To Improve Productivity By Using Work Study & Design A Fixture In Small Scale Industry


Abstract – The purpose of this research is to improve production capabilities for small scale industry and this research focused on the company, which produce Stay vane of Francis turbine. This research used work study technique to improve work process in company, and the research objectives towards accomplished this study is to identify problems in the production work process and improved it in terms of production time, number of process and production rate by proposing an efficient work process to company. This research used systematic observation, flow process and stopwatch time study as research methodology. Pro-E model software used for model testing and develop new model. The improvement of work process was executed by eliminating and combining of work process, which reduces production time, number of process and space utilization.

Field of research: Production time, Productivity, Work study, Work measurement, Design of model

I. INTRODUCTION

1.1 Background of study

Industry consists of small numbers of employees and annual turnover. They can categorize into three criteria – primary agriculture, manufacturing and services. The company produces Stay Vane on vertical machining center. The small of its enterprise caused difficult for them to competing with other firmed companies. Thus, this research takes initiative to used work study technique to improve the work process in order to permit them to compete with international rivalry. The work study will examine the work process and eliminate nonproductive process, which can reduce number of process, space utilization and production and operation time. Time is important in production industry because according Fred (1992), time is money and time tells us exactly how much money was used. Besides that, this research was conducted based on industry development strategies and encouragement.

1.2 Scope of study

The scopes of this research are:

- This study concentrates on small scale industry, which is the company produced Stay vane of Francis turbine.
- The research is focused on time and the flow of work process in production department from the start until it produces finish products, which it will concentrate on production time and number of work process.

The data that needs to be carried out in this study is flow process of the work, the details for each process, the required time for specific process, number of stay vane that they produced in specific time.

II. LITERATURE REVIEW

According to Abdul Talib Bon and Aliza Ariffin they are working on “An impact of time and motion study on small medium enterprise”. The purpose of this research to improve work process in small medium enterprise industries. In that they use time and motion study to improve work process in small medium enterprise industries. The improvement of work process was executed by eliminating and combining of work process, which reduces production time, number of process and space utilization.

They conclude that these modeling techniques are not designed to facilitate productivity measurement and analysis as they focus on the availability of the unit/equipment, which is only one aspect of the system performance. Among all the continuous improvement methodologies surveyed, no single methodology can be crowned as the best. The approach would help factory professionals to systematically perform factory diagnostics by quantitatively focusing on critical areas constraining manufacturing system productivity.

According to Charles F. Keberdle set up reduction is to reduce machine down time. Reducing setup time will boost your company’s capacity, increase your manufacturing flexibility, and help increase overall
output. A simple saying I often use is, “If the machine is not running, you are not making money”.

They conclude that there are several benefits of reduction of machine setup and changeover time which are listed below:

1. Shorter lead time and increased capacity
2. Better quality/more-consistent processes
3. Lower manufacturing costs
4. Fewer inventories
5. Increased flexibility
6. Better workforce utilization
7. Less process variability

2.1 Productivity

According to Eatwell and Newman (1991) defined productivity as a ratio of some measure of output to some index of input use. Put differently, productivity is nothing more than the arithmetic ratio between the amount produced and the amount of any resources used in the course of production.

\[
\text{Productivity} = \frac{\text{total output}}{\text{total input}} \text{ which is identical to total results achieved/total resources consumed or effectiveness or efficiency.}
\]

2.2 Time study

According to Frederick W. Taylor (1880) they are working on time study by using a stopwatch to study and measure work content with his purpose to define “a fair day’s work.” Among his study is ‘Taylor Shovelling Experiment’ which they studied between 400 and 600 men that using their own shovel from home to moving material from mountains of coal, coke and iron ore in around two mile-long yards. Purposes of Taylor to identify that there have different size of shovels and which shovel was the most efficient. Thus analyzing it using stopwatch the results were fantastic which it reduced time, saving numbers of workers and budgeting for every year.

2.2.1 Stop-watch time study

This method involves making direct observation by means of a stop-watch the main steps that are required to be taken under this method are:

1. Check that the prescribed method is being followed in doing the job.
2. Divide the job observable and distinct element.
3. Choosing an appropriate operator, record the timing for each the work elements.

4. Rate the performance of the operator in each element and repeat measurement through a statistically, determined number of cycles of the job.
5. Based on the observations, compute the normal time for a unit of out.

III. PROBLEM STATEMENT AND OBJECTIVE

3.1 Problem statement

The company use vertical machining center in producing their stay vanes, where most of their work process was done manually by their workers. Sometimes, the production takes extra time in producing the stay vane. Moreover, the production department does not have any fixed or standard time for each process. They just decide and estimate the time for each process. Because of that, they often take longer than the time estimated. Also they have not proper methods for setting up the job on the machine bad. So the position of job may change at every cycle of production. This will affect the total job setup time at every cycle of machining, overall number of production of stay vane and also affect the overall production rate. Thus, it might be difficult for them to increase productivity and competes with other rivals.

The production method used currently in the company is time consuming as well as cumbersome. In order to reduce time and make the process simple, we applied various methodologies (Work study) and designed the new fixture accordingly. The new fixture so designed reduced the overall time period from job set up time to final dispatch.

3.2 Objectives

1. Identify the proposed methodology which reduces manufacturing lead time.
2. To design the template fixture in pro-e for vertical machining center.
3. Compare time study of both method and analyses on production.
4. Improve productivity by implementing new method.
5. Cost analysis of fixture components and analysis of net profit to the company.
4: DATA COLLECTION

4.1 Plant layout

Plant layout refers to the arrangement of physical facilities such as machines, equipment, tools, furniture etc. in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of raw material to the delivery of the final product.

Figure 4.1 Plant layout

4.2 Details of job (Stay vane)

4.2.1 Final stay vane after machining

After machining of stay vane there are four welded road are attached to the stay vane which are used for the job setup on the bed of the VMC machine. This welded rod is required to remove and then final grinding require for final finishing of the stay vane

BEFORE GRINDING

AFTER GRINDING

Figure 4.2 Final stay vane

4.3 Flow process of raw material to finished stay vane

Chart 4.1 Flow process of raw material to finished stay vane

4.4 Actual job setup used before implementation

This is the actual position the job setup in the machine in which four welded rod is used to setup the job on the bed with the help of some clamps and metal blocks.

Figure 4.3 Actual job setup
V. DATA ANALYSIS

5.1 Comparison of new designed machining setup with company setup

5.1.1 For first side machining setup

Figure 5.1 Company setup

Figure 5.2 New designed setup

5.1.2 For second side machining setup

Figure 5.3 Company setup

Figure 4.4 Clamps used for holding the job
5.2 Difference between company setup and new design setup

<table>
<thead>
<tr>
<th>First side setup</th>
<th>Company setup</th>
<th>New design setup</th>
<th>Second side setup</th>
<th>Company setup</th>
<th>New design setup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required four welded rod</td>
<td>No requirement of welded rod</td>
<td>Required four welded rod</td>
<td>Required two welded rod</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requirement of job positioning at every cycle</td>
<td>No requirement of job positioning at every cycle</td>
<td>Requirement of job positioning at every cycle</td>
<td>No requirement of job positioning at every cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possibility of failure is more</td>
<td>Possibility of failure is less</td>
<td>Possibility of failure is more</td>
<td>Possibility of failure is less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.3 Time study comparison

This table shows the comparisons of times which was reduced according to new implementation

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Activity</th>
<th>Time study comparison (hr: min: sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>After</td>
<td>Before</td>
</tr>
<tr>
<td>1</td>
<td>Transfer material from storage to welding section</td>
<td>00:10:00</td>
</tr>
<tr>
<td>2</td>
<td>Welding time</td>
<td>00:45:00</td>
</tr>
<tr>
<td>3</td>
<td>Transfer material from welding section to vmc machine-3</td>
<td>00:10:00</td>
</tr>
</tbody>
</table>

Table 5.1 Time study comparison

5.4 Analysis of monthly production of stay vane

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Description</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>total time for complete stay vane</td>
<td>28:15:57 (hr: min: sec)</td>
<td>26:00:57 (hr: min: sec)</td>
</tr>
<tr>
<td>2</td>
<td>number of job produced in one month</td>
<td>19(546/18=19)</td>
<td>21(546/26=21)</td>
</tr>
</tbody>
</table>

Here 546 is the total working hours in one month

Table 5.2 Analysis of monthly production of stay vane
VI. COST AND PROFIT ANALYSIS

6.1 Cost of fixture

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Part name</th>
<th>No. of Part</th>
<th>Volume mm³</th>
<th>Raw material</th>
<th>Machining cost</th>
<th>Welding cost</th>
<th>Drilling and threading cost</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L-shape clamp- 1(width 200 mm)</td>
<td>1</td>
<td>1300000</td>
<td>560</td>
<td>100</td>
<td>20</td>
<td>40</td>
<td>770</td>
</tr>
<tr>
<td>2</td>
<td>L-shape clamp- 2(width 300 mm)</td>
<td>1</td>
<td>1950000</td>
<td>840</td>
<td>100</td>
<td>20</td>
<td>40</td>
<td>1050</td>
</tr>
<tr>
<td>3</td>
<td>L-shape clamp (without rib)</td>
<td>3</td>
<td>850000</td>
<td>370</td>
<td>100</td>
<td>-</td>
<td>40</td>
<td>1530</td>
</tr>
<tr>
<td>4</td>
<td>T-clamp</td>
<td>5</td>
<td>200000</td>
<td>90</td>
<td>50</td>
<td>-</td>
<td>20</td>
<td>800</td>
</tr>
<tr>
<td>5</td>
<td>Bright flat plate-1</td>
<td>1</td>
<td>225000</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>160</td>
</tr>
<tr>
<td>6</td>
<td>Bright flat plate-2</td>
<td>1</td>
<td>112500</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td>7</td>
<td>Bright flat plate-3</td>
<td>1</td>
<td>191250</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>40</td>
<td>120</td>
</tr>
<tr>
<td>8</td>
<td>45° taper clamp</td>
<td>4</td>
<td>301000</td>
<td>130</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>920</td>
</tr>
<tr>
<td>9</td>
<td>45° taper plate use for welding</td>
<td>2</td>
<td>400000</td>
<td>180</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>400</td>
</tr>
<tr>
<td>10</td>
<td>Fixture base plate</td>
<td>2</td>
<td>16200000</td>
<td>7000</td>
<td>-</td>
<td>-</td>
<td>80</td>
<td>14160</td>
</tr>
</tbody>
</table>

Total cost of fixture = 20,000

Table 6.1 Cost of fixture

6.2 Profit analysis

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Detail</th>
<th>Before implementation</th>
<th>After implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No. of job per month</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>No. of job per year</td>
<td>19*12=228</td>
<td>21*12=252</td>
</tr>
<tr>
<td>3</td>
<td>Profit per year</td>
<td>228*6600 = 15,04,800Rs</td>
<td>252*6600 = 16,63,200Rs</td>
</tr>
</tbody>
</table>

Net profit per year = 1663200 - 1504800 = 15,8400 Rs

Here 6600 is the total machining cost of manufacturing of one stay vane in Rs

Table 6.2 Profit analysis
6.3 Net profit analysis after deducting cost of fixture

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Detail</th>
<th>Net profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Profit per year</td>
<td>158400-20000=1,38,400Rs</td>
</tr>
<tr>
<td>2</td>
<td>Profit per month</td>
<td>138400/12=11,500Rs</td>
</tr>
</tbody>
</table>

Table 6.3 Net profit analysis after deducting cost of fixture

VII. SUMMARY & CONCLUSION

7.1 Summary

1. After applying work study and making design of fixture for stay vane total time reduced for manufacturing one stay vane from 28:15:57(hr:min:sec) to 26:00:57(hr:min:sec) shown in table 5.1.

2. By analysis of working hour for month, improving method study of stay vane and applying time study total number of job increased per month 19 to 21 shown in table 5.2.

3. After calculating machining cost and deducting cost of fixture from profit then net profit for company for producing stay vane per year is 1,38,400 Rs as shown in table 6.3.

7.2 Conclusion

From the discussion of the above parameters, it can be concluded that this process can be improved based on the five parameters (work process, method study, time measurement, fixture design and cost analysis) it will improve the current work process. These modifications are made by eliminating the wasted time and reduction of the work contents. From the comparison between current and new work process shown in topic 5.2, it indicates that the best alternative towards this problem by new method. After implementing new method on this stay vane job production it will increase production (2 stay vanes) as compare to company method. (In company method it would produce 19 stay vanes and after applying new method they can produce 21 stay vanes per month see table 5.2). This improvement was successfully implemented and it achieves the project goals and objectives, which improve processes, production layout, economy in human effort and the reduction of unnecessary fatigue.

VIII. REFERENCES


[8] Text book of Industrial Engineering, Tech max publication By Dr. Pradip Kumar Sinha, [page no 3-18, 3-19, 3-22,3-23]

