AN EXPERIMENTAL STUDY ON THE AUTOMOTIVE PRODUCTION LINE TO REDUCE THE CYCLE TIME

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ABSTRACT

The main aim of an assembly line is to group the different facilities and workers in an efficient manner in order to obtain effective utilization of manpower and machine. This calls for uniform rate of production as well as decrease in the work in process inventory. Today's highly competitive market influences the manufacturing industry to improve their production systems to become the optimal system in the shortest cycle time as possible. One of most common problems in manufacturing systems is the assembly line balancing problem. The assembly line balancing problem involves task assignments to workstations with optimum line efficiency. This paper mainly focuses on application of line balancing to minimise idle time of workstation in production line. The methodology adopted includes calculation of cycle time of process, identifying the non – value-added activities, calculating total work load on station and distribution of work load on each workstation by line balancing, in order to improve the efficiency of line.

Keywords: Cycle time, Line balancing, work station

1. INTRODUCTION

The most common assembly line is a moving conveyor that passes a series of workstations in a uniform time interval called the workstation cycle time (which is also the time between successive units coming off the end of the line). At each workstation, work is performed on a product either by adding parts or by completing assembly operations. The work performed at each station is made up of many bits of work, termed tasks, elements, and work units. Such tasks are described by motion-time analysis. Generally, they are groupings that cannot be subdivided on the assembly line without paying a penalty in extra motions.

The sum of the tasks assigned to that workstation is equal to the total work to be performed at a workstation. In the line balancing to a series of workstations all tasks are to be assigned where each workstation has no more than one job can be done in the workstation cycle time, and so that the unassigned (idle) time across all workstations is minimized.

Productivity is a very important branch of any organization. And productivity growth should be ensured at each step in the organization. Productivity growth is a crucial source of growth in living standards. Productivity growth means more value is added in production and this means more income is available to be distributed.

Productivity growth is important to the firm because it means that it can meet its (perhaps growing) obligations to workers, shareholders, and governments (taxes and regulation), and still remain competitive or even improve its competitiveness in the market place. When there is productivity growth, even the existing commitment of resources generates more output and income. Income generated per unit of input increases. Additional resources are also attracted into production and can be profitably employed.

At the national level, productivity growth raises living standards because more real income improves people's ability to purchase goods and services (whether they are necessities or luxuries), enjoy leisure, improve housing and education and contribute to social and environmental programs. Over long periods of time, small differences in rates of productivity growth compound, like interest in a bank account, and can make an enormous difference to a society's prosperity. Nothing contributes more to reduction of poverty, to increases in leisure, and to the country's ability to finance education, public health, environment and the arts. The main process, which is involved in increasing productivity, is cycle time reduction. Here we have studied the main causes of increase in cycle time by Pareto analysis and the corrective measures to reduce cycle time have also been discussed.

2. MEASUREMENT OF PRODUCTIVITY

The productivity of an organization can be measured with the help of many factors. But here we are considering the criteria of measuring machine cycle time to measure the productivity of an organization.

2.1 CYCLE TIME

Machine cycle time is the time a machine actually requires producing one unit of output. Machine cycle time has three basic components. It has the time to load the machine, the actual machining or machine time and the unloading time.

In a manual machine, the operator's cycle time and machine cycle time overlap. But when a machine is automated, the operator is separated from the machine. With automatic machines, a person is freed up to do additional tasks, or can operate multiple machines. In situations where a person is working with automated machines, the term cycle time is often not specific enough. A person hearing it might not know if the speaker was referring to the time the machine takes, or the time the person spends on the process. Machine cycle time provide more clarity.

2.2 CYCLE TIME REDUCTION

It is the strategy of lowering the time it takes to perform a process in order to improve productivity. In addition, cycle time reduction often improves quality. When a cycle time is too close to the takt time, there is a little margin for error. Here, lean takt time is the required pace of production to meet customer demand. It is working time available divided by customer demand.

Reducing cycle time is a low cost way to add a bit of a buffer to avoid defects due to inconsistency in processes. Standard work provides the framework to do cycle time reduction. While simply stabilizing a process does not in and of itself reduce cycle time, it provides a foundation upon which to make improvements. Cycle time reduction is accomplished through a variety of Kaizen methods –judoka (separating people from machines), improving manufacturing fixtures, redesigning parts to make them easier to assembly, improving software, poka yoking process (mistake proofing), and whatever else creative employees can think of.

Here, Kaizen is a Japanese word that loosely translates to (change for good). So, Kaizen simply means to make improvements to a process. Kaizen makes use of the Deming PDCA (Plan-Do-Check-Act) to improve processes. A large part Kaizen gains come from observing a process and identifying waste (Plan).

Ten Ground rules for Kaizen:

- Don't try to justify past-challenge fixed ideas.
- Be positive.
- Use data, not per theories.
- Use wisdom, not memory.
- Work smarter t harder.
- Set high standards.
- Correct failures immediately.
- Lead by example.
- Create a team.
- Identify the root cause.

The factors affecting cycle time can be reduced and simply simply analysing the problems and finding the root cause can also reduce cycle time. These problems can be analysed in a simple way by a process named Pareto analysis.

2.3 PARETO ANALYSIS

It is a statistical technique in decision-making that is used for selection of a limited number of tasks that produce significant overall effect. It uses the Pareto principle- the idea that by doing

20% of work, 80% of the advantage of doing the entire job can be generated. Pareto principle (80-20 rule) states that roughly 80% of the effects come from 20% of the causes. Or, a large majority of problems (80%) are produced by a few key causes. So, we find out the main cause of the reduced productivity from all the problems suggested with the help of Pareto analysis.

So, now we will study the operations taking place in the 4-W assembly line, their proper functioning and the productivity of previous years.

Departments in the factory:

- 2-W Rod line
- Fork pipe line
- Damper case line
- Bottom case line
- 4-W Rod line
- Bottom tube line
- 2-W assembly line
- 4-W assembly line
- Plating shop
- Qc receipt
- Qc lab
- Maintenance

Essential things needed in a production line of any kind or any industry itself:

- Quality
- Productivity
- Delivery with safety
- MSDS - Material Safety Data Sheet
- TPM – Total Productive Maintenance
- WI – Work Instruction
- OCS – Operating Control Standards
- TPM Check Sheet
- Counter measures (Poka Yoke)

3. DATA ANALYSIS

Line and work cell balancing is an effective tool to improve the throughput of assembly lines and work cells while reducing manpower requirements and costs. Assembly Line Balancing, or simply Line Balancing (LB), is the problem of assigning operations to workstations along an assembly line, in such a way that the assignment be optimal in some sense. Ever since Henry Ford's introduction of assembly lines, LB has been an optimization problem of significant industrial importance: the efficiency difference between an optimal and a sub-optimal assignment can yield economies (or waste) reaching millions of dollars per year.

Thus, we used line-balancing technique to achieve:

1. The minimization of the number of workstations;
2. The minimization of cycle time;
3. The maximization of workload smoothness;
4. The maximization of work relatedness.

3.1 OPEN STAY LINE

Now the first process that comes in the way of increasing productivity is calculation of cycle time and tact time of each machine and cycle time of the whole line with the help of stopwatch of 4-W assembly line and applying line balancing technique.

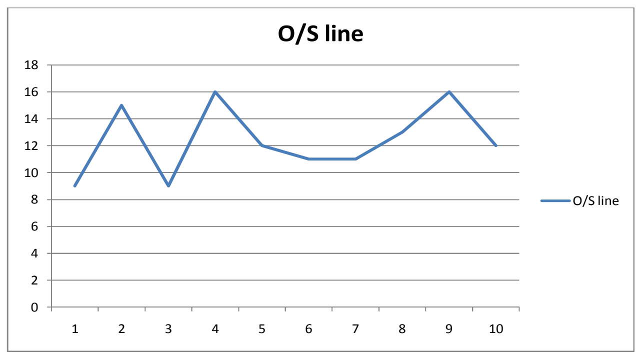

Fig 1: Graph of O/S Line

From the graph it is clear that the cycle time for o/s line is 16 seconds. The total time available is 7 hours 30 minutes i.e., 27000 second. On calculation, we find that the capacity of o/s line according to the cycle time should be 1687 pieces. But the actual capacity of o/s line is 1500 pieces per shift.

3.2 CYCLE TIME O/S CRIMPING

If we calculate the productivity according to this data, it comes to be around 2000 pieces/shift. But the actual productivity is almost 1300 pieces/shift. This large difference can be due to many reasons:

Work function	Time (in sec)
Loading time	3
Crimping time	7
Unloading time	2
Gauge checking time	1
Tact time	13

- Time for putting caps before loading is not included.
- Time for trolley movement is not included.
- The same operator is involved in crimping process and trolley movement.
- If the trolleys are not properly repaired, then it can take more time to keep the pieces in trolley.

Measures:

- One more manpower is needed to bring the empty trolley and carry the loaded trolley away so that time of operator is saved.
- Proper welding, repairing, and maintenance of the trolleys should be done.

Now, the next step is to reduce cycle time itself. This process is known as cycle time reduction by applying Pareto analysis.

	No of working days	Shifts	Cycle time	Available time (in secs.)/shift	Available time (in secs.)/month
January 12	26	1	16	27000	702000
February 12	25	1	16	27000	675000
March 12	27	1	16	27000	729000
April 12	26	1	16	27000	702000
May 12	27	1	16	27000	729000

The increased cycle time is also a major problem which decreases productivity. The process of cycle time reduction can help up to a great extent in increasing productivity.

Methods to reduce cycle time:

1. By Pareto analysis to find out the root cause.
2. By simplifying the motion of operator in a process thus reducing tact time.
3. By eliminating unnecessary steps in a process.
4. By eliminating time difference of work cycles by line balancing technique.

The result of these breakdowns is unwanted rejections. Rejections are the most important reason of low productivity because rejections occur after the pieces are partly or fully made. The material, operator's time, machine's capacity, everything is wasted due to rejections. Rejections may occur due to many reasons:

1. Damping force NG due to wrong assembly
2. Damping force NG due to dust & chips
3. Damper NG 2nd Dent/Line mark
4. Gas leakage
5. Reaction low
6. Torque low

There is a need to reduce the amount of rejection & rework in each line so as to increase overall production.

Pareto Analysis helps to determine the major causes for defects.

4. CONCLUSION

Cycle time reduction:

Cycle time for o/s line as is clear from the data, is 16 seconds.

Current capacity of o/s line = 47445 pieces per month.

If the cycle time for final assembly is reduced to 13 seconds, then the overall capacity will increase to 56393 pieces per month, i.e., by 18.7%.

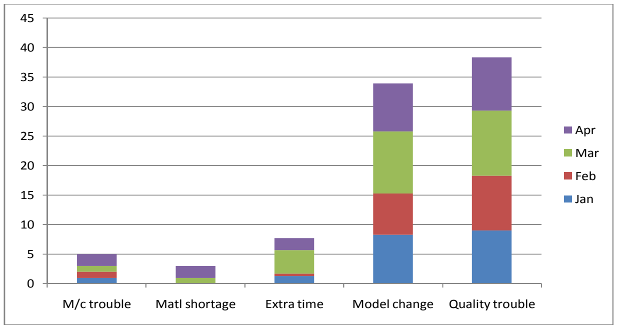

Fig 2: Breakdown

It is clear from the graph that model change and quality trouble are responsible for 82.1% of the total breakdown time of 4-W assembly line.

Measures:

- Maintenance dept. should keep a check on working condition of m/c s in the industry.
- Training should be given to operators to solve certain machine defects.
- Maintenance department should keep a check on the quality of raw material
- Supply and Demand department should look for ways to supply sufficient material for the changed model.

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