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Redesigning of Horn Assembly Line Using Ecrs Principles

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Abstract: ***In today's competitive manufacturing environment, companies are constantly looking for ways to improve in their production process. A new redesigned assembly line is proposed for bottleneck problem for continuous flow type horn assembly line. This paper presents the improvement of production rate and balance loss ratio of the manual assembly line. Using ECRS four principles (Eliminate, Combine, Rearrange and Simplify) minimize the idle time of machine at bottleneck station or the percentage of line balance loss. Verification of proposed system can be prepared by means of time values calculated from Modular Arrangement of Predetermined Time Standards (MODAPTS) method. The result shows that Bottleneck time (crimping stage time) reduced from 23.04 to 16.65 seconds and Production rate increased from 156 to 216 pieces per hour.***

Keywords**-Assembly Line, ECRS Principle, MOD Method, Work Study.**

I. INTRODUCTION

The basic assembly line consists of a set of workstations arranged in a linear fashion, with each station connected by a material handling device. The basic movement of material through an assembly line begins with a part being fed into the first station at a predetermined feed rate. A station is considered any point on the assembly line in which a task is performed on the part. These tasks can be performed by machinery, robots, and/or human operators. Once the part enters a station, a task is then performed on the part, and the part is fed to the next operation. The time it takes to complete a task at each operation is known as the process time. The cycle time of an assembly line is predetermined by a desired production rate. This production rate is set so that the desired amount of end product is produced within a certain time period. In order to improve productivity, various techniques have been developed to handle problems from different areas such as work measurement, method improvement, and quality improvement tools and line balancing technique. Efficiency is a tool to measure any industry organization's performance while productivity is used to measure this efficiency. This paper deals with the problems of bottleneck process, machine idleness and operator fatigue and improvement can be done using ECRS principles (Eliminate, Combine, Rearrange, and Simplify) and robots can be used in order to maximize the utilization of the machine at a minimum operating time.

II. CONCEPT OF WORK STUDY

Work study has become one of the important methods in improving production operation system and production efficiency. During the implement of work study, all kinds of factor which may affect the production efficiency were investigated and analyzed. Work Study is the generic name of Methods Study and Work Measurement. It was the most important basis technique in industry engineering. The most obvious character is using less investment or no investment to increase the production efficiency and benefit , reduce the cost and to strengthen the competition ability through improving the operating process and method, implementing the advanced and reasonable working quota, fully utilizing the human resources, material resources and financial resources inner the enterprise.

Work study includes method study and work measurement. Method study mainly on searching efficiency working method, whereas work measurement is to determine the scientific and reasonable working time quota of each operating. The main analysis tools in method study are 5W1H (What, Where, When, Who, Why and How) question-asking method, the four principles of ECRS (Eliminate, Combine, Rearrange and Simplify) and the principles of motion economy.

Work measurement is to work out a time standard for fulfilling a job with economical and rational methods. The main methods under work measurement are stopwatch time study, work sampling, predetermined time system and standard data method. Among them, the predetermined time system is simply called PTS method. It is used to determine the time required for different operations on basis of the time standard predetermined for various motions instead of direct observation or measurement. Under PTS method, there are a few methods for determination of standard working hours.

III. PROBLEM IDENTIFICATION IN ASSEMBLY LINE

The horn manufacturing company produces several types of horns for automobiles. In that Smart one horn is an important type. It has 14 assembly stages.

Below is correlative formula:

The yield of one person in one hour = 3600 / (number of people x the time of bottleneck processes) (1)

The ratio of production line balance = total time of each processes / (number of people x the time of bottleneck processes) x 100% (2)

The ratio of balance loss = 1 - The ratio of production line balance (3)

TABLE I: Time study of existing assembly process before optimization

Operation	Average time in	No of operators	Normal time in sec.	Allowances in %		Standard time in secs
				Fatigue	personnel	

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	sec.					
Spool holder riveting	13.05	1	12.39	5	7	13.89
Terminal base, Point plate, Point holder, Diode assembly	12.09	1	11.49	5	7	12.87
Terminal riveting & Tuning screw insertion	13.81	1	13.12	5	8	14.83
Diode continuity/ Clamping voltage checking	6.67	1	6.34	5	6	7.04
Diaphragm assembly riveting & height measuring	12.17	1	11.56	5	7	12.95
Gasket assembly precrimping & final crimping	21.46	1	20.39	5	8	23.04
Air gap measuring & adjusting	15.13	1	14.37	5	8	16.24
Pretuning & mounting bracket assembly	16.53	1	15.70	5	8	17.74
Horn tuning & Testing	16.9	1	16.06	5	6	17.83
Measurement of tuning range and batch coding	11.8	1	11.21	5	7	12.56
Paint applying	5.4	1	5.13	5	6	5.69
Black paint duco applying	5.34	1	5.07	5	6	5.63
DH batch	3	1	2.85	5	5	3.14
Quality 100% inspection	7.76	1	7.372	5	6	8.18

Table I represents that gasket assembly, pre-crimping and final crimping stage is the bottleneck process while cycle time for each station also varies from one another. The total time of processes is 172.45 seconds, the number of people is 14, the time of bottleneck processes is 23.04 seconds (process 6), take the value above into the formula:

The production rate of one person in one hour = 3600/the time of bottleneck process; =3600/23.04 =156 pieces;

The ratio of production line balance = Total time of each process/ (Number of people*the time of bottleneck process)*100%;

=171.63/ (14*23.04)

=53.21%;

The ratio of balance loss = 1-The ratio of production line balance;

= 1-53.21% = 46.79%;

Thus, 46.79% of the production time is idle due to the imbalanced line and it has to be improved. The main operating steps of gasket assembly pre-crimping and final crimping are below:

1. Run out to take housing from conveyor to vacuum cleaner and take diaphragm.
2. Take keeper ring & gasket to assemble with diaphragm.
3. Move the assembled horn for pre-crimping and final crimping.

IV. The Plan Of Optimization Of Assembly Line

A. Adjustment of the Processes Using ECRS Principles

ECRS means Eliminate, Combine, Rearrange and Simplify. Eliminate the goal to combine or reset the place, time and person and to simplify the method provides better effect and process flow method.

The adjustments made in gasket assembly pre-crimping and final crimping process:

E: Eliminate

S. No	Proposals	Annotations	Efficient	Cost	Time
1.	Automatic pre&final crimping	Eliminating operator fatigue. Time reduction:2sec	Zero defect	Rs.15000	0sec
2.	Indexing table with fixture	Eliminating machine idle time	Zero defect	2 lakhs	8secs
3.	Fixture for assemble	Eliminating one hand idle	Zero defect	Rs.2500	6secs

C: Combine

S. No	Proposals	Annotations	Efficient	Cost	Time
1.	Combing vacuum cleaner with conveyor	Reduce time (1.4secs) for vacuum cleaning	Zero defect	Rs.15000	0sec
2.	Combining pre & final crimping in a single machine	90degree crimping in a single machine	Zero defect	Rs.22000	7.5secs

R: Rearrange

S. No	Proposals	Annotations	Efficient	Cost	Time
1.	Vacuum cleaner placement	Eliminating hand movement	Zero defect	Rs.0	1.2secs
2.	Placement of keeper ring	Reduce distance	Zero defect	Rs.0	2secs
3.	Providing chute in housing conveyors with sensors	Making work easy	Zero defect	Rs.0	0sec

S: Simplify

S. No	Proposals	Annotations	Efficient	Cost	Time

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1.	Spring loading for keeper ring	Load huge amount of keeper ring for 1 shift	Zero defect	Rs.300	2secs
2.	Simplified pick and place for scara robot	Fast pick and place	Zero defect	20 lakhs	2secs
3.	Magnets to pick & place between pre, final to conveyor	Keeper ring & tone disc may damage	Defects may occur	Rs.7000	3secs

B. Using MOD Method to Improve the Bottleneck Processes

MOD method is a typical work measurement method. It is an indirectly effective method to formulate standard working time. It is not only suit to formulate the standard operating working time but also to improve the operation the working people in the assembly line in this company have accomplished the standardization and corresponded with the apply conditions of MOD method. So the bottleneck processes emphasis on the "Gasket assembly, pre-crimping and final crimping" using MOD method to implement the action analysis and formulate theory standard working time to improve bottleneck processes. Due to the uncontrollable reasons, the liquidity of people in assembly line is relatively large and not fixed. So the operating level of people is not stable and proficient. Therefore, we should widen the value of the unit of MOD time. If 1 MOD=0.129 s, the working people likely do not accomplish the quota of workload. So 1 MOD=0.143 s (include 10.75% of recover time).

S. No	Action of left hand	Action of right hand	Activity analysis	Mod value	Time in secs
1.	Moving housing to fixture from vacuum cleaner (M3G3)	Taking gasket to fixture (M3P5)	M3G3 M3P5	14	2.002
2.	Moving diaphragm to fixture (M4G3)	Taking keeper ring and assemble (M4G3)	M4G3 M4G3	14	2.006
3.	Giving signal for final crimping (M3G4)	Giving signal for pre crimping (M3G4)	M3G4 M3G4	14	2.002

Total = 6.006 secs
Machine time:
Machine moving below = 1.44secs;
Machine moving above = 1.39secs;
Crimping process @ machine= 4.67 secs;
Vacuum cleaner time =3secs (completed while assemble);
Robot moving time =2secs;
Total time (crimping)=6.006+1.44+1.39+4.67+2 =15.51secs;
Standard time =15.51*0.95(1+0.05+0.08)=16.65secs;

TABLE II: Time study for proposed assembly process

Operation	No of operators	Standard time in secs
Spool holder riveting	1	13.89
Terminal base, Point plate, Point holder, Diode assembly	1	12.87
Terminal riveting & Tuning screw insertion	1	14.83
Diode continuity/Clamping voltage checking	1	7.04
Diaphragm assembly riveting & height measuring	1	12.95
Gasket assembly precrimping & final crimping	**1**	**16.65**
Air gap measuring & adjusting	1	16.24
Pretuning & mounting bracket assembly	1	17.74
Horn tuning & Testing	1	17.83
Measurement of tuning range and batch coding & Paint applying	**1**	**19.3**
Black paint duco applying, DH batch & Quality 100% inspection	**1**	**19**

We can conclude from Table I that the 10th operation to 14th operation was done by 4 workers and the times taken were 12.56, 5.72, 5.66, 3.15 and 8.23 seconds. After the action analysis of these two processes, we found the above processes can be done by 2 persons. It will not become the new bottleneck processes. Otherwise, the 10th and the 11th could be combined into one process also 12th, 13th and 14th processes could be combined into one process after standardization. It could be cased after inspection. Thus, the entire assembly line could reduce 3 persons.

C. Effect Analysis of Optimization Plan

1. The production rate of one person in one hour = 3600/the time of bottleneck process =3600/16.65 =216 pieces;
2. The ratio of production line balance = Total time of each process/ (Number of people*the time of bottleneck process)*100%; =168.34/ (11*16.65) =91.9%
3. The ratio of balance loss = 1-The ratio of production line balance; = 1-0.919% = 8.1%;

The ratio of balance loss should be controlled in 5%-13%.

V. CONCLUSION

Time oriented assembly line balancing problem implies idle times on workstations. There are different objectives and different work study methods are used for finding final solutions. Work study investigates all production problems for resulting feasible solutions. The objective of this paper has been achieved which is to improve line balance ratio. The results obtained as the production rate increased from 156

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pieces to 216 pieces, production line balance ratio improved from 53.21% to 91.9% and the ratio of balance loss is controlled from 46.79% to 8.1%.

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