners	70
3	Checking the orientation and making fixture true	Manual	480
4	Mounting and clamping of master job	spanner	40
5	Checking tool offsets	Tool presetter	450
6	Tool clamping	manual	70
7	Offset insertion	manual	430
8	machining		390
9	Unload the Component from Machine	Spanner/Jack	40
10	Blow air for a Chip removal	Pneumatic Blower	8

From the above mention data, we can observe that the total setting process has taken 2028sec i.e.33 minutes & 48 sec

In the above-mentioned activities, some of the activities are required to perform again until the component does not appear OK in the inspection process. Also, the next component cannot be operated for the machining process until getting a green signal from the inspection team.

Sorting of Internal activities and External activities.

Table - 2: segregation of activities

activity	description	Type	Time (sec)
1	Cleaning of the bed	Internal	50
2	Mounting and clamping of fixture	Internal	70
3	Checking the orientation and making fixture true	Internal	480
4	Mounting and clamping of master job	Internal	40
5	Checking tool offsets	Internal	450
6	Tool clamping	Internal	70
7	Offset insertion	Internal	430
8	machining	External	390
9	Unload the Component from Machine	Internal	40
10	Blow air for a Chip removal	Internal	8

4.4 Stage 4 - Transformation of internal activities into external activities.

Converting internal activities to external helps crucially to reduce the setup time by a massive percentage. This can be done by modifying tasks without changing their function related to material handling, information gathering, adjustment, and control.

After the application of SMED to the setting activities and converting a few of them from internal to external category total time of setting operation is decreased by 28.9 percent. Initially, the time was 2028 sec and after SMED the time is 1443sec.

Changes done in activity no 4. Is proper organization of tools, hardware, fasteners, etc. so that the operator doesn't spend lots of time searching for setup hardware and other tools. All the tools and required hardware must be arranged in proper fashion so that all of these become available and handy in a short time and within less movement.

Changes done in activity no 5. Is allocating a person to do the task of tool presetting by collecting tools required for machining through the study of drawings and provide necessary information to the operator so it becomes easy for him while working over the part program.

For activities, no 9 & 10 changes cannot be done because the operator needs to wait till the inspection of the machined component is done. Once the component is machined as per tolerance then another pallet can be used for the 9th & 10th activity which will further reduce the cycle time.

Table - 3: Converting Internal to External Activity.

Activity	Description	Before SMED	Improvement idea	After SMED	Time saved
1	Cleaning of the bed	50	Pallet change	0	50
2	Mounting and clamping of fixture	70	Pallet change	0	70
3	Checking the orientation and making fixture true	480	No change	480	0
4	Mounting and clamping of master job	40	Kaizen	25	15
5	Checking tool offsets	450	Kaizen	0	450
6	Tool clamping	70	No change	70	0
7	Offset insertion	430	No change	430	0
8	machining	390	No change	390	0
9	Unload the Component from Machine	40	No change	40	0
10	Blow air for a Chip removal	8	no change	8	0
		2028		1443	585

5. Conclusion

Lean philosophy helps in identifying the root causes of problems that occurred and with help of its methodology's problems can be tackled. For small batch production, the SMED principle brings a huge change to an organization. SMED simply eliminates the non-value adding activities in a procedure. In this case study, the SMED method was implemented at a company with a high number of different manufacturing products. Data was taken od the entire 2 months and its explicit analysis has shown a remarkable change in reducing the setup time by 28.9 percent. By eliminating the waste in the entire process productivity improves and the cost of poor quality reduces.

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