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Implementation of Single Minute Exchange of Die in Motor Manufacturing Unit

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Abstract- *Nowadays, industries are adopting new tools and techniques to increase productivity, operational availability and better overall efficiency of the production line. The Single Minute Exchange of Die (SMED) is one important lean tool to reduce waste and improve flexibility in manufacturing processes allowing lot size reduction and manufacturing flow improvements. SMED reduces the non-productive time by streamlining and standardizing the operations for exchange tools, using simple techniques and easy applications. However, the process doesn't give the specific actions to implement which can result in overlooking improvements. To overcome this, common statistical and industrial engineering tools can be integrated in the SMED approach to improve SMED implementation results. The applicability of the SMED technique was tested for 8 ton notching machine press changeover at the motors plant. The implementation has enabled reduction in setup time, without the need for significant investment.*

Key Words: Downtime, Setup Time, Changeover, Changeover time, Internal and External activities, Vale Added activity, Non- Value added activities.

1. LITERAUTRE REVIEW

Various research and articles have been published on SMED and its implementation. To accomplish this step, this is based on the consultation of various journals, all of which are related to Lean manufacturing and allied areas.

Globalization has created the need to produce small lots, causing a significant increase in the frequency of setup, causing the reduction of times production for each lot. For this reason, it is important that changeovers are quick, so that the flexibility of respond to demand is not affected (McIntosh et al, 2007) [1].

Shingo defends that SMED system is a method that includes a set of techniques that makes it possible to have a setup less than 10 minutes, that is the number of minutes expressed by only one digit (Shingo, 1989). Also shown that SMED consists of three conceptual stages namely separating internal and external setup, converting the internal setup to external setup, streamlining all aspects of the setup operation.

The single minute exchange of dies is one important lean tool to reduce waste and improve flexibility in manufacturing processes allowing lot size reduction and manufacturing flow improvements. SMED reduces the non-productive time by streamlining and standardizing the operations for exchange tools, using simple techniques and easy applications, (Ana Sofia Alves et.al, 2009) [2], and concluded that the SMED methodology can be combined with other classic tools, providing very positive results for companies such as chart analysis and statistical analysis allowed the identification and separation of different groups for analysis, and added value of traditional SMED methodology.

(Trovinger et.al, 2005) [3] applied the principles of SMED to pick and place chip shooter machines and they were able to reduce setup times by removing all activities that could be done off-line. They used a computerized information system to assist with feeder management and also used computerized tools, e.g. barcode readers and wireless terminals. This resulted in reducing the incremental setup time per feeder from 1.7 minutes to 11 seconds. They proved that SMED and sophisticated (computer) methods are interrelated to each other and having optimum effect while used in combination.

(Cakmakci,2008) [4], showed the relation between both the setup time reduction (SMED) and product design efficiency through quality control technique, and process capability analysis, he also showed that SMED is still a suitable method not only for manufacturing improvement but also for equipment/die design development, and also concluded that SMED is suitable not only for manufacturing improvement but also for equipment development and integrated the SMED system and 5S technique.

(Michels, 2007) [5], stated that application of SMED methodologies is an effective way to analyze, improve and reduce existing processes used to change over manufacturing equipment. This field study has shown that it is possible to reduce the amount of time required to perform a changeover as well as reduce the amount of direct labor needed to perform a changeover through improvement of processes. Applying the SMED methodology to the punch press changeover detailed in this study, the researcher concludes that SMED is an effective tool to provide improved changeover methods resulting in reductions in overall time and labor and also proved that setup reduction is an effective tool which can be applied to improve a manufacturing organization's ability to improve customer satisfaction through better utilization of plant resources. The most important step in implementing SMED is distinguishing between internal and external activities. Preparation of parts, tools and maintenance activities should not be performed while the machine is stopped.

(Sivasankar et. al, 2011) [6], performed the experimental verification of Single Minute Exchange of Dies and concluded that SMED improvement techniques may be assessed both in terms of their allocation to the methodology's stages and in terms of their collective representation of a full range of potential improvement options.

(Kayis et al, 2007) [7], described the results of SMED system in three categories namely: Mechanical improvements, Procedural improvements and organizational improvements and also concluded that setup reduction (SUR) is an extremely valuable approach in modern manufacturing. To ensure its success it must begin at a grass roots level of the organization and a constant drive towards improvement must come from all levels of the company.

Mehvish Jamil, Manisha Gupta, Abhishek Saxena and Vivek Agnihotri [8] reported highlights a methodology developed for standardization in the process activities by using Maynard's Operation Sequence Technique and minimization of fatigue among the workers in manufacturing line by using Ergonomics. Thus, this research uses they like Ergonomics as the work study and Maynard Operation Sequence Technique (MOST) as the time study method. They main objective is to achieved Optimization of the system with integration of M.O.S.T. and Ergonomics.

Tarun Kumar Yadav [9] use methodology starts from a suitable assembly system selection and there after decides suitable cycle times, parallel workstation requirements, and parallel line implementation for the type of assembly system being selected. They suggested Work measurement is a systematic procedure for the analysis of work and determination of time required performing key tasks in processes, it is typically based on time standards for manual tasks.

2. METHDOLOGY

The SMED methodology is a part Lean tool that supports organizations in the reduction of setup times and in the elimination of wastes identified in the changeover operations.

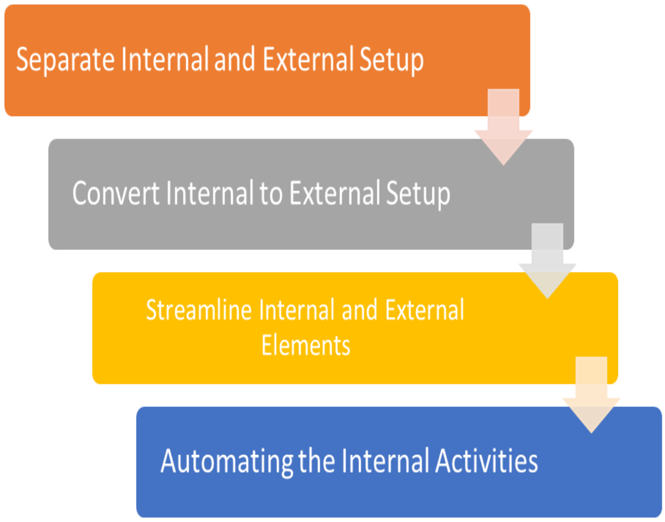

Fig -1: Methodology

2.1 Identification of Internal and External Activities:

The time required to make the die change will be calculated using Maynard Operation Sequence Technique (MOST). The current die change was observed and each activity was scrutinized for identifying the internal and external activities. Following operations/ activities are carried out by the operator:

Operations List	
Operation No.1	Pre-staging operations includes gathering toolbox, drawings, data sheet containing information of the die set to be changed
Operation No. 2	Changing the Centering Ring; operator changes the centering ring on which the centering mandrel is kept.
Operation No.3	Changing the Centering Mandrel.
Operation No.4	Die Change; operator removes the old die set and replaces it with new punch and die block as stated in the data card.
Operation No.5	Changing of Outer Diameter Guide and Support Plate.
Operation No.6	Setting of Blank Holder and Blank Holding Cap.
Operation No.7	Set blank holder for correct setting on mandrel.

Operation No.8	Setting of Indexing Gears; indexing gears are changed according to the number of slots needed to be punched into the lamination.
Operation No.9	Setting of Notching Diameter.
Operation No.10	Setting of reverse matching of laminations.
Operation No.11	Inspection of notched sample.
Operation No.12	Passing of sample by inspector.

Table -1: List of Operations

Overview of time consumed in Internal and External Activities in the current die Setup.

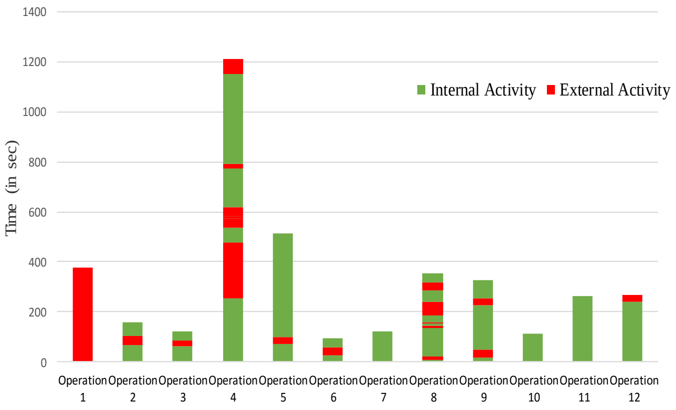

Fig -2: Graph of Current flow of setup operations

The following observations are made from current die setup: As the External and Internal activities are not segregated, the machine downtime is high.

The total time consumed in External activities alone is 18mins i.e. 27.43% of the total time of the die setup.

The machine downtime lasts throughout the die setup i.e. from Operation 1 to Operation 12 due to mixing of external activities with internal ones.

In order to reduce the machine downtime, the external activities must be organized so that they are done before the Internal activities.

Hence, the machine press can still be running as these External activities are carried out and the productivity can be increased.

Flow of operations after separating Internal and External activities;

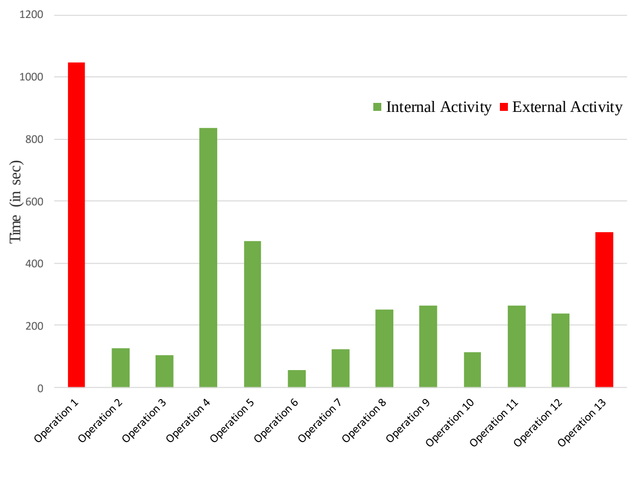

Fig -3: Flow of setup operations after SMED implementation

Effects of separating activities:

All activities like getting new data sheet and drawing, new die set, cleaning the shims and die sets, which were done during machine downtime will be done as Pre-Staging Operation.

Due to this change in flow of activity, the overall die setup process will start before the machine press is actually shut for the changeover and thus the productivity of the press will increase.

As seen in the bar graph, Operation 13 is added as Post-Setup Operation.

This operation consists of returning the old die set, shims and indexing gears to their respective storage places. These activities were previous done during the machine downtime and hence the machine was not used to its full production potential since such External Activities were carried out as Internal Activities.

Thus, the machine downtime lasts only from Operation 2 to Operation 12 and the total time consumed in these operations is also reduced due to the correct organization of Internal and External Activities.

2.2 Modifications and Proposals for Locators and Jacks:

The Support plate is used to support and guide the lamination Outer diameter during the notching process. The Locator helps in aligning the support plate during the setup and the Jack is used to maintain the level of the support plate by adjusting its height using screw jack mechanism.

The observations made during the setting up of the support plate are as follows:

For bolting the locator, the operator had to first align the locator and the two holes for the allen bolts on the fixture and then insert and tighten the two bolts to the fixture.

The process of aligning the locator and the bolts was unnecessarily time consuming.

The support plate is then mounted on the locators and the jacks were placed underneath the support plate.

The jacks had to be aligned with the support plate and the fixture plate so that they could be bolted together.

This adjustment of the jack had to be done blindly as the support plate was already placed on the locator.

Due to this trial and error method of adjustment, this step consumed a lot of time.

As the support plate is heavy, it causes worker fatigue and also increases the time taken for the adjustments as the operator has to lift the heavy plate during the alignment of the jack and the base plate.

Proposed solutions to observed problems:

a. Modifications for Locators

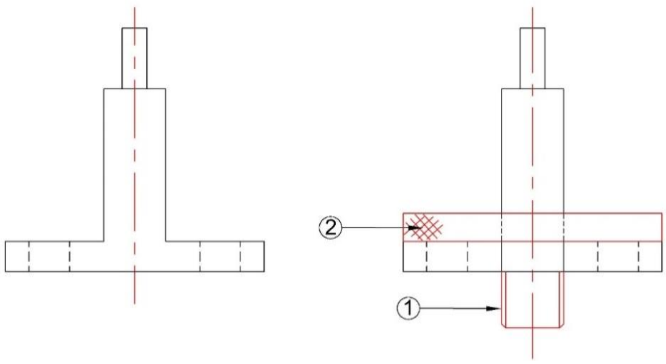

Fig -4: Current and Proposed Modification for Locators

Annotation 1 shows addition of threaded portion at the bottom of the locator.

This portion will help the operator in locating and fixing the locator on the fixture plate.

The addition of the threaded portion helps in eliminating activities like selecting the correct allen key and tightening the two allen bolts currently used in fixing the locator on the fixture plate.

Instead of tightening two allen bolts the operator will only have to directly tighten the locator on the fixture plate. Thus it will save the time which is spent in selecting, placing and tightening one allen bolt of one locator.

As in all 4 locators are used in this operation, we will be effectively saving time required for selecting, placing and tightening four allen bolts. However, in the current design of the locator there is not enough grip available for the operator to turn the locator with his hands even if a threaded extension is provided. Annotation 2 shows an addition of a knurled ring to the locator. This will help the operator in gripping the locator and turn the locator to tighten it in the fixture plate.

b. Modifications for Jacks

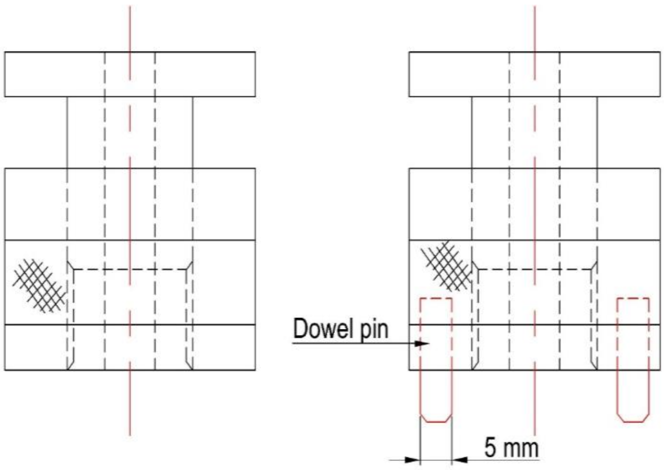

Fig -5: Current and Proposed Modification for Jack

The operator has to guide the jack on the fixture plate to align its center with the drilled holes in the fixture plate and the support plate.

The operator cannot see the jack as his vision is blocked by the support plate on top of the jack. Thus the alignment of the jack is done by trial and error and consumes time.

To easily locate the jack on the fixture plate, the jack can be attached with dowel pins having Φ5mm.

Holes having diameter slightly larger than the dowel pins can be drilled on the fixture plate to easily locate the jack and thus save the time spent in trial and error method of adjustment.

The level of the support plate is maintained by 5 jacks. Thus, by adding this modification to the jacks the time required for aligning 5 jacks will be saved thereby reducing the overall time taken by the activity and reducing the machine downtime further as this is an Internal activity.

3. USE OF SPAGHETTI DIAGRAM TO OPTIMIZE OPERATOR FLOW DURING DIE SETUP

Spaghetti plot is a method that uses a continuous line to trace the path and distance travelled of a particular object or person throughout a process. The main reason to create a spaghetti diagram is to document the current movement of work and people. It gives us an insight into the distances travelled and the number and locations that work has to travel to. It clearly shows transport wastes, and gives us a bird's eye view of our operations which we rarely encounter on a day to day basis.

Process followed in plotting the operator flow:

The locations of the machine press, tool crib, inspection table, tool store and the Instamat machine were mapped out.

The travel pattern of the operator was then observed during the actual die setup activity.

The path taken by the Operator during each operation was observed and different colours were assigned to distinguish each operation.

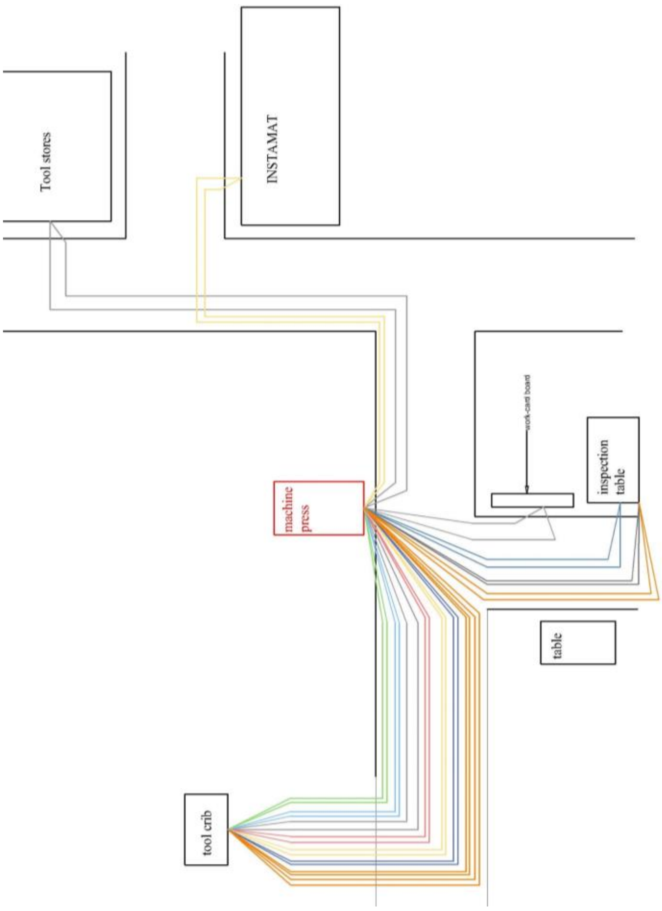

Fig -6 Spaghetti diagram of Travel pattern of operator during die setup

Observations made from the spaghetti diagram:

The tool stores and Instamat were located far away from the machine press. Hence time was wasted as the operator went from the press to these locations.

During each operation the operator used to walk to the respective storage space of the material and retrieve it.

The operator had to walk to the toll crib during 8 of the 12 operations. This is a waste of transport as all the required material can be gathered at one time instead of during each operation.

The worker sometimes had to take extra trips to the tool store to get any tools or instruments that he had forgotten to take for the setup.

3.1 Methodology followed to reduce the travel path of the operator:

A list of all the tools, instruments, and drawings needed for the die setup was made.

The importance of each item in the inventory was studied and a path was decided for the operator so that a logical travel path is created to collect the required items for the die setup.

The data card and drawings are first collected as they contain the details of the die set and the required tolls for the die setup.

After collecting the drawing, the operator goes to the Instamat and selects the required die set for the setup.

After collecting the drawing, the operator goes to the Instamat and selects the required die set for the setup.

After collecting the die set, the operator then goes to the tool crib and then selects all the other components need for the setup. Thus repeated trips to the tool cribs are removed.

As the operator is provided with the setup checklist, any chance of the operator forgetting any components or tools is negated. Hence the operator will not waste time in collecting any forgotten components during the setup time.

As the operator didn't have any means to carry all the required inventory in one trip, a trolley is implemented to hold all the inventory.

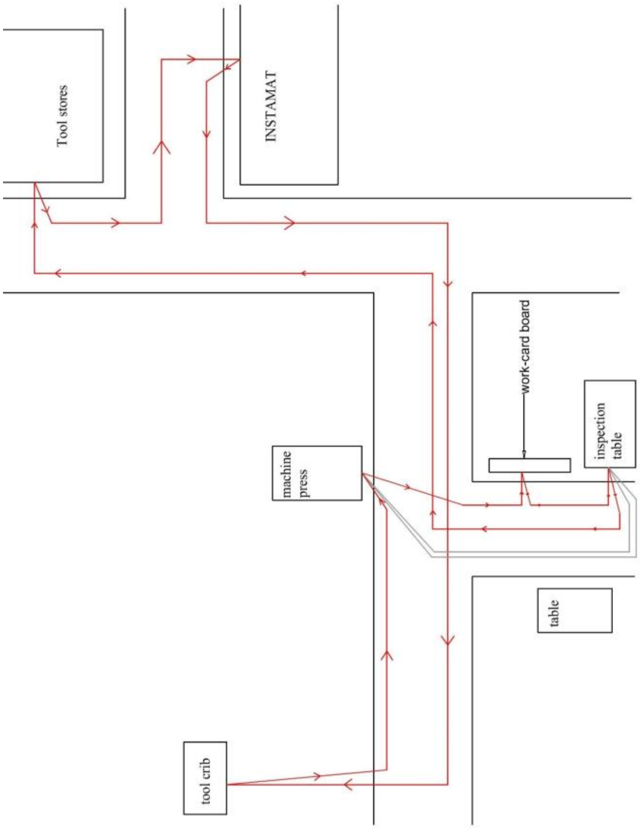

Fig -7 Travel pattern after implementing the proposed changes for die setup.

4. DESIGN OF SMED TROLLEY

While observing the setup operation, the following observations were made:

The tool box of the operator was cluttered with extra tools and inventory and the operator had to search for the right size tools multiple times during the changeover.

Fig -8 Current state of toolbox

The changeover items like guide plate and new die set were kept on space available on the machine and stamped laminations due to lack of any designated place. Due to this, the laminations used to get damaged and had to be scrapped. This was an unnecessary wastage of inventory.

Due to lack of any storage space, nut and bolts of various sizes are always kept on machine. This posed a safety hazard. As the bolts of different length and sizes are kept together, the operator has to choose a bolt of right size by trial and error and wasted time in the process.

4.1 Methodology followed in designing the trolley:

The space available for the operator around the machine was limited, hence the outer dimensions of the trolley was decided by measuring the space available for the operator to work. The breadth of the trolley was the main constraint while deciding the outer dimensions of the trolley.

The top most shelf and mid shelf of the trolley were kept at a distance of 920mm and 645mm from ground level so that the operator can access its contents without bending and with minimum hand moments.

The operator had to sit down during change of the indexing gears. Hence the bottom most shelf contained the components and tools needed for changing the indexing gear. This helped the operator is accessing these components without reaching out on a higher level as is currently the case.

4.2 Implementing 5S Workplace Organization Methodology for SMED trolley:

5S is a system to reduce waste and optimize productivity through maintaining an orderly workplace and using visual cues to achieve more consistent operational results. The term refers to five steps – sort, set in order, shine, standardize, and sustain.

"A place for everything and everything in its place" is the mantra of the 5S method. The result is an improved manufacturing process and the lowest overall cost for goods produced.

A place for the tool. As the contours of each tools are different, there is no possibility of keeping a tool in the wrong place. Thus the objective of "A place for everything, and everything in its place" was achieved.

3S (Shine): To keep the tools and components of the trolley, clean the trolley was designed such that it would be easy to clean all the shelves. Hence, less time will be needed to keep the trolley and its contents clean and will also lengthen the life of the tools and other components.

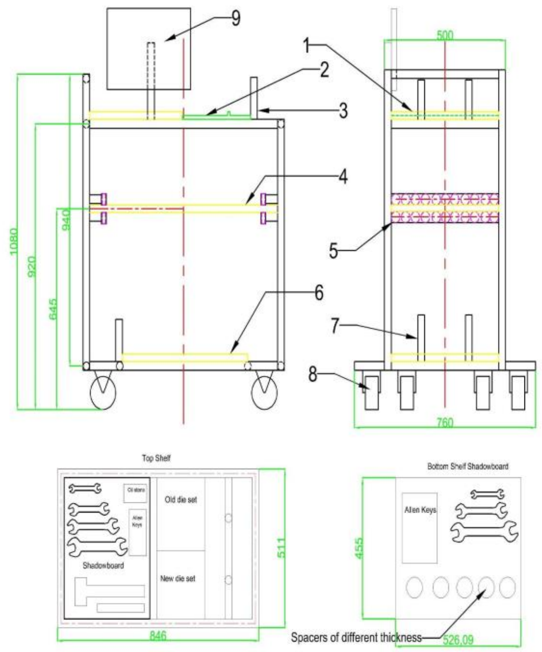

Fig -9 CAD drawing of SMED trolley and shadow boards

4.3 Details of SMED trolley:

1. Shadow board of tools frequently used: This shadow board is located on the top shelf and contains the tools used frequently during the setup.
2. Space is allocated to keep the new die set and the old die set after it is removed from the press. This is kept on the top shelf for easy handling of dies.
3. The die setup requires a mandrel and blank holder. These pipes act as locators for keeping the components on the trolley during the setup. The diameter of the pipe is such that all sizes of the mandrel and blank holder can be accommodated on it.
4. The middle shelf is designed to carry the support plate. The height of this shelf is such that the operator need not bend to get its contents.
5. As the support plate is heavy, rollers are provided which give throughout support to the shelf and prevent it from breaking apart due to the weight of the support plate.
6. The bottom most shelf carries the shadow board for the tools needed for changing the indexing gears. This shadow board is kept at the bottom most shelf as the indexing gear housing is at a low level on the machine press and the operator has to change the gears while sitting down.
7. The indexing gears are located on these two rods on the trolley. The inner diameter of the gears is more than these rods and hence can be easily located and transported on the trolley.
8. The trolley has two swiveling wheels and two fixed wheels for direction control. The swiveling wheels are spaced further out than the trolley so as to maintain the balance of the trolley and prevent it from toppling over its sides. The fixed wheels have to be kept inside the 500mm constraints due to the space availability constraint at the machine press.
9. The trolley is given a display board on which the operator may attach the drawings, data card and the checklist. Thus all the information will always be in front of his eyes and he won't have to reach out for these documents every time to refer any data as is currently the case.

5. STUDY AND IMPLEMENTATION OF MAYNARD OPERATION SEQUENCE TECHNIQUE (MOST)

Maynard Operation Sequence Technique (MOST) is a predetermined motion time system that is used primarily in industrial settings to set the time in which a worker should perform a task. To calculate this, a task is broken down into individual motion elements, and each is assigned a numerical time value in units known as time measurement units, or TMUs, where 100,000 TMUs is equivalent to 1 hour. All the motion element times are then added together and any allowances are added, and the result is the standard time.

The most commonly used form of MOST is BasicMOST, which was released in Sweden in 1972 and in the United States in 1974. Two other variations were released in 1980, called MiniMOST and MaxiMOST. The difference between the three is their level of focus—the motions recorded in BasicMOST are on the level of tens of TMUs, while MiniMOST uses individual TMUs and MaxiMOST uses hundreds of TMUs. This allows for a variety of applications—MiniMOST is commonly used for short (less than about a minute), repetitive cycles, and MaxiMOST for longer (more than several minutes), non-repetitive operations. BasicMost is in the position between them, and can be used accurately for operations ranging from less than a minute to about ten minutes.

More specifically, MOST is used to:

a. Break down the operation/process into smaller steps/units.

b. 2. Analyze the motions in each step/unit by using a standard MOST method sequence

c. Assign indices to the parameters constituting the method sequence for each task.

d. Sum up the indices to arrive at a time value for each step/unit.

e. Sum up the time values for all the steps/units to arrive at the 'normal time' required to perform that operation/process.

5.1 Use of BasicMOST for study of die setup:

The focus of Basic MOST is on work activity involve the movement of objects. The majority of industrial manual work does involve moving objects (e.g., parts, tools) from one location to another in the workplace. Basic MOST uses motion aggregates (collections of basic motion elements) that are concerned with moving things. The motion aggregates are called activity sequence models in Basic MOST. There are three activity sequence models in Basic MOST, each of which consists of a standard sequence of actions:

General move: This sequence model is used when an object is moved freely through space from one location to the next (e.g., picking something up from the floor and placing it on a table).

Controlled move: This sequence model is used when an object is moved while it remains in contact with a surface (e.g., sliding the object along the surface) or the object is attached to some other object during its movement (e.g., moving a lever on a machine).

Tool use: This sequence model applies to the use of a hand tool (e.g., a hammer or screwdriver).

Table -2: Sequence models of activities

Activity	Sequence Model	Subactivities
General Move	ABG ABP A	A - Action Distances
		B - Body Motion
		G - Gain Control
		P - Place
Controlled Move	ABG MXI A	M - Move controlled
		X - Process time
		I - Align
Tool Use	ABG ABP * ABPA	*F – Fasten
		*L – Loosen
		*C – Cut
		*S – Surface treat
		*R – Record
		*M - Measure

General Move:

Standard sequence in General Move:
ABG ABP A
ABG: to get an object;
ABP: to move the object to a new location;
A: return.

TABLE 14.6 MOST Parameters and Index Values for the General Move Activity Sequence Model

General Move activity sequence model = **A B G A B P A**

Index	A = Action distance	B = Body motion	G = Gain control	P = Placement
0	Close ≤ 5 cm (2 in.)			Hold, Toss
1	Within reach (but > 2 in.)		Grasp light object using one or two hands	Lay aside Loose fit
3	1 or 2 steps	Bend and arise with 50% occurrence	Grasp object that is heavy, or obstructed, or hidden, or interlocked	Adjustments, light pressure, double placement
6	3 or 4 steps	Bend and arise with 100% occurrence		Position with care, or precision, of blind, or obstructed, or heavy pressure
10	5, 6, or 7 steps	Sit or stand		
16	8, 9, or 10 steps	Through door, or Climb on or off, or Stand and bend, or Bend and sit		

1 Index = 10 TMU

Table -3: MOST Parameters and Index Values for the General Move Activity Sequence Model

Example of a General move:

Pick up die set and load on bolster plate:

The operator takes a new die set from the Instamat machine and carries it to the machine press which is 63 steps away from the Instamat machine.

Therefore, the activity can be broken down as follows:

A1 B0 G3 A113 B0 P3 A0

Where
A1 = Walk to Instamat, which is 'Within Reach' as the operator is already at the INSTAMAT.
B0 = No body motion.
G3 = 'Grasp heavy' die set.
A113 = Walk back 63 Steps to the Machine Press.
B0 = No body motion
P3 = 'Adjust' the die set on the bolster
A0 = No Motion.
Sum of index values = 1+0+3+113+0+3+0 = 120
Normal time = 10 x 120 =1200 TMU = 1200*0.036 = 43.2 sec.

Change in time of the activity due to SMED:

Since we have segregated the external and internal activities, the operator will have the new die set ready by the machine press during the changeover process. Hence we have eliminated the time taken to walk 63 steps from the Instamat to the machine press.

Therefore, the new time taken for the activity will be as follows:

A1 B0 G3 A0 B0 P3 A0

Where
A1 = The die set will be 'Within Reach' on the trolley.
B0 = No body motion.
G3 = 'Grasp heavy' die set.
A0 = No Motion.
B0 = No body motion
P3 = 'Adjust' the die set on the bolster
A0 = No Motion
Sum of index values = 1+0+3+0 +0+3+0 = 7
Normal time = 10 x 7 = 70 TMU = 70*0.036 = 2.52 sec.

Control Move:

It is used when an object is moved through a path that is somehow constrained.

M: Move, controlled
X: Process time
I: Align
Standard sequence in Controlled Move:
ABG MXI A
ABG: to get an object.
MXI: to move the object followed by a process time and alignment
A: Return

TABLE 14.7 MOST Parameters and Index Values for the Controlled Move Activity Sequence Model

Controlled Move activity sequence model = **A B G M X I A**				
Index	**M** = Move, controlled	**X** = Process time[a]		**I** = Alignment
		Seconds	Minutes	
1	Push, pull, pivot: button, switch, knob (≤ 12 in.)	0.5	0.01	Align to one point
3	Push and pull, turn, open, seat, shift, press: resistance encountered, or high control required, or 2 stages of control (≤ 12 in.); 1 crank of lever.	1.5	0.02	Align to 2 points, Close align (≤ 4 in.)
6	Open and shut, operate, push or pull: with 1 or 2 steps (> 12 in.); 3 cranks of lever.	2.5	0.04	Align to 2 points, Close align (> 4 in.)
10	Manipulate, maneuver, push, or pull with 3, 4, or 5 steps; 6 cranks of lever.	4.5	0.07	Precision align
16	Push or pull with 6, 7, 8, or 9 steps included; 11 cranks of lever.	7.0	0.11	High precision align

[a]For process times longer than those listed in the table, the actual process time in seconds can be multiplied by 2.78 and rounded to the next higher value to obtain the index for the X parameter.

Table -4: MOST Parameters and Index Values for the Controlled Move Activity Sequence Model

Example of a Controlled move:
Align the shims with Die plate:

In this activity, the operator has to maintain the level of the die block with the level of the mandrel. To do this, he puts the die plate on shims. The shims have to be aligned with the base of the die block or they may not adequately support the die block and will damage the die block during press operation.

Therefore, the activity can be broken down as follows:

A3 B0 G3 M3 X0 I6 A0

Where
A3 = 1 to 2 steps from trolley to machine press.
B0 = No body motion.
G3 = Get heavy die block and shims
M3 = 'Push/ Pull' shims under die block.
X0 = No process time.
I6 = Align shims (more than 10cm)
A0 = no motion.
Sum of Index values = 3 + 0 + 3 + 3 + 0 + 6 + 0 = 15
Normal time = 10 x 15 = 150 TMU = 150 x 0.036 = 5.4 secs

As this activity has to be done 4 times we will multiply the normal time by 4.

Therefore, the total time for the activity = 5.4 x 4 = 21.6 sec.

Tool Use:

Tool Use table applies to a variety of situations:
F: fasten

L: loosen

C: cut

S: surface treat

M: measure

R: record

T: think

Only one is used in a sequence:

ABG ABP * ABP A

ABG: to get the tool

ABP: put the tool in the position

*: tool use code

ABP: put the tool aside

A: return

ABG ABP * ABP A
Get Tool Put Tool Use Tool Aside Tool Return

Tool Use

F L
Fasten or Loosen

Index x10	Finger Action	Wrist Action				Arm Action					Tool Action
	Spins	Turns	Strokes	Cranks	Taps	Turns		Strokes	Cranks	Strikes	Screw Dia.
	Fingers, Screw-driver	Hand, Screw-driver, Ratchet, T-Wrench	Wrench, Allen key	Wrench, Allen key, Ratchet	Hand, Hammer	Ratchet	T-Wrench 2-Hands	Wrench, Allen key	Wrench, Allen key, Ratchet	Hand, Hammer	Power Wrench
1	1	-	-	-	1	-	-	-	-	-	-
3	2	1	1	1	3	1	-	1	-	1	1/4" (6mm)
6	3	3	2	3	6	2	1	-	1	3	1" (25mm)
10	8	5	3	5	10	4	-	2	2	5	
16	16	9	5	8	16	6	3	3	3	8	
24	25	13	8	11	23	9	6	4	5	12	
32	35	17	10	15	30	12	8	6	6	16	
42	47	23	13	20	39	15	11	8	8	21	
54	61	29	17	25	50	20	15	10	11	27	

Table -5: MOST Parameters and Index Values for the Tool Use Activity Sequence Model

Example of Tool Use:
With Allen key tighten Allen screw:

The operator has to fasten the die block with 4 Allen screws. Therefore, the activity can be broken down as follows:

A3 B0 G1 A3 B0 P12 A1 F128 A3 B0 P1 A0

Where
ABG = get the allen screw
ABP = Put the allen screw in position.
F 128 = 32 x 4 i.e. 17 turns of each screw.
ABP = Put the allen key aside.
Sum of Index values = 3+0+1+3+0+12+12+128+3+1 = 163
Normal time = 10 x 163 = 1630 TMU = 1630 x 0.036 = 58.68 sec.

As seen in the Tool Use chart, if we use a ratchet instead of allen key we can save time in multiple activities.

Sample papragraphDefine abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

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3. CONCLUSIONS

This study described an effective industrial application of the SMED methodology (setup of 8 Ton Notching Press), which led to reduction of 27.5% in the machine downtime. SMED methodology was applied to prepare an optimal standard procedure for changeover operations on Notching press. A series of time study data was collected during the setup activities in the notching press and cross referenced using BasicMOST. It was possible to verify that relatively simple solutions can bring great improvements at low cost.

By systematically organizing the activities in the die setup, the machine downtime was reduced by 18mins. The SMED trolley helped in improving the setup activity and assisted in the implementation of the new flow of activities in the setup. The tools' maintenance and acquisition processes became more effective due to the development and adoption of SMED trolley and setup checklist.

To ensure the sustainability of the achieved results, the setup occurrences should be frequently monitored. By implementing the proposals in this report, the machine downtime can be further reduced to 40% of the original machine downtime.

In terms of future developments, creation of one or more SMED teams is a must for continuous improvement.

4. REFERENCES

[1] Sugai. M., McIntosh R., Novaski. O, Metodologia de Shigeo Shingo (SMED): análise critica e estudo de caso", Gestão & Produção, 2007; 14(2), 323-335.

[2] Ana Sofia Alves and Alexandra Tenera, Improving SMED in the Automotive Industry: A case study, Production and Operations Management Society 20th Annual conference Orlando, Florida U.S., 2009.

[3] Trovinger and Bohn, Setup Time Reduction for Electronics Assembly: Combining simple (SMED) and IT-based methods", Production and Operations Management Society, 2005, 14(2), ISSN 1059-1478.

[4] Cakmakci M, Process Improvement: Performance analysis of the setup time reduction – SMED in the automobile industry, International Journal of Advanced Manufacturing Technology, 2009; 41; 168-179.

[5] Michels T.B, Application of Shingo's Single Minute Exchange of Dies (SMED) Methodology to Reduce Punch Press Changeover Times at Krueger International", Thesis, University of Wisconsin-Stout, 2007.

[6] Sivasankar M, Dhandapani N, Manojkumar S, Karthick N, Raja K, Yuvaraj J, Experimental verification of Single Minute Exchange of Dies (SMED), Recent Research in Science and Technology, 2011; 3(3); 92-97.

[7] Kayis.B and Kara.S, Set-Up Reduction in Injection Molding Process: A Case Study in Packaging Industry, 4th International Conference and Exhibition on Design and Production of Machines and Dies/Molds, Cesme, Turkey, 2007.

[8] Mehvish Jamil, Manisha Gupta, Abhishek Saxena and Vivek Agnihotri (2013) "Optimization of Productivity by Work Force Management through Ergonomics and Standardization of Process Activities using M.O.S.T Analysis" in Global Journal of Researches in Engineering.

[9] Tarun Kumar Yadav (2013) "Measurement Time Method for Engine Assembly Line with Help of Maynard Operating Sequencing Technique (MOST)" in International Journal of Innovations in Engineering and Technology (IJIET).