SMED METHODOLOGY FOR REDUCING SETUP TIME IN GEAR GRINDING SECTION OF THE FACILITY

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ABSTRACT

Setup time plays a major role in the performance of the company and its manufacturing capability as the Setup time above a prescribed limit is considered waste for the company. The following paper provides an insight in implementing Single Minute exchange of dies (SMED), a productivity improving technique for reducing setup time and significantly reducing changeover time in gear grinding section of Bharat Gears Ltd.

KEYWORDS

SMED, Setup time, changeover time, productivity, time study.

1. INTRODUCTION

Productivity is defined as the ratio of output produced to the input resources utilised in the production [6]. Productivity plays a key role in determining the performance of a manufacturing firm. To enhance productivity companies frequently develop tools and techniques, thus achieving competitive advantage and allows them to have success for a longer period. Market demands for flexibility for an established firm, for this purpose manufacturers opt to reduce machine downtime, for reducing machine down time a firm must reduce setup time. Setup time refers to the time incurred to prepare for manufacturing process and system for production. According to Mashitah Mohamed Esa, Nor Azian Abdul Rahman who conducted an analysis in reducing setup time in an automotive firm in Malaysia came to a conclusion that High Setup time is considered waste for the company [1]. Thus, companies must find a way to reduce setup times and eliminate wasting time as well as limit activities without real added values. One of the efficient techniques in reducing setup time is SMED [2].The SMED methodology was developed by Shingo (1985), who essentially described it as a scientific approach to reduce setup times for changing production equipment within the bound of 10 minutes. [2, 3]. Shingo claimed that SMED is a scientific approach to set-up time reduction that can be applied in any factory in any machine [4]. SMED allows for the reduction of lot sizes and enables one to meet the fluctuation of demand. It further eliminates the waste inherent to stock build up and enhances a reduction in lead time [2].

1.1 Case Study:

This paper is concerned with reducing setup time in bore grinding machine for gear manufacturing company. One high demand product is Bevel Gear which is a major product of Bharat Gears Ltd. and its production operates daily. This product consists of **12** machining steps, where the **7, 8, 9, 10** steps is the bottleneck. We realised that the chuck changeover time is the major reason of longer setup time for Bevel Gear and had assigned their most skilled and dedicated workers to work on this product. During the setup process, the operator used too much time to load the fixture onto the machine, and a lot of time is consumed to adjust the location of workpiece while in contact with the fixture. Due to the insufficient information in the fixture design, the workers are unable to create a new fixture and are forced to satisfy the current production with the existing fixture. The objective of this paper is to identify the underlying problems in the current setup , propose a new design, fabricate and test the new design to record the setup improvement.

2. METHODOLOGY:

The following research is conducted in the company Bharat Gears Ltd. The paper presents a case study on how productivity will be improved by the application of SMED methodology in the gear grinding section for the production of Crown bevel gear. Initial step is to analyse the ongoing process for the production of crown bevel gears and to identify the cause (bottleneck) for high manufacturing time for the product.

2.1. Information Collection

A detailed study of the setup operations and existing changeover procedure were done in the grinding section. A chart to analyse the steps involved in assembly and disassembly of the fixtures was thus prepared, later the activities involved were segregated into internal and external activities.

Table-1: Previous method

Sr. no	Steps	Activity
	Big Parts Production	
1	Big back plate is mounted on the spindle of the grinding machine and trued	Internal
2	Big chuck is mounted on the back plate and trued	Internal
3	Big P.C.D plate is mounted on the chuck and trued	Internal
4	Clamping fingers are assembled and Big parts production starts	Internal
	Small Parts Production	
5	Clamping fingers are removed from the chuck	Internal
6	Big P.C.D plate is removed from the chuck	Internal
7	Big chuck is removed from the back plate	Internal
8	Big back plate is removed from the machine spindle	Internal
9	Small back plate is mounted on the spindle of the grinding machine and trued	Internal
10	Small chuck is mounted on the back plate and trued	Internal
11	Small P.C.D plate is mounted on the chuck and trued	Internal
12	Clamping fingers are assembled and small parts production starts	Internal

3.2. Brain storming

The high manufacturing time was identified by Brainstorming. Then the given causes were validated by finding the impact it has on the process flow. Initial stage of the thesis was carried out by analysing the whole process involved in manufacturing the two products of crown bevel gear, after identification of the bottleneck which in this case is the changeover time in the gear grinding section. SMED productivity improvement techniques was than implemented in order to achieve the desired results. When implementing SMED tool, the converting of internal to external setup is the most important stage to reduce machine setup time significantly. In other words, SMED implementation will considers as an unsuccessful activity when the conversion stage is fails. Next, SMED is difficult to apply when all steps of the current process are internal setups. Thus, jig and fixture were introduced as a tool to eliminate internal setup and further reduce external setup time. In addition, SMED required a long period of time to conduct the four conceptual stages whereas jig and fixture is always designed according to the workpiece structure, clamps and supporters [5].

Thus, a new method was proposed which allowed for implementation of adaptor plate which could accommodate small pcd plate and further can be mounted on big chuck of the previous big part production, thus eliminating wastages i.e. bottleneck from steps 7 to 10.

Table 2: **Proposed method for reducing setup time**

Sr no:	Steps	Activity
	Big Parts Production	
1	Big back plate is mounted on the spindle of the grinding machine and trued	Internal
2	Big chuck is mounted on the back plate and trued	Internal
3	Big P.C.D plate is mounted on the chuck and trued	Internal
4	Clamping fingers are assembled and Big parts production starts	Internal
	Small Parts Production	
5	Clamping fingers are removed from the chuck	Internal
6	Big P.C.D plate is removed from the chuck	Internal
7	Adaptor plate is mounted on the big chuck	Internal
8	Small P.C.D plate is mounted on the chuck and trued	Internal
9	Clamping fingers are assembled and Small parts production starts	Internal

3.3 Time Study:

By using the redesigned fixture, a time motion study was conducted to determine the degree of improvement of machine setup time. Similarly, each setup task and its exact time required are listed in the monitoring paper (Table3 & 4), for comparing all the data collected before and after improvement.

4. RESULT:

A time study was conducted to calculate the reduction in setup time and hence, improvement in productivity was thus determined. Table depicted below is the detailed time study carried out before and after improvements of the setup operations.

Table 3: Time study (Previous method)

Operation: Bore Grinding		**Area:** Hard section	
Machine involved: Nova Grinding Machine		**.**	
No of workers:1			
Sr no	**Elements**	**Reading in Minutes. Seconds**	**Average time**

		1	2	3	4	
	Big Parts Production					
1	Big back plate is mounted on the spindle of the grinding machine and trued	61.47	63.12	57.54	58.03	60.14
2	Big chuck is mounted on the back plate and trued	70.47	74.32	68.17	70.18	70.58
3	Big P.C.D plate is mounted on the chuck and trued	66.07	67.17	63.02	63.44	65.03
4	Clamping fingers are assembled and Big parts production starts	16.43	17.06	14.11	15.53	15.58
	Small Parts Production					
5	Clamping fingers are removed from the chuck	11.49	13.35	8.20	10.07	10.57
6	Big P.C.D plate is removed from the chuck	32.33	32.57	29.56	31.19	31.41
7	Big chuck is removed from the back plate	51.49	52.25	49.37	49.47	50.54
8	Big back plate is removed from the machine spindle	41.08	41.39	41.13	40.38	41.09
9	Small back plate is mounted on the spindle of the grinding machine and trued	60.42	62.15	57.30	58.51	59.49
10	Small chuck is mounted on the back plate and trued	71.06	72.08	70.31	69.44	70.52
11	Small P.C.D plate is mounted on the chuck and trued	57.19	56.24	55.30	54.30	55.55
12	Clamping fingers are assembled and small parts production starts	15.48	15.33	13.53	14.43	14.59
Total	**In Minutes**					548.28
	In Hours					09:08:29

Average Time	9hrs8min29sec	**Equipment Used:**
Normal Time	10hrs58min10sec	Pen, pencil, Stopwatch, Paper etc
Total Allowance	15%	
Standard Time	12hrs36min54sec	

Table 3: Time study (Previous method)

Operation: Bore Grinding		**Area:** Hard section				
Machine Involved: Nova Grinding Machine		.				
No of Workers: 1						
Sr no	**Elements**	**Reading in Minutes. Seconds**				**Average Time**
		1	**2**	**3**	**4**	
	Big Parts Production					
1	Big back plate is mounted on the spindle of the grinding machine and trued	59.47	61.33	61.02	59.55	60.34
2	Big chuck is mounted on the back plate and trued	69.17	70.43	71.11	69.54	70.16
3	Big P.C.D plate is mounted on the chuck and trued	63.14	65.52	66.19	64.05	64.52
4	Clamping fingers are assembled and Big parts production starts	15.16	15.59	16.20	14.36	15.32

	Small Parts Production					
5	Clamping fingers are removed from the chuck	8.36	9.51	11.03	9.25	9.43
6	Big P.C.D plate is removed from the chuck	29.11	30.41	31.06	29.48	30.11
7	Adaptor plate is mounted on the big chuck	29.35	31.26	32.51	30.13	31.01
8	Small P.C.D plate is mounted on the chuck and trued	53.57	56.18	55.58	54.49	55.15
9	Clamping fingers are assembled and Small parts production starts	13.40	15.39	16.20	14.34	15.03
Total	In Minutes					352.27
	In Hours					05:52:27

Average Time	5hrs52min27sec	Equipment Used:
Normal Time	7hrs2min56sec	Pen, pencil, Stopwatch, Paper etc
Total Allowance	15%	
Standard Time	8hrs6min22sec	

5. FUTURE WORK

In order to achieve a higher daily production rate of "Spiral bevel gear", the total setup time per part can be further reduces by applying the same methodology to study the setup processes in lapping and cutting processes.
The second recommendation is to study the effect of different improvement method such as increasing the number of operators to assist in the process of machine cleaning, jig clamping and workpiece positioning. In the current setup process, the average time that is consumed in the machine cleaning

5. CONCLUSIONS

The implementation of SMED principles on the setup procedure of a machine in line layout in the bearing manufacturing plant reduces the total setup time from an initial time of **548.48 minutes** to **352.25 minutes,** saving **196.23 minutes** i.e. **35.7423%** of total time. This indicates that SMED is an effective tool to reduce production loss in a similar batch manufacturing plant having a line layout In order to achieve a higher daily production rate of *Spiral Bevel Gear*, the total setup time per part can be further reduced by applying the same methodology to study the setup processes.

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