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

Tushar Bhakte[1], Pratik Badwaik[2], Ankita Gosewade[3], Devyani Bhakte[4], Siddhant Zelgonde[5], Riddhi Badwaik[6], Kashak Jambhulkar[7]

[1, 4] *Shri Ramdeobaba College of Engineering and Management, Nagpur,*
[2]*Priyadarshini College of Engineering, Nagpur,*
[3]*St. Vincent Pallotti College of Engineering and Technology, Nagpur,*
[4]*Laxminarayan Institute of Technology, Nagpur,*
[5]*Yeshwantrao Chavan College of Engineering, Nagpur,*
[6]*Vishwakarma Institute of Information Technology, Pune*

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

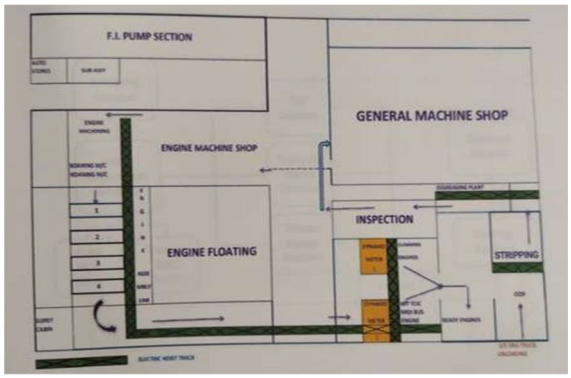

Fig. No. 1 Engine Shop Layout

The arrows shown the flow of all the activities, Green lines represent the Electrical Hoists, Assembly lines is represented by number 1, 2, 3 & 4, Yellow box represent the section area

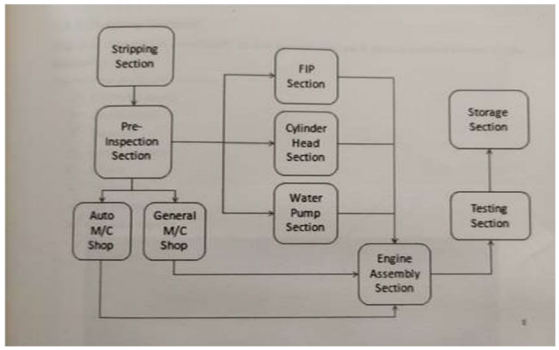

Fig. No. 2 Flow of Engine Section

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 (C_2HCL_3) is poured in the tank and tank is then heated at constant temperature. Fumes generated in the tank helps in cleaning of parts.

Fig. 3 Degreasing Chamber

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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

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

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.

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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

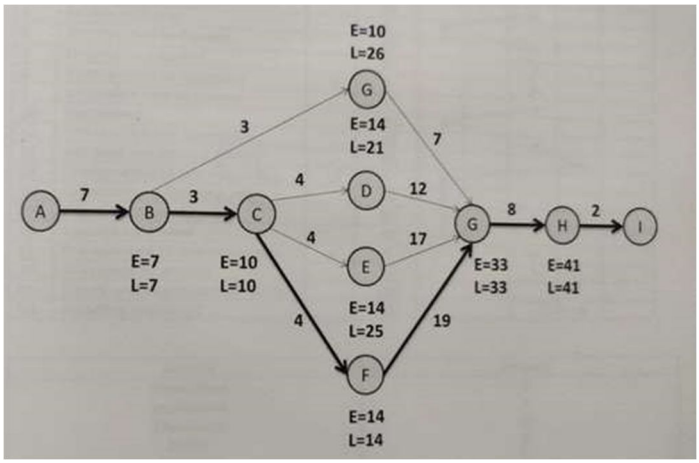
A detailed methodology was followed in the same sequence for the proper study.

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	Degreasing	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



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 set 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.

Sr No.	Description	Dist (m)	Time (min.)
1	Stored in old engine store		10
2	Engine picked up		5
3	Transported to stripping bay	12	5
4	Unloaded on to engine stand		10
5	Engine stripped		6
6	Transported to basket		10
7	Loaded into basket		20
8	Transported to degrease	9	5
9	Unloaded into degrease		15
10	Degreased		120
11	Unloaded from degreaser		15
12	Allowed to cool in a trolley		25
13	Transported to pre inspection	17	5
14	Unloaded on cleaning area		10
15	All parts cleaned		80
16	Loaded on trolley		10
17	Transported to pre inspection	1	5
18	Unloaded to ground		15
19	Check and inspection of parts		100
20	Awaiting transport		15

Sr No.	Description	Dist (m)	Time (min.)
1	Parts loaded on trolley		10
2	Parts transported to auto shop	10	10
3	Parts unloaded to auto shop		10
4	Removing of sleeve from blocks		40
5	Inserting of new sleeves		80
5	Boring		170
6	Honing		60
7	Checking of bore diameter	2	5
8	Block transported to assembly		15
9	Loading of crank and cam shaft	2	10
10	Transported to bending M/C		---
11	Unloaded to bending M/C		5
12	Inspection if any bending		15
13	Removal of bending		30
14	Loading to trolley	4	5
15	Transported to grinding M/C		10
16	Centre less grinding	14	20
17	Transported to assembly line		10
18	Loading of connecting rod	1	---
19	Transported to bush M/C		---
20	Loading to bush		5
21	Press and cutting		40
22	Finishing and inspection		10
23	Transported to assembly	12	10

Activity	Present
Operation	7
Inspection	3
Transport	14
Delay	---
Storage	---
Distance (m)	55
Time (min)	710
Value Added Time(Operation Time)	440
Non Value Added Time	270

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.

Sr No.	Description	Dist (m)	Time (min.)
1	Parts transported to general shop	24	20
2	Unloading of body and parts		15
3	Sorting for different operations		80
4	Welding inspection		70
5	Welding operation		105
6	Operational delay		90
7	Welding operation		70
8	Final inspection		60
9	Loading of body and parts		15
10	Transported to auto M/c shop	14	15
11	Inspection for brazing		60
12	Brazing operation		135
13	Final inspection		60
14	Awaiting for cooling		90
15	Loading to trolley		15
16	Transported to auto M/C shop	14	10
17	Inspection for threading and drilling		60
18	Drilling/threading operation		80
19	Final inspection		60
20	Loading of parts		15
21	Transported to auto M/C shop	14	15

Activity	Present
Operation	7
Inspection	3
Transport	9
Delay	—
Storage	—
Distance (m)	158
Time (min)	970
Value Added Time(Operation Time)	865
Non Value Added Time	105

4) F.I Pump and Head Section

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

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

Sr No.	Description	Dist (m)	Time (min.)
1	Head transported to head section	32	15
2	Unloading		5
3	Head inspection		15
4	Removing of wall sheet		220
5	Inserting of new wall sheet		230
6	Lapping		25
7	Inspection for lapping		20
8	Sent to assembly line	34	15
9	Loading of pump		---
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

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.

Sr No	Description	Dist (m)	Time (min.)
1	Loading of parts from pre inspection		5
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

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.

Sr No.	Description	Dist (m)	Time (min.)
1	All parts transported to assembly line		—
2	Unloading of parts on trolley		15
3	Assembling of parts		150
4	Delay due to improperly repaired parts		120
5	Loading of parts that requires reworks		10
6	Transported to respective section	36	20
7	Rework of parts		60
8	Loaded on trolley		10
9	Transported to assembly section	36	10
10	Assembling of parts		45
11	Final inspection of assembled engine		15
12	Engine loaded on trolley		15
13	Transported to testing section	22	10
14	Unloading of engine		15
15	Inspection of engine on dynamometer		90
16	Transported to ODS	17	10
17	Unload to ODS		10
18	Storing in ODS		—

Activity	Present
Operation	2
Inspection	2
Transport	7
Delay	—
Storage	—
Distance (m)	100
Time (min)	455
Value Added Time(Operation Time)	360
Non Value Added Time	95

Activity	Present
Operation	3
Inspection	2
Transport	11
Delay	1
Storage	1
Distance (m)	111
Time (min)	605
Value Added Time (Operation Time)	255
Non Value Added Time	350

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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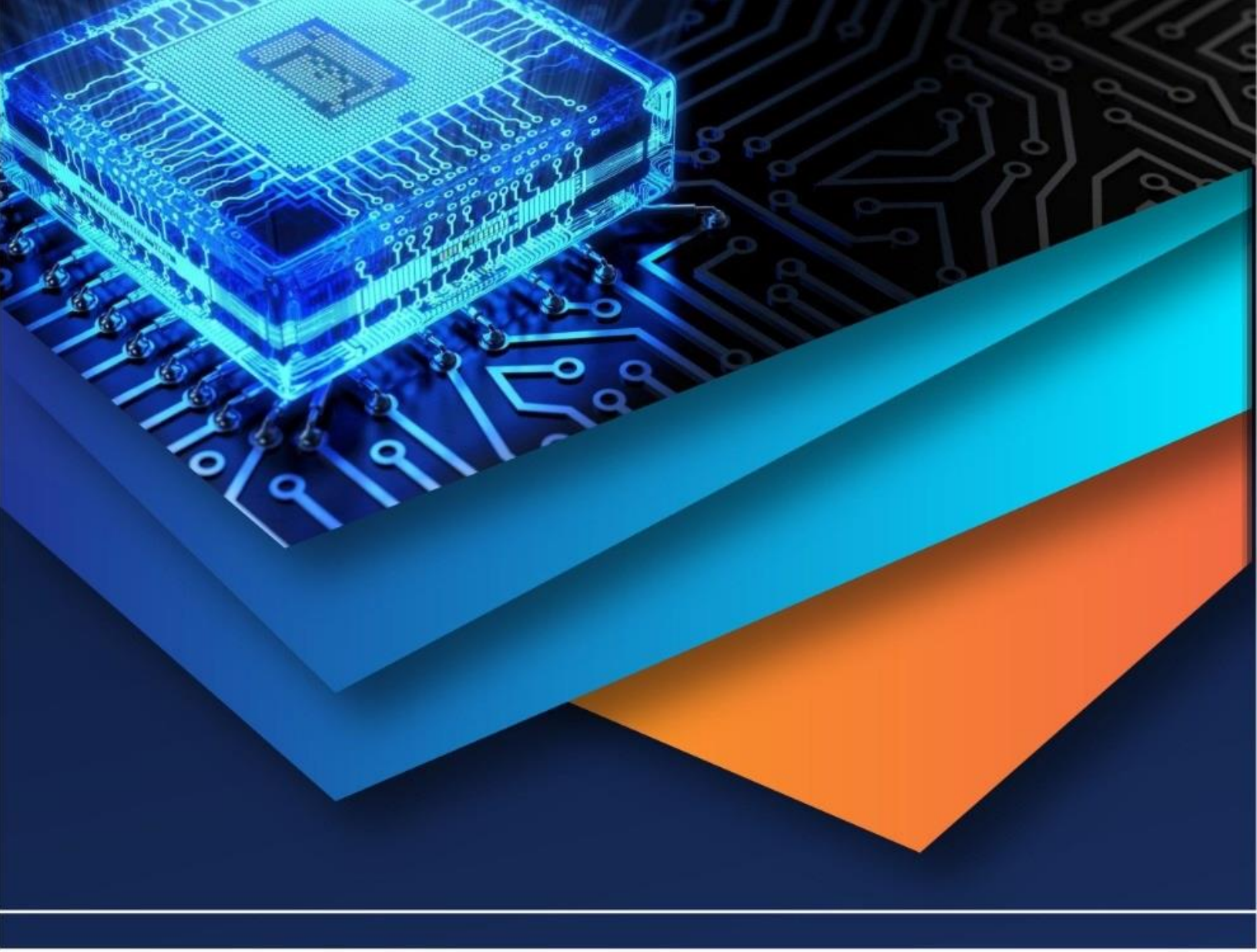

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