Setup Time Reduction through SMED Technique in a Stamping Production Line

Arun Abraham[1], Ganapathi K. N.[2], Kailash Motwani[3]
1- M.Sc. [Engg.] Student, 2-Asst.Professor,
Dept. of Mechanical and Manufacturing Engineering, MSRSAS, Bangalore -560 058
3-General Manager Operations

Abstract

The competition in the current business world is marked by intense agitation and severe contention. This agitated situation has made organisations to revitalize themselves by marching in different routes like Agile, Lean, TPM, TQM etc to keep them competitive in the market as well to accomplish their objectives positively. Now a day's most of the organisations have taken the established route – Lean to crush the competition. This condition has improved the lean management strategies like, improving the value stream, reduce the change over times, creating flow in manufacturing, levelling the production based on demand; reducing capital investment etc. This concept has provided the organizations a major source of competitive advantage. The utilization of the source is mainly due to the capability of the organisation to change and manage the change.

In this study, a press shop which is used BMS press for the production of Hose clamps, which required set up time reduction and need to improve the productivity had been taken for project. The main objective is to reduce the set up time from 7 hours to 2 hours and improve the productivity. The objective needs to be achieved with no investment or with very minimum investment because investment plays a vital role at the growth stage of the product life cycle. The scope includes the BMS press the proposed implementation of new Toggle clamps, new "ZF" assembly, new camera mounting, SOP, etc. A seven step methodology used for set up time reduction to attain the objectives of the project.

The main results attained from the study are Tool change time had been reduced from 7 hours to 2 hours. This leads to the productivity improvement of the BMS machine, which can make 105000 clamps / day were before it was 60000 clamps /day. We conclude that modifying the existing practices has resulted in significant NVA elimination.

Key Words: Set –Up Time Reduction, SMED, 5S, SOP, NVA Elimination.

Abbreviations

CAD	Computer Aided Design
MNC	Multi National Company
NVA	Non Value Adding Activity
OEE	Overall Equipment Efficiency
QC F	Quick Change Fixture
SMED	Single Minute Exchange of Dies
SOP	Standard Operating Procedure.

1. INTRODUCTION

The present manufacturing scenario demands low quantity and high variety parts. This can be achieved only through lean manufacturing. The present production system likeJust-in-Time manufacturing demands smaller production quantities which in turn mean more setup times (non-productive time). Companies should focus on reducing non-productive time in order to remain competitive. Thus quick change over is a critical element in lean manufacturing. Quick changeover is also known as setup reduction which focuses on eliminating or reducing non value added activities during the setup. This helps companies to efficiently change the tool/mould from one part to another.

Changeover time is referred to as the total time required for change from one product to the second product. As shown in figure 1, total change over time is considered as lost production which includes ramp-down time, setup time and ramp-up time.

Ramp down time Run down period is the time between the end of a batch production till the lot quantity is completed.

Setup Time Setup time is the non production time in which change over takes from one part to another.

Ramp uptime The time between setup is completed and the full production is achieved.

Single Minute Exchange of Die (SMED) emphasises on setup time reduction to single minute. The need of SMED is mandatory due to increased demand for variable products and reduced product life cycles. It helps the company to keep reduced inventory and effective utilisation of the equipment. SMED analysis has to be started up with detailed process map and time study. It needs analysing everything that happens during the changeover to understand the possibilities of activities that can be moved outside the changeover window. Non value added activities has to be eliminated or to be converted to external. If an internal activity is inevitable, it has to be simplified with the help of jigs, fixtures etc. Implementation of SMED starts from identifying the change over process and sorting it into internal and external activity.

Internal activity Activities that are done after stopping the machine.

External activity Operations that can be done without stopping the machine.

Internal activities have to be converted to external wherever possible. Then focus should be on optimising external activities. Maintaining of 5S is important at

each level of implementation. At each stage of advancement, the process has to be standardized and again scope of improvement has to be analysed and implemented focusing on continuous improvement. With the help of continuous improvement, the total changeover has to be brought down to single minute, ie aim of SMED.

1.1 Place of Work

Oetiker is an Automobile Clamp manufacturing company. It is a Switzerland based MNC Company, which has production units in India, China, Switzerland, Germany, Spain, Canada, and America.

2. PROBLEM DEFENITION

Aim is to reduce changeover time from ***7 Hours to 2 Hours*** through SMED Technique in a Stamping Production Line. To review the literature on SMED, lean concepts, Stamping Process.

- To study the existing procedure and manufacturing lead time and collect the data.
- To categorize the internal and external activities and to convert the internal to external where ever possible.
- To implement system for safety and serene work place.
- To develop a new change over system.
- To implement the new change over system and validate the same.

3. METHODOLOGY

- Reviewed Literature about SMED and lean principles by referring books, journals and manuals.
- A detailed study of the operations and existing changeover procedure done by video recording.
- Conversion of internal activity to external is carried out by ensuring availability of tools, fixture.
- Implemented 5 S systems for safety and serene workplace.
- Feasibility study done for the type of Quick Clamping Fixture to be used with respect to the machine clamping facility.
- Designed quick clamping fixtures for Stamping Tool with respect to the machines they are loaded.
- Standardized the stamping tool shut height with respect to the machines they are loaded.
- Implemented proposed solutions and validated new change over system.

4. DATA COLLECTION & ANALYSIS

The data has been collected from the planning department of the Oetiker India Pvt Ltd. The production schedule for the last three months has been analyzed. The analysis showed that BMS machines setting were the bottle neck in the company. Setup process is thoroughly evaluated on the BMS machine. It is found that there are several non value added activities happening during the setup process. The company is more into agile manufacturing and it needs varieties of tool changes. The less time in tool change will improve the productivity of the company. Tools used for setup time reduction are SMED, Quick Clamping Fixture design, 5S, SOP, Poka-Yoke etc.

Analysis is carried out by various stages such as

- Identification of the bottleneck machine.
- Detailed time study and attributes contributing for setup.
- Selection of major areas of focus.
- Analysing and developing the new model.
- Planning & Implementing.
- Results and validation.

4.1 Time Study

The figure 1 graph shows the analysis of average tool change time taken on BMS machine from January -11 to September-11. The data shows an average tool change times as 7 hours

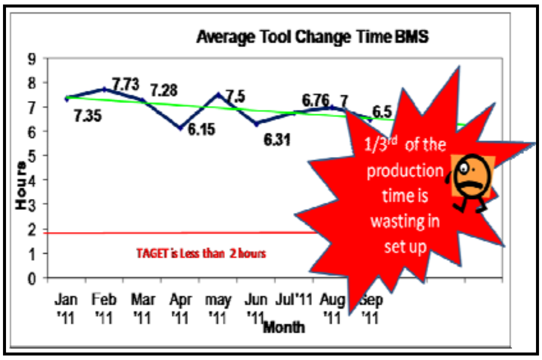

Fig. 8 Time study

4.2 Different Tool Set up Details of BMS Machine

Table 1 shows the different tool set up time required for various stage on the machines. The table helps to find out the time taken in different clamps setting. All the operation done here was internal only. So the set up time exceeds 6.5 hours to 7 hours. Also the maximum time consuming while set up was the *Rounding Tool* setting.

4.2.1 Inference from Table 1

Table. 6 bottle neck identification BMS machine setting

Description	Present	Current Activities is Internal([illegible] setting)	Current All Activities is Internal([illegible] Setting)	Current All Activities is Internal([illegible] Setting)	Current All Activities is Internal([illegible] Setting)	Average (All in Minutes)
Spool Change	I	[illegible]	32	[illegible]	[illegible]	[illegible]
Unload the old spool	I	17	[illegible]	[illegible]	[illegible]	[illegible]
Return the old spool	I	32	27	[illegible]	22	[illegible]
Tool Transport time till Maintenance room	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Removal of last tool from the machine	I	27	[illegible]	[illegible]	[illegible]	[illegible]
L2 setting	I	[illegible]	[illegible]	[illegible]	22	[illegible]
Bar tool setting	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rounding tool setting	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Camera setting	I	25	[illegible]	[illegible]	[illegible]	[illegible]
FIR	I	[illegible]	25	[illegible]	[illegible]	[illegible]
Parallel Block Installation	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Documentation	I	[illegible]	25	[illegible]	[illegible]	[illegible]
Total		357	401	411	[illegible]	[illegible]

- Average time take for setting is about 6.5hours.

- Maximum time taken set up was Rounding Tool Setting which is 1.2hours.

4.3 Bottleneck Identification

The collected detailed times are analyzed for finding out the bottleneck process while setting which is shown on below figure 2.

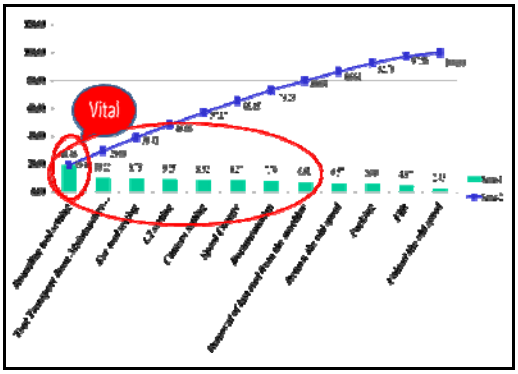

Fig. 9 Pareto analysis to identify bottleneck setting

4.3.1 Inference from the Pareto chart.

- In the overall loss, 20% of loss is contributed by Rounding Tool setting.
- Tool Transportation from maintenance contributed 10% of the overall loss.
- On an average 76 minutes is lost only for Rounding tool setting.
- The scope for reducing the overall setting time is very high.

4.4 Identification of Internal and External Activities

The table 1 shows the data of the different activities during set up. The table also shows the areas can covert internal activities to externals. The company was doing all activities as internal

4.4.1 Inference from Table 2

- All activities were doing under Internal activity.
- The tool change is taking on an average of 6 to 7 hours.
- Tool transportation from maintenances takes more than 43 minutes which is an external activity, but company was doing this action as an internal activity.

Table. 7 Internal and external activities

Description	Past	Planned	Current All Activities is Internal (in Mins)
Spool Change	**I**	E	**30**
Unload the old spool	**I**	I	**15**
Return the old spool	**I**	E	**27**
Tool Transport from Maintenance room	**I**	E	**43**
Removal of last tool from the machine	**I**	I	**28**
L2 setting	**I**	I	**35**
Ear tool setting	**I**	I	**35**
Rounding tool setting	**I**	I	**76**
Camera setting	**I**	I	**32**
FIR	**I**	I	**26**
Parallel Block Installation	**I**	E	**23**
Documentation	**I**	E	**29**
	Total		**399**

4.5 Observations

The above data collections shows that maximum time taken in set up is because of not converting internal activities to externals. Also in internal set up maximum time is taken for rounding tool setting.

5. PROBLEM SOLVING

5.1 Right Strategy and Methodology for Right Solution

The success of any study or a study lies on the proper selection of an appropriate strategy and right methodology. Also it is essential to have a systematic procedure to approach the problem. The right approach towards the problem will increase the confidence level of the organization. Without one, the solutions may be ineffective and may lead to some painful consequences.

Single-minute exchange of dies (SMED) is one of the very important lean tools which require committed effort. For this activity a Cross Functional Team created, which includes Production, Design, Quality and Maintenance departments. This team helped to brainstorm the problems and helped to reduce the Setup time A Seven step methodology is adopted for successful implementation of SMED as shown in Figure 3.

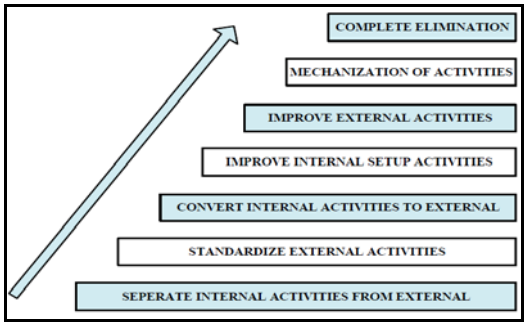

Fig. 3 Seven step methodology for set up time reduction

5.2 Separate Internal and External Activities

This step helped to identify, all the activities that can be externalized from the whole existing activities. Prior to this separation all the activities are done as internal activities. Table 3 shows the activities which had been identified for externalizing. The activities identified for internal are marked as I and for externalizing as E.

Table. 3 Activities need be externalized

Description	Before	Planned	Internal (in Mins)
Spool Change	I	E	30
Unload the old spool	I	I	15
Return the old spool	I	E	27
Tool Transport from Maintenance room	I	E	43
Removal of tool from the machine	I	I	28
L2 setting	I	I	35
Ear tool setting	I	I	35
Rounding tool setting	I	I	76
Camera setting	I	I	32
FIR	I	I	26
Parallel Block Installation	I	E	23
Documentation	I	E	29
Total Time			399

5.3 Externalizing Internal Activities

In this step the activities which needed to be converting to external had been converted. This could save 152 minutes of setup. The result of this step the tool change time is reduced and the result graph is shown in figure 4.

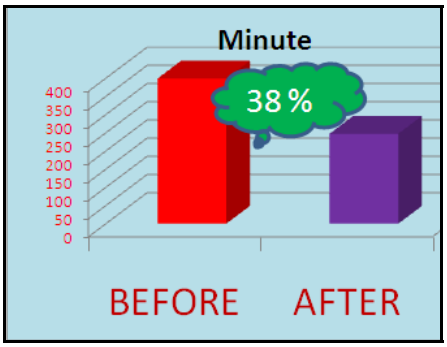

Fig. 4 Graph shows time saving after externalizing

5.4 Improve External Activities

The external activities had been standardized and improved after separated from the internal activities. The separation of internal activities from externals has been done by giving training to the employees. Also improve the activities by implementing 5S which shows in figure 6. The figure 5 shows the implementation of SMED Trolley near to the BMS-machines.

Fig. 5 SMED trolley

Fig. 6 Implementation of 5 S.

5.5 Improve Internal Activity

The externalizing of the activities finished, the remaining part is the internal activities. This has to be focused and the efficiency of the internal activities has to be improved to further reduce the tool set up time. To find out the possible causes which were leading to the inefficiency of internal activities a cause and effect diagram is plotted. The figure 7 shows the cause and effect diagram.

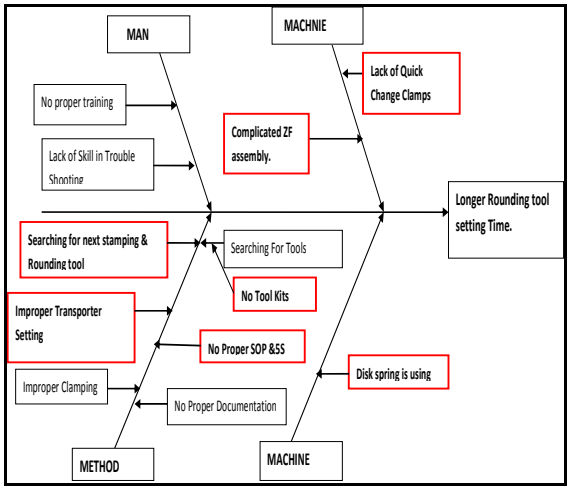

Fig. 7 Cause and effect diagram for inefficient internal activities

5.6 SMED Implementations

According to the outcome of Why- Why analysis actions were initiated to complete the SMED Improvements. In that a few significant improvements are explained by before and After Photographs .The design also shown below.

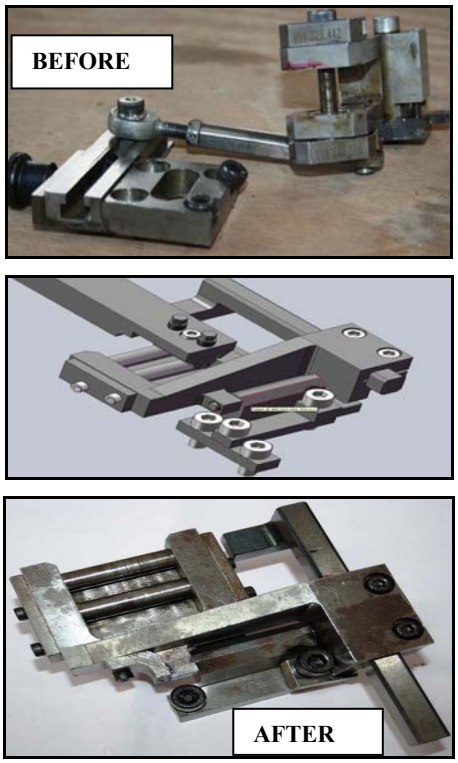

Fig. 8 New and old 'ZF' assembly

5.6.1 Benefits of new "ZF" from old "ZF" assembly

- Old "ZF" assembly which consumes 30-35 minutes of setting time
- New 'ZF' Assembly, this new system can set up within 15mints of internal setting time.

5.6.2 Benefits of toggle clamps versus fixed clamps

- The old clamping system need 6 clamps for fixing the tool on the machine.
- The new toggle clamps reduces this by 3 numbers.
- The old clamps required 15 minutes of internal setting time to clamp the tool.
- The new toggle needs only 5 minutes to clamp the tool.

Fig. 9 Improved clamping system using toggle clamps

5.6.3 Benefits of new camera mounting versus old clamping

- To remove Bolts and adjust the Camera takes more than 15 mins with old clamps.
- The new clamping system can finish the camera setting within 10 mins of Internal Setting time.
- The Measure that marks on the ruler is Reflected in the set-up sheet and position the camera-2 in each set-up.
- The levers position the Camera in few seconds without hand tools.

5.7 Implementation of Standard Operating Procedure

The table shows the standard operating procedure for the setting of feeder. The same format and SOP had been made for the setting of Transporter and the full setting of BMS machine. This helps the operator to work easily without making any mistakes.

5.8 Conclusion

The above implementations and improvements helped to improve the set up time of the BMS machine. The set up time of each setting drastically came down. The SOP and other newly implemented clamping systems helps to easier the working on machine. The newly implemented camera mounting helps the unskilled person also to set it. This also improves the morale of the employees.

6. RESULT AND DISCUSSIONS

6.1 Results-Tool Set up Time after SMED

The ultimate result of the study is to enhance the productivity. To support that some of the sub results also need to be addressed. The sub results are the results after SMED implementation. Let's have a look at the SMED results.

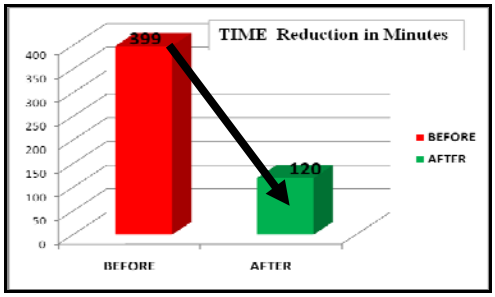

Fig. 10 Graph after implementation of SMED

As a result of implementing SMED the tool change time has been reduced from 7 hours to 2 hours in overall. 75% of tool change time reduction is achieved as shown in table.

6.2 Result- Capacity Improvement after SMED

After the implementation on SMED the productivity of the BMS machines had been increased. The graph shows the details. The capacity had been increased from 60000 thousand clamps per day to 105000 clamps per day in three shifts. This improves the outcome and turnover of the company. SMED implementation

reduced the setup time as well as the efficiency of the works.

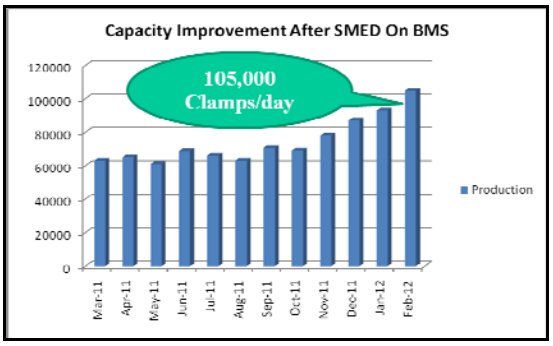

Fig. 11 Capacity after SMED

6.3 Benefits from the Study

This study has given enormous benefit to the organization, not only benefited in terms of capacity also in various measures such as productivity, quality, cost, morale and safety. The study also improves the attitude of the workers towards the Set up.

6.4 Validation of the Improvements

The key results had been validated. The graph shows the drastic reduction of tool change time in month wise after the implementation of SMED. The setting time reduced from ***7 hours to 2 hours***, with the help of several improvement tools and SMED methods and methodologies.

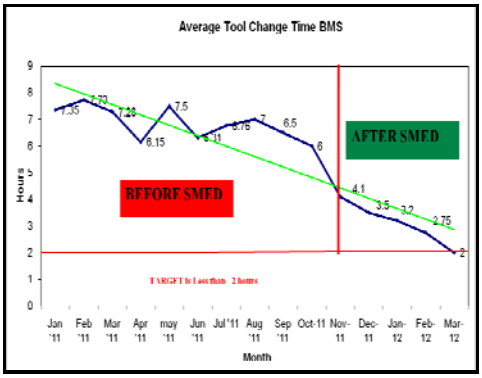

Fig. 12 Tool Change Graph after SMED implementation

7. CONCLUSIONS

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 organisational benefits. As a result of this project, the production capacity of BMS presses has been increased from 60,000 to 1,05,000 clamps/day. The Elimination waste in the entire operation improves productivity, reduces the cost which in turn delights customer and helps organizations in moving towards their vision and goals. We conclude that modifying the existing practices has resulted in significant NVA elimination.

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