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Improving Productivity using SMED

Prafulla C. Kulkarni, Gautam Lahiri

Abstract*: Single Minute exchange of Die is popularly known as SMED. The phrase is coined by Shigeo Shingo at Toyota Motors in sixties and used as a synonym for fast changeover of die. SMED was the result of a project that Toyota had assigned to Shigeo Shingo. It was realized that to succeed more than one model of car has to be made. Also it is realized that multiple car models meant multiple changeovers of stamping presses. Under this strategy, not more than 10 to 12 hour press changeovers. Shigeo Shingo had used standard industrial engineering techniques to analyze the changeover. These allowed Shigeo Shingo to reduce the typical press changeover from 12 hours to less than 10 minutes. The tools and techniques developed are widely known as SMED. This paper presents applications of similar SMED tools and techniques for improving productivity on 200 Ton press in an automotive component manufacturing industry. Overall productivity improved by 50% using some of the SMED tools and techniques.

Keywords: SMED, internal setup, external setup, value added activity, non-value added activity, total productive maintenance, total employee involvement.

I. INTRODUCTION

Measure of output from a production process, per unit of input is called as productivity. Labor productivity is typically measured as a ratio of output per labor-hour, an input. Thus productivity is conceived as a metric of efficiency of typical production system. In a high volume manufacturing, fast equipment setups play an important part in maximizing the capability of our equipment at the cost of productivity. The increasing product demands with shifting to daily scheduling sales order, it is expected that production line will be "jerked" to meet the needs of our customers. Single-minute exchange of die (SMED) application is necessary tool used for this purpose.

II. REVIEW: IMPORTANT CONCEPTS / TERMS

Single-Minute set-up is known as the SMED. The term refers to the theory and techniques for performing setup operations in less than ten minutes or a single digit. Although not every setup can literally be completed in single-digit minute, this is the goal of the system. Even where it cannot, reduction is still possible and results are tremendous improvement.

Die: Shigeo's first application of SMED was on the mechanical press equipment which composed of a die as the part which was being replaced during setup.

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***** Correspondence Author
Dr. Prafulla C. Kulkarni*, Principal, Gokhale Education Society's R. H. Sapat College of Engineering, Management Studies and Research, Nashik, India. Email: Prafulla_Kulkarni1@Hotmail.Com
Gautam Lahiri, Project engineer, TVS Motor Company Limited. Bangalore, India. Email: gautam.lahiri@rediffmail.com

In semiconductor equipment applications, "die" is defined as any part of the equipment which is being replaced when a new product will be processed on the same equipment. Some examples are die chase in mould, work holder in Lead bond, DUT board connecting testers and handlers.

Types of Setups: There are two types of setups considered in SMED namely, external and internal which are defined below:

1. External Setup - setup done while the machine is running, e.g., tools and dies preparation before setup or returning of tools and die after setup is done. Internal Setup - setup done while the machine is off, e.g., installation or replacement of new die.
2. SMED's Conceptual Stages: The theoretical approach to SMED was composed of three stages which serve as the guide/process on reducing setup time of particular equipment.

Table 1. SMED Conceptual Stages

Preliminary	Internal and External setup not differentiated
Stage 1	Separate Internal and External setup
Stage 2	Shift Internal setup to external Setup
Stage 3	Improve all elemental operations

A. METHODOLOGY

A. Study of previous work:

The paper titled "Changeover Improvement: Reinterpreting Shingo's SMED Methodology" by Richard McIntosh, Geraint Owen and Steve Culley and Tony Mileham is used as a reference paper. It brings out that a rapid changeover capability is widely acknowledged as an essential prerequisite to flexible, responsive small batch manufacturing. Its importance in mass customization is recognized, where minimal losses need to be incurred as manufacture switches between differing products. Retrospective improvement of existing changeover practice is often undertaken, arising from pressure to respond better to customer demands, wherein improvement personnel frequently engage Shigeo Shingo's Single Minute Exchange of Die (SMED) process.

B. SMED application:

Project is mainly engaged in manufacture of Fuel tank assembly, deep drawn sheet metal and tubular components along with welded subassemblies being supplied to all above OEMs.

C. Scope of project:

Quality performance of this company at customer end was less than 500 p.p.m. which was further strengthened by receipt of "Best Supplier" award. Also in-house quality management systems with sustained actions through QCC, TEI helped to maintain a reasonable good quality.

This company is ISO certified which makes it mandatory to get the quality system reviewed periodically. Since quality was not a major concern and losses on account on QCD was studied and found that majority of the sheet metal parts are formed on 200Ton press, productivity of this press was bottleneck to achieve delivery targets of every month. Last three months (June'09 ~ August'09) data was studied and it revealed that set-up changeover on 200ton press was one of the prime reasons for non-achievement of delivery. Hence focus of the project was on reducing setup changeover time on 200Ton press. Changeover was understood as the time elapsed between last OK components of previous setup to first OK components of next setup. Changeover plays a very important role in reducing the productivity of Press. During changeover both equipment and operator are occupied but there is no output. During this period Value added activity becomes near to zero. On an average 33 minutes were lost in each changeover which based on number of set-ups added up to 34.6hrs (Jun'09), 33.7hrs (July'09) & 30.75hrs (Aug'09). This project focused on reducing the die changeover time &not the reducing number of set-ups.

D. P-D-C-A (a TQM approach):

The project was designed on Plan-Do-Check-Act approach of TQM. Detailed activity plan follows. PDCA (plan–do–check–act) is an iterative four-step management process typically used in business. It is also known as the Deming circle/cycle/wheel, Shewhart cycle, control circle/cycle, or plan–do–study–act (PDSA).This terminology became very popular in Japan after devastation in Japan during World war when entire Japan's economy was coming up from zero. PDCA helps in systematic review and execution of a project.

B. PROJECT EXECUTION

A. Mapping Current Changeover process

For the project Video tape method and subsequently Chart analysis was used. Entire Video tape during setup change was studied and put on to Chart analysis table. During Chart Analysis each activity was noted with start and end time. The mapping gives output of entire setup changeover being disintegrated into activity. The activities are identified as operation, transport, storage, inspection and delay. The total setup changeover time was 30 min 38 seconds.

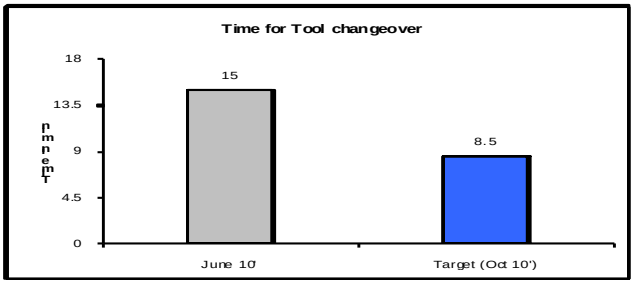

Figure 1: Setup changeover time reduction target

B. Identifying Internal and External Activity

Once Chart analysis is done all activities were classified as internal & external activities. Any activity which is calling for Press down is termed as internal activity. In this project all activities were internal activities suggesting that each will call for Press stoppage. The video analysis output is put into chart analysis. Thus Chart analysis gives image of what percentage of entire setup changeover activity is internal and balance as external.

The project was done on ECRSS methodology and videography was done for current changeover process and subsequently disintegrated into elemental activity.

Step 1: Observe the Current Practice of Tool Change activity.
Step 2: Study the Elemental Activities of Die Changeover.
Step 3: Separate the Internal and External Activities.
Step 4: Analysis using ECRSS Methodology.
Step 5: Externalizing internal activities.
Step 6: Make internal activities more efficient.

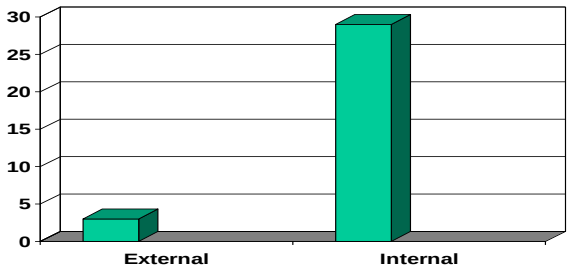

Figure 2. Distribution of External & Internal activity

Step1: Observation of current practice: Through video each activity was identified and description was made for each one of them. Totally 32 elemental activities were plotted for entire setup changeover.

Step2. Study the elemental internal activities of Die Changeover: In this step crucial internal activities were studied to ascertain work content in each of them.

Step3. Separate the Internal and External Activities.

All the 32 activities were further classified into External and internal activities with further defining each of internal activity as value added or non-value added activity.

Step4. Analysis using ECRSS Methodology: This methodology is used to identify each micro activity if it can be categorized under any one of these are eliminate (E), combine (C), rearrange (R), simplify (S) and standardize (S). By using ECRSS tool a total of 18 number of KAIZEN were identified.

Step5. Externalizing internal activities: For reducing setup time, internal activities which calls for downtime of hydraulic press were planned to convert into external activity.

Step6. Make internal activities more efficient: Improvements were initiated to alter fork length of die loader to reduce activity time.

C. Converting internal into external activity

This aids in reducing machine down time since any external activity can be done without stopping the machine/press. Out of the 9 activities identified, Activity no. 4 (die storage activity) was identified to be converted into external activity.

D. Simplify internal and external activity

All internal and external activity were studied and subsequently improved thru TEI Kaizen. In this project scope of Kaizen was limited to improvement in die setup changeover time reduction through Kaizen and total employee involvement. During this project all Kaizen activities which were directly and indirectly supporting in reducing changeover time were also considered and implemented.

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III. RESULT AND BENEFITS

In summary result of using SMED and subsequent Kaizen implementation program overall setup changeover time reduced by 45%. More than eight kaizen were identified and implemented. Total investment of Rs. 28000 was made. As a result of all the improvements setup changeover time reduced from 30.6 minutes to 16.8 minutes.

IV. DEPLOYMENT

Based on the learning, another improvement project was taken up in TVS Motor Company Ltd. It is located in Hosur (Tamilnadu), 40kms away from Bangalore.

A. Project Background

The improvement project was taken up in one of the plant (Plant2), where motorcycles are produced. The scope of work was limited to Press and forming shop where sheet metal is formed into fuel tank sub assembly parts. Analysis of demand against supply shows that 300T press is always a bottleneck in Press shop of Plant 2 for meeting market demand. Hence set-up changeover time reduction on 300 Tonne press was taken up as SMED project. Data collected showed that on an average 57 setup changeover were there in a month and on an average each setup change was taking 15 minutes. Total setup changeover loss was around 855 min/month.

B. Target and Methodology

In the project setup changeover time reduction target was taken to be reduced from 15 minutes (June'10) to 8.5 minutes (Oct'10).

C. Impact on Changeover time

Setup changeover time was reduced up to 11.5 minutes (23% improvement). Further few incomplete projects are targeted to be completed so as to achieve set-up changeover time in single digit.

D. Benefits

At TVS Motor Co. Ltd: Time saving (per month) = no. of setup change per month X reduction in setup time. = 57*(15-11.5) = 200 minutes/month; Tangible gain= Time saving/takt time * cost per stroke = 37000 Rs per annum; Manpower reduced from 3 to 2 during setup change.

Implementing SMED on 300T press has reduced setup time from 15 minutes to 11.5 minutes. Cost impact of this reduction is around Rs 37000 per annum. In addition to this there is manpower saving during setup changeover. At Precision Auto Industries: Monetary benefits: Cost/stroke- Rs 2.5; Number of strokes increased/setup change- 55; Number of setup changeover/month – 65(average of 3 months); Tangible benefit= 2.5x55x65= 9000/- per month. = 1.08 lacs/year; ROI (Return on investment) - 28000/9000= 3months approx.

All the 32 activities were further classified into External and internal activities with further defining each of internal activity as value added or non-value added activity.

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Minitab Software was used to interpret statistical evaluation the before and after data. First the Normality of data was checked (Figure no. 5). Set-up change data was plotted and Normality was checked. The normality (p) value was 0.025 which is less than 0.05. Hence the data is normal. This was followed by box plot to compare before and after situation. In box plot (Figure no. 6) barring one outlier of 41 minutes, mean lies around 32 minutes (Before SMED). In case of after implementation of SMED, mean improved to around 16 minutes (After SMED), which is around 45% improvement in setup changeover time. If we compare this improvement with results of other SMED projects, it is comparable. Improvement in productivity varies between 44% to 52% based on the initiatives implemented. This project could have yielded further 10 to 15% improvements in productivity with some improved tools.

V. CONCLUSIONS

The objective of the present study was to reduce loss of productivity during setup change over. These works includes various methods for capturing set up change over process and improve upon reducing it. First study of iimplementing SMED methodology at Precision Auto Industries could aid in reducing set-up changeover time from 31min (Before) to 16 min (After). There was a significant 45% reduction in set-up changeover time. This has increased the productivity by 55 units per set-up change. At TVS Motor company die setup changeover time was around 15 minutes before start of this project itself, hence further bringing it down was a challenge. In order to have better analysis of activity ECRS tool was used in this project. This project yield was 23% reduction in setup changeover time. Die changeover time reduced to 11.5 min thru SMED, Thus, SMED is very effective tool to improve productivity thereby improving delivery in any industry. Tools like Chart Analysis, ECRS are very effective in analyzing the activities involved for setup changeover.

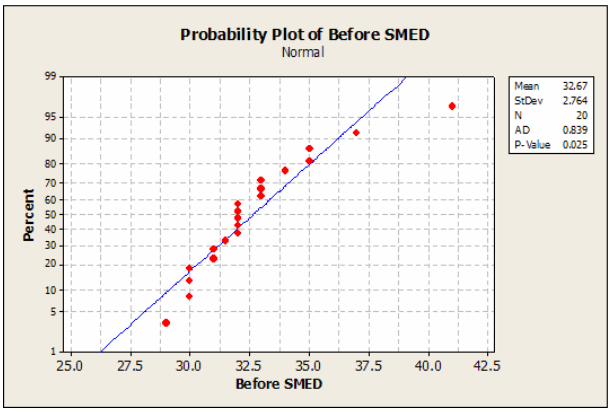

Figure 5. Normality check for setup changeover data

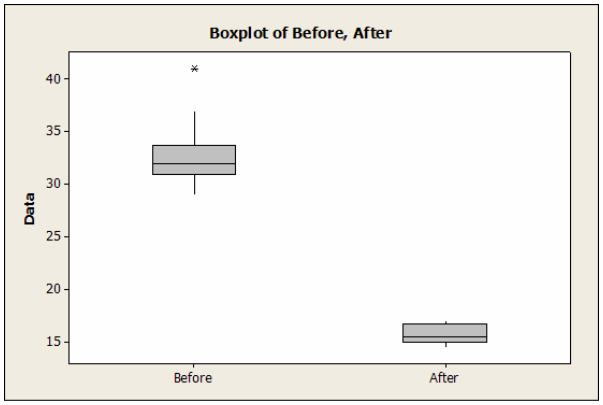

Figure 6. Box plot of setup changeover time before and after SMED

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This project was executed at M/S Precision Auto Industries, located at F143, MIDC, Ambad, Nashik. The company is a Tier-I supplier for major OEMs like Mahindra & Mahindra, MUSCO, Lear corporation and Force Motors. Apart from this activity, company is also exporting flywheel ring gears to European countries and is catering to the requirements of major four wheeler companies. The second phase was conducted at TVS Motor Company Ltd. It is located in Hosur (Tamil Nadu), 40 km. away from Bangalore. Authors are indebted to Owners for allowing & implementing the project.

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AUTHORS PROFILE

Dr. Prafulla C. Kulkarni, is working as a principal at Gokhale education society's R. H. Sapat College of Engineering, Management studies and Research, Nashik having 30 years of teaching experience in reputed engineering colleges and apt for Production engineering subjects.

Mr. Gautam Lahiri, is working as Project engineer at TVS Motor Company Ltd. Hosur, Near to Bangalore. Done this as part of project as an M. E. student in Production engineering. Previously worked at Mahindra & Mahindra Ltd. Nashik