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IMPROVING PRODUCTIVITY USING SMED

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ABSTRACT

Single Minute Exchange of Die is popularly known as SMED. It is a phrase coined by Shigeo Shingo at Toyota Motors in the 1960s and has come to be used as a synonym for fast changeover. SMED was the result of a project that Toyota had assigned to Shigeo Shingo. Toyota realized that they needed to make more than one model car to succeed. They also realized that multiple car models meant multiple changeovers of stamping presses. Under this strategy, they could no longer live with 10 to 12 hour press changeovers. Shingo used standard industrial engineering techniques to analyze the changeover. These and other techniques allowed Shigeo Shingo to reduce the typical press changeover from 10 to 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 in Nashik. Overall productivity improved by 50% using some of the SMED tools and techniques.

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

1. Introduction

Productivity is a measure of output from a production process, per unit of input. For example, labor productivity is typically measured as a ratio of output per labor-hour, an input. Productivity may be conceived as a metric of the technical or engineering efficiency of production. In a high volume manufacturing, fast equipment setups play an important part in maximizing the capability of our equipment. With the increasing product demands and shifting from weekly to daily scheduling sales order, it is expected that production line will be "jerked" to meet the needs of our customers. This is where single-minute exchange of die (SMED) application is necessary

2. SMED Concept

Single-Minute set-up is popularly known as the SMED system. The term refers to the theory and techniques for performing setup operations in less than ten minutes. Although not every setup can literally be completed in single-digit minutes, 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. 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

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3. 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 basic reference [1]. 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:

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. It 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 as under. (Annexure: 1) 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.

4. 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.

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.

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.

Table 2. Chart Analysis (observed data)

Process Analysis Worksheet

Name of Process: Changeover time on 200Thyd Press

No	Activity	Operation	Transport	Storage	Inspection	Delay	Rework	Observations Time (Sec / Min / Hrs) From min	From sec	To min	To sec	Time
1	Opening of Die bolts	●	⇨	▽	□	D	D	0	42	4	40	238
2	Remove Blocks top die	○	⇨	▽	□	D	D	4	40	5	30	50
3	Remove skid plates	○	⇨	▽	□	D	D	5	30	8	30	180
4	Storing die on rack.	○	⇨	▼	□	D	D	8	30	10	30	120
5	Putting cushion pins	●	⇨	▽	□	D	D	10	30	13	4	154
6	Placing new die	○	⇨	▽	□	D	D	13	4	19	50	406
7	Closing die bolts	●	⇨	▽	□	D	D	19	50	24	5	255
8	m/c setting & 1st piece	●	⇨	▽	□	D	D	24	5	27	0	175
9	First piece inspection	○	⇨	▽	■	D	D	27	0	31	20	260
	Floor to Floor time											15
	Total Time											1853 (30 min 38 sec) 30.9

5. Results 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.

6. Horizontal Deployment (At TVS Motor Co Ltd)

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).

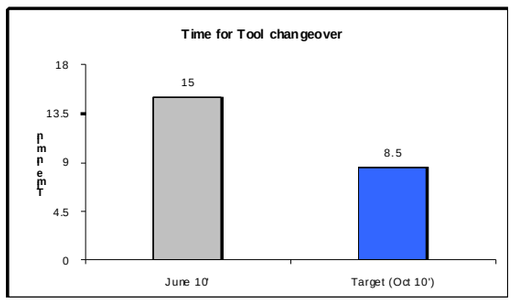

Fig. 2 Setup changeover time reduction target

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.

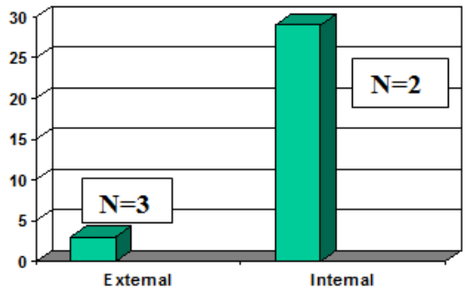

Fig. 3 Distribution of External & Internal activity

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.

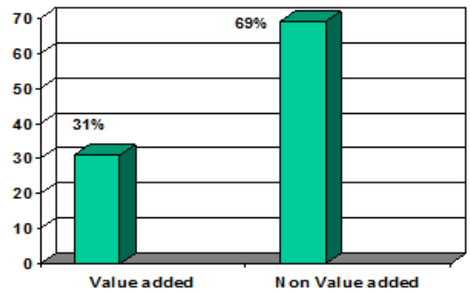

Fig. 4 Ratio of VA and NVA activity

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. 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.

Table3. Detailing Internal Activity into Value added and Non value added

Sl. No.	Activity	Internal/ External		Value
1	Press Tool Unload From Die Loader	External		
2	Press Tool Load To Die Loader	External		
3	Dismantling Ram Bundle	External		
4	Move The Scrap Pallet And Component Trolley From Press	Internal	185	Nva
5	Two Hand Push Buttons Moved Away From Press	Internal	4	Nva
6	Trolley And Trolley Chute Moved From Press	Internal	24	Nva
7	Clearing The Press Tool	Internal	17	Nva
8	Set The Press Ram In Bock	Internal	20	Va
9	Component Conveyor Moved From The Press	Internal	30	Nva
10	Remove All The T Bolts From Tool - 8 No's	Internal	51	Va
11	Move The Die Loader To Unload The Press Tool From Press	Internal	35	Nva
12	Lift The Press Tool On Press Bed	Internal	10	Nva
13	Move The Die Loader Fork Forward To Unload The Tool	Internal	21	Va
14	Retract The Die Loader Fork	Internal	12	Nva
15	Move The Die Loader To Its Home Position	Internal	14	Nva
16	Clean The Bed And Change Cushion Pins As Per Layout	Internal	56	Va
17	Move The New Die Loader To Press	Internal	30	Va
18	Move The Tool From Die Loader To Press	Internal	19	Va
19	Activate Cushion Pin Movement (2)	Internal	8	Nva
20	Move The Fork Forward	Internal	6	Nva
21	Activate Cushion Pin Movement (2)	Internal	8	Nva
22	Move The Fork Forward	Internal	15	Nva
23	Move The Fork To Home Position	Internal	50	Nva
24	Position The Die With Crow Bar	Internal	14	Nva
25	Set The Ram To Bock Position	Internal	68	Va
26	Tighten All The 8 Bolts	Internal	12	Nva
27	Set The Press Ram To Tdc Position	Internal	15	Nva
28	Set The Process Parameters	Internal	32	Va
29	Move The Component Conveyor To Home Position	Internal	28	Nva
30	Move The Scrap Pallet And Component Trolley Near Press	Internal	240	Nva
31	Move The Ram Trolley Near Working Area	Internal	62	Nva
32	Load Ram Bundle On Trolley With Ohc	Internal	55	Nva

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.

7. Statistical Evaluation

Minitab was used to interpret the before and after data. First the Normality of data was checked. 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. 7) barring one outlier of 41minutes, mean lies around 32 minutes (Before SMED).In case of after implementation of

SMED, mean improved to around 16minutes (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.

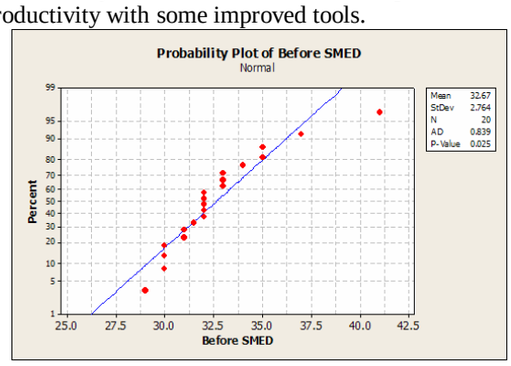

Fig. 5 Normality check for setup changeover data

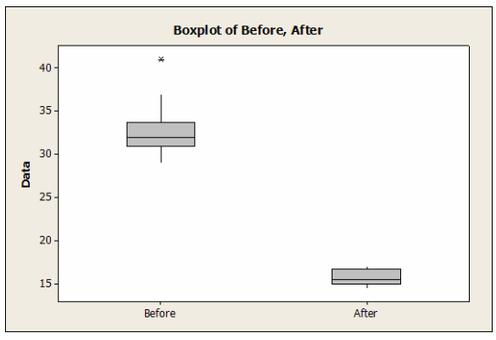

Fig. 6 Box plot of setup changeover time before and after SMED

8. Conclusions

Implementing 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 15minutes 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. SMED is very effective tools to improve productivity thereby improve delivery in any industry. Tools like Chart Analysis, ECRS are very effective in analysis activities involved for setup changeover.

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