Study on Process and Time Optimization using Flow Process Chart, Time Study and Critical Path

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Abstract: The main aim of the study is to learn and analyze the processes involved in engine repairing and reconditioning section at MSRTC, Central Workshop, Nagpur and to suggest possible Movements to optimize the process to increase efficiency and the output of the plant.

There are 6 types of engines which are used in the buses and these are repaired and maintained at MSRTC. In this study the primary focus is on the two major engine types. In the 1st phase of the study, we initially observed the industry, understanding in brief the overall process and working of the industry. The work was done at engine repairing and reconditioning unit within the industry.

There were multiple processes involved starting from stripping to the testing of the engine. In the industry it was found that the main problem was that there was no fixed standard time for doing a job. Hence this resulted in the workers not working to their full potential and therefore the time they took to complete that job was more than the time in which it could have been done. Also another major problem was that the plant layout had discrepancies and flaws which violated the principles of facility layout planning.

Hence to correctly estimate the man hours required to complete the job, the process was broken down into different activities and the flow process charts for various activities were plotted. It was concluded that conducting a method study and facility layout planning would help us improve the efficiency of the plant. So the process was studied and flow process charts for the various sub-sections of the plant were made.

I. INTRODUCTION

A key concern for any manufacturing company is the ability to produce a variety of high quality products by reducing manufacturing time and cost. Thus the aim is to improve the layout of operations/processes so that product assembling and manufacturing time and cost can be reduced.

There were some problems because of which the output of plant was affected. These included:

1) Improper facility layout which resulted in excess movement of materials.
2) Since there was no set standard time for performing the various jobs, this resulted in workers working at a slow work rate.
3) This affected the output; there was a scope of improvement in the existing method in the industry.

A. Study Conducted on the Engine types Used in MSRTC

1) 697 TCIC: 6 cylinder engine
2) 712 BS3: 4 cylinder engine (used for midi buses)
II. DIFFERENT SECTIONS IN THE ENGINE SECTIONS

A. Striping Section
Engine is dismantled completely in this section and each part is moved further to the degreasing room. The various parts may include: Cylinder head, Crankshafts, Pistons, Turbochargers, Liners, Camshafts, Oil pumps, Cylinder blocks.

B. Degreasing Plant
In degreasing plant, separated parts and dump in degreasing tank, Trichloroethylene (C₂HCL₃) is poured in the tank and tank is then heated at constant temperature. Fumes generated in the tank helps in cleaning of parts.
C. Pre Inspection Section
Dismantled parts are inspected in this section and the rejected parts are scraped. The usable parts are then distributed to different sections. In this section the parts are also cleaned and inspected for any damage.

![Fig.4 Pre inspection section](image)

D. Auto Machine Shop
Different activities are performed in this shop. Firstly the sleeves are taken out from the cylinder with the help of hydraulic press then with the help of boring machine diameter of sleeves are increased to 96.93mm. Then the further precision of 0.07 is achieved with the help of honing machine. Honing is a super finishing operation. Also in this section bending in camshaft and crankshaft is eliminated with Hand press machine. Also crank grinding machine is used to repair the bearing surface.

E. General Machine Shop
General operations are performed like: Threading, Welding, Brazing, Finishing.

F. Sub Assembly & Cylinder head Section
Different parts are repaired and maintained like: Air compression block, Cylinder head, Water pump, Rocker arm, Heat exchanger plate, Turbocharger.

G. F.I. Pumps Section
In this section the following process are done: Recondition Repairing, Replacing parts, Cleaning, Checking, and Testing.

H. Assembly Section
Parts from different sections are brought and assembled in the assembly section.

![Fig. 5 Assembly area](image)

I. Testing section
Engine is tested for various parameters: Proper water circulation, Engine blow by, Noise test, Oil leakage test, Fuel system test, Proper oil pressure.
J. Dynamometer

Fig. 6 Dynamometer used for engine testing

III. PROBLEM IDENTIFICATION

A. Poor Layout Management
Since the layout management is improper. Hence the workers have to carry out the extra transport of materials from one area to the other which could have been easily avoided.

B. Improper Arrangement of Machinery and Equipment
Since the machinery and necessary material required are at some distance from each other, this results in the more and more time consuming of the process also while the material handling of the raw materials some amount of it is wasted which is avoidable.

C. Improper Material Handling
Due to excessive material handling, worker faces fatigue as he has to carry out unnecessary movements associated in transport of the materials and thus this result in reduction in his output. Also the materials may get damaged due to the improper material handling.

D. No Standard Time Available
Since there was no set standard time for performing the various jobs, this resulted in workers working at a slow work rate. This affected the output of the plant. The workers can now work as per their own speeds as there is no set times to complete the job.

IV. WORK CARRIED OUT

A. Methodology
A detailed methodology was followed in the same sequence for the proper study.
1) Detailed plant study,
2) Existing layout,
3) Process flow of engine section,
4) Flow process chart,
5) Time study,
6) Identification of value added and non-value added Activities.

B. Precedence Diagram

| Activity | Precedence | Description         | Duration [Hrs] |
|----------|------------|---------------------|----------------|
| A        |            | Stripping           | 7              |
| B        | A          | Degressing          | 3              |
| C        | B          | Pre-inspection      | 4              |
| D        | C          | Auto machine shop   | 12             |
| E        | C          | Sub Assembly shop   | 17             |
| F        | C          | General machine shop| 19             |
| G        | B          | F.I. pump section   | 7              |
| H        | D,E,F,G    | Assembly line       | 8              |
| I        | H          | Testing Section     | 2              |
| J        | I          | ODS section         | ...            |
C. Critical Path

![Critical Path Diagram]

D. Flow Process Chart Of Different Sections

1) Striping Section, Degreasing Plant & Pre-Inspection Section: In this the Engine is dismantled completely in this section. After the stripping section the engine is sent to the degreasing section. Then it is sent to the pre inspection section. Here the dismantled parts are inspected. The rejected parts are then scraped.
2) Auto Machine Section: Various operations are performed here like hydraulic press, center less grinding, pressing, honing, boring, etc. The parts are reconditioned according to their condition and sent further to assembly area.

3) General Machine Section: According to the need of the parts the various operations are performed in general machine shop and moved further to the various sections. The various operations performed are Threading, Welding, Brazing, and Finishing.
4) **F.I Pump and Head Section**

a) **Pump:** The various steps involved are repairing, replacing parts, cleaning, checking and testing.

b) **Head:** Removing of wall sheet, inserting of new sheet, lapping.

c) **Sub Assembly Section:** Different parts which are collected apart from cylinder head are repaired and reconditioned. Air compression block, Cylinder head, Water pump, Rocker arm, Heat Exchanger plate, Turbocharger.

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**Table 1: Pump and Head Section**

| Sr No. | Description                        | Dist (m) | Time (min.) |
|--------|------------------------------------|----------|-------------|
| 1      | Head transported to head section    | 32       | 15          |
| 2      | Unloading                          |          |             |
| 3      | Head inspection                    | 5        |             |
| 4      | Removing of wall sheet             | 15       |             |
| 5      | Inserting of new wall sheet        | 220      |             |
| 6      | Lapping                            | 230      |             |
| 7      | Inspection for lapping             | 25       |             |
| 8      | Sent to assembly line              | 20       |             |
| 9      | Loading of pump                    | 34       | 15          |
| 10     | Transported to pump section        | 43       | 10          |
| 11     | Unloading of pump                  |          |             |
| 12     | Removing parts from pump           | 130      |             |
| 13     | Cleaning of pump with kerosene     | 60       |             |
| 14     | Assembling of pump parts           | 150      |             |
| 15     | Pump transporting for testing      | 2        | 5           |
| 16     | Testing of pump                    | 50       |             |
| 17     | Final inspection                   | 10       |             |
| 18     | Pump loaded on trolley             |          |             |
| 19     | Pump transported to assembly       | 47       | 10          |

**Table 2: Sub Assembly Section**

| Sr No. | Description                        | Dist (m) | Time (min.) |
|--------|------------------------------------|----------|-------------|
| 1      | Loading of parts from pre inspection| 5        | 15          |
| 2      | Transported to sub assembly section| 32       | 15          |
| 3      | Unloading of parts                 | 10       |             |
| 4      | Operation of HEP, WP, air compressor| 340      |             |
| 5      | Final inspection                   | 25       |             |
| 6      | Loading of parts in trolley        | 5        |             |
| 7      | Transported to assembly line       | 34       | 15          |
| 8      | Replacing of oil pump and oil filter| 20       |             |
| 9      | Final inspection                   | 5        |             |
| 10     | Loading of oil pump and oil filter  |          |             |
| 11     | Transported to assembly line       | 34       | 15          |

**Table 3: Activity and Present**

| Activity                  | Present |
|---------------------------|---------|
| Operation                 | 4       |
| Inspection                | 7       |
| Transport                 | 8       |
| Delay                      | 2       |
| Storage                    |         |
| Distance (m)              | 66      |
| Time (min)                | 1140    |
| Value Added Time (Operation Time) | 390 |
| Non Value Added Time       | 750     |
d) Assembly Section: When the parts are repaired and reconditioned they are transported to the assembly area. The assembly of the engine is started.

V. CONCLUSION

Hence we have identified the major areas of improvement within our industry and by using the principles of method study and facility layout optimization we are striving towards coming up with a better method to solve the existing problem. Using flow process charts we have been able to identify the major problems areas within the industry. This has helped us to categorize the activities on the basis of value added time and non-value added time within the process. Thus we can try to reduce the man value added time of the process by improving the existing method and optimizing the layout so that it reduces cost and leads to the reduction of man hours required to perform the job and ultimately more engine can be repaired within the given time.

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