APPLICATION OF MODULARITY IN A PISTON PUMP ASSEMBLY LINE OF A HYDRAULIC SYSTEM

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ABSTRACT

Modularity refers to products that fulfill various functions through the combination of distinct modules, processes and resources. Modularity plays an important role in assembly lines. An assembly line is that which consists of a number of work stations arranged along a transportation line such as a conveyor belt. In the present work an assembly line of Piston pump in a hydraulic system has been selected for analysis. Assembling times at individual stations during different times of a day have been recorded and analyzed. It has been observed that during the process some of the stations are running idle for some time. To fix the problem of wasting time, the total assembly line has been simulated using the Flexsim software. Modularity has been applied in the simulation and the results were analyzed. Observing positive response from simulation, the same has been experimented on the assembly line. The results were compared and found to be successful in increasing the total components assembled by decreasing the idle time of the stations.

Keywords: modular manufacturing; assembly line; simulation; modularization; product design; modular design.

INTRODUCTION

An assembly line is a manufacturing process in which interchangeable parts are added to a product in a sequential manner to create an end product. In most cases, a manufacturing assembly line is a semi-automated system through which a product moves. Assembly line methods were originally introduced to increase factory productivity and efficiency. Advances in assembly line methods are made regularly as new and more efficient ways of achieving the goal of increased throughput (the number of products produced in a given period of time) are found. While assembly line methods apply primarily to manufacturing processes, business experts have also been known to apply these principles to other areas of business, from product development to management. Today, using modern assembly line methods, manufacturing has become a highly refined process in which value is added to parts along the line. Increasingly, assembly line manufacturing is characterized by “concurrent processes”-multiple parallel activities that feed into a final assembly stage. These processes require sophisticated communications systems, material flow plans, and production schedules. The fact that the assembly line system is a single, large system means that failures at one point in the “line” cause slowdowns and repercussions from that point forward. Keeping the entire system running smoothly requires a great deal of coordination between the parts of the system.

ASSEMBLY LINE METHODOLOGIES

- Modular Assembly-this is an advanced assembly line method that is designed to improve throughput by increasing the efficiency of parallel subassembly lines feeding into the final assembly line. As applied to automobile manufacturing, modular assembly would involve assembling separate modules-chassis, interior; body-on their own assembly lines, then joining them together on a final assembly line.

- Cell Manufacturing-this production method has evolved out of increased ability of machines to perform multiple tasks. Cell operators can handle three or four tasks, and robots are used for such operations as materials handling and welding. Cells of machines can be run by one operator or a multi-person work cell. In these machine cells it is possible to link older machines with newer ones, thus reducing the amount of investment required for new machinery.

- Team Production-Team-oriented production is another development in assembly line methods. Where workers used to work at one- or two-person work stations and perform repetitive tasks, now teams of workers can follow a job down the assembly line through its final quality checks. The team production approach has been hailed by supporters as one that creates greater worker involvement in the manufacturing process and knowledge of the system.

- U-shaped assembly "line"-a line may not be the most efficient shape in which to organize an assembly line. On a U-shaped line, or curve, workers are collected on the inside of the curve and communication is easier than along the length of a straight line. Assemblers can see each process; what is coming and how fast; and one person can perform multiple operations. Also, workstations along the "line" are able to produce multiple product designs simultaneously, making the facility as a whole more flexible. Changeovers are easier in a U-shaped line as well and, with better communication between workers, cross-training is also simplified. The benefits of the U-shaped line have served to increase their use widely.
EXPERIMENTATION

A piston assembly line has been selected for experimentation. There are 10 stages to assemble the different parts. A complicated product in traditional assembling method requires a long assembly line which makes the balancing complicated. Modularity in assembling makes long assembly into simple combined assembly line for different products. Traditionally the process is done in a single assembly line. By observation the data is collected. The total number of pumps assembled in an 8 hours’ day is 40. Modularization of the existing assembly of piston pump is considered and a model of modified assembly system for producing both the sub assemblies is presented in the figure 4. It has been proposed to apply modularity to increase the number of components assembled in a day with the same resources. To apply modularity, the total assembly has been divided into two sub-assembly lines. At the tail end of these two lines one station is incorporated to assemble these two sub-assemblies. The same processes have been simulated using Flexsim software and compared with the practical results.

Table-1. Average time to assemble before applying modularity.

<table>
<thead>
<tr>
<th>Part name</th>
<th>Station number</th>
<th>Average time to assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Body, Main shaft</td>
<td>Station 1</td>
<td>562±2.944</td>
</tr>
<tr>
<td>Ex-center, Piston, connecting rod side cover</td>
<td>Station 2</td>
<td>527±2.1602</td>
</tr>
<tr>
<td>Pump stand</td>
<td>Station 3</td>
<td>567±2.3094</td>
</tr>
<tr>
<td>Pulley</td>
<td>Station 4</td>
<td>552±2.4495</td>
</tr>
<tr>
<td>Base plate</td>
<td>Station 5</td>
<td>557±3.1623</td>
</tr>
<tr>
<td>Water jacket assembly</td>
<td>Station 6</td>
<td>527±2.1602</td>
</tr>
<tr>
<td>Air chamber assembly</td>
<td>Station 7</td>
<td>577±1.4142</td>
</tr>
<tr>
<td>Plunger</td>
<td>Station 8</td>
<td>567±1.8257</td>
</tr>
<tr>
<td>Gland and sleeve assembly</td>
<td>Station 9</td>
<td>572±1.4142</td>
</tr>
<tr>
<td>Suction valve door</td>
<td>Station 10</td>
<td>562±2.8284</td>
</tr>
</tbody>
</table>
The single assembly line used in the traditional process is replaced with a dedicated modular sub assembly system. By applying modularity in design and in process the assembling time has been reduced. Also the idle time of each work station has been reduced. Before applying modularity, the assembly line can produce 40 pumps in a day. The total assembly line is divided into two sub assembly lines with same processing times. The productivity has been increased by 15% after applying modularity in assembly line. The total number of components produced is enhanced from 40 to 46. Thus the productivity of the assembly line has been increased without much change in resources input. The simulation results also revealed that the modularity can be applied on the assembly line by increasing the total number of components produced. The experimentation results are observed to be in agreement with the simulation results.

CONCLUSIONS
The conclusions drawn from the experimentation in applying modularity on the assembly lines are as follows.

- Modularity can be conveniently applied on the assembly line system to increase the productivity.
- The total number of components produced in an assembly line has been increased from 40 to 46, and the increment is about 15%.
- The experimentation results are in agreement with simulation results.
REFERENCES


