Assembly Line Balancing using Simulation in Manufacturing Industry

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Abstract: The design of assembly lines for mass production is the leveling of the work load across all operations; Assembly line will likely have many work stations with varied tasks and work contents. Manufacturing is dependent on the time each task takes, and the number of staff available and their skill level, machine capacity is also an important consideration. With so many different and potentially conflicting requirements the outcomes of line balancing, can be difficult to predict. Simulation software can help manufacturers to test and implement a well-balanced line that has the flexibility to achieve desire output. Using line balancing simulation, manufacturers can identify system bottlenecks, test production schedules, and evaluate the impact of design and scheduling decisions, such as buffering requirements and product mix.

Keywords: Assembly- line balancing, simulation, flexibility, bottlenecks.

Introduction

Assembly lines play a critical and valuable role in the manufacturing system. Production efficiency of automobile manufacturing industry and competitiveness of enterprises are affected by the level of an automobile assembly line balancing. To stay competitive and reach a high productivity, mixed model assembly lines need to handle variations in capacity requirements induced by the different variants manufactured. Therefore workforce flexibility is required. Balancing refers to the procedures of adjusting the operation times at work centers to conform as much as possible to the required CT (cycle time). Required cycle time is the production target of a process or operation that is determined by the demand for the item being produced. A balanced process is one where the actual cycle times at every stage are equal. simulation are the techniques available to support companies like manufacturing automobile parts in gaining a better understanding of their manufacturing system behaviors that helps for decision making. simulation tool are used to simulates worker flexibility according to the produced variants and their sequence.

Simulation in assembly line

Simulation shows great promise for raising productivity, improving product quality, shortening lead times, and reducing costs in the future. However, today the application of this technology is not very wide spread in the manufacturing industry. One of the major reasons for this fact is that simulation modeling and analysis is a labor-intensive and time-consuming activity. Today, the trend in manufacturing industry is to be more responsive to changes in product design and market conditions. Simulation modeling would tend to delay that process. Reducing time and the high level of effort will require the development of new simulation capabilities that automate the input of simulation parameters.

Simulation Advantages

- Reduction in production time – having a machine that is automated definitely speeds up the production time since no thinking is needed by the machine, there is better repeatability, and less human error.
- Increase in accuracy and repeatability – when an automated machine is programmed to perform a task over and over again, the accuracy and repeatability compared to an employee is far greater.
- Less human error – no one is perfect, and we are all prone to making mistakes. Which is why a machine that performs repeated tasks is less likely to make mistakes than an employee.
- Less employee costs – by adding automated machines to an operation, means less employees are needed to get the job done. It also indicates less safety issues, which leads to financial savings. With having less employees, there are numerous costs that are diminished or reduced such as payroll, benefits, sick days, etcetera.
- Increased safety – having automated machines means having less employees who perform tasks that can be dangerous and prone to injury, which can make the work environment safer.
- Higher volume production – investing in automated equipment creates a valuable resource for large production volumes, which in turn, will increase profitability.

Objective

The most important objective of simulation in manufacturing is the understanding of the change to the whole system because of some local changes. it is very difficult or impossible to assess the impact of change in the overall system. Simulation gives us some measure of this impact. Measures which can be obtained by a simulation analysis are:

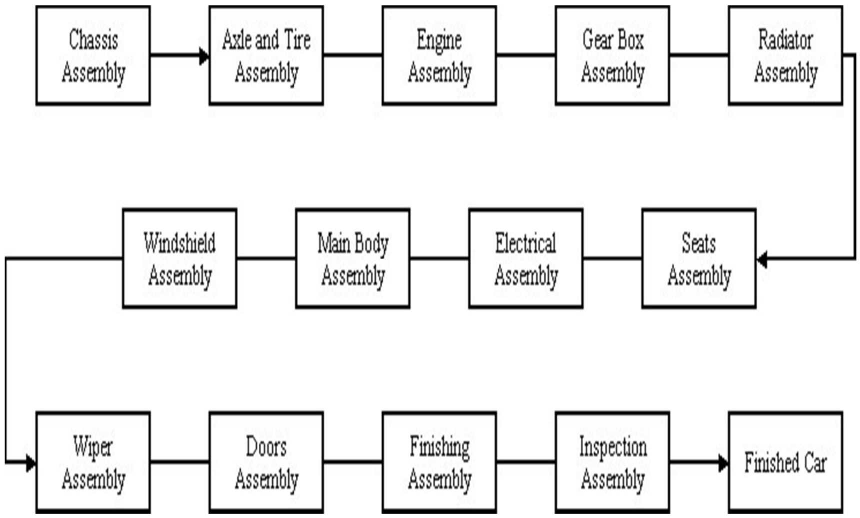
- Parts produced per unit time
- Time spent in system by parts
- Time spent by parts in queue
- Time spent during transportation from one place to another
- In time deliveries made
- Build up of the inventory
- Inventory in process
- Percent utilization of machines and workers.

Assembly line design process

We assume that we had to develop the manufacturing process design for a prototype product for which the assembly line had yet to be realized. As such, the procedure is as follows:

(i) A prototype of the product is disassembled to determine the components parts list and quantity. Table 1 shows some of the components that make up the product.
(ii) An assembly tree is constructed showing the different stages of assembly of the product and the sequence of the various assembly processes.
(iii) Using precedence relations between assembly operations and time associated to perform each operation, a number of operations are aggregated into tasks that can be performed at a single workstation.
(iv) The arrangement of workstations on the production line was determined.
(v) Material handling requirements were also specified.

Item no.	Description	Quantity
1a	Housing	2
1b	Spindle pin	1
2	Spindle gear	3
14	Name plate	1
15	Brush assembly	2



Additional Workstation Operations

1. Pick Completed Unit And Inspect It Visually.
2. Use chuck key to insert a drill.
3. Connect the cord to the power supply.
4. Test its performance taking not of power output and speed of rotation while listening for any vibrations.
5. Decide to accept or reject the unit.
6. If the unit is accepted place it in outbound bin or belt conveyor.

7. If the unit is not faulty and needs repair put in bin designated for repair.
8. If unit is faulty beyond repair send to scrap.

Simulation Modeling Overview

Software and methods the simulation model was constructed using three software applications. A CAD package was used for modeling the geometry of components. The two simulation tools were used to model individual station operations and the overall flow of the line. The synergistic effect of different software applications provided a platform upon which the simulation model of the manufacturing system was built. The applications that were used are:

(i) SCADA, a supervisory control and data acquit ion system is used for simulation.
(ii) AutoCAD, a computer-aided design application for object modeling.

Methodology

The CAD system used for modeling objects is both a two and a three-dimensional (2D-3D) design and drafting plat form that automates design tasks. Various professionals such as architects, engineers, drafters, and design-related professionals use it to create, view, manage, plot, share, and reuse accurate, information-rich drawings. The components and subassemblies of the product and tools, input and output bins, subassemblies and fixtures were modeled manually using the CAD tool. The models of the components and parts were exported into the simulation applications. It has an ergonomics-analysis option (ERGO) that can be used to model assembly and materials handling operations between workstations. This option is basically used to design safe working environments that accommodate a wide range of workers and for ergonomic assessment and task analysis. It was used to address the human interface issue that impacts the ability of a wide range of humans to assemble the prototype product and the process times needed for each task. Libraries of whole body and hand postures were used. The software also provided point and click routines to generate walking, climbing, lifting and carrying sequences. To model a workstation operation, the worktable, parts and bins and human operator were imported as “devices” and placed at appropriate locations in the workstation. Using the ergonomics option, the human device was “taught” to perform the assembly process by creating a series of positions of the human hands while holding and assembling the product. Other features that were used provided functions for “grabbing” and “releasing” objects, orienting operator limbs in various positions, walking, bending and rotating fingers. The successive positions of operator and part during operation of a station were stored and later played like a video recording. Interpolation between consecutive positions produced the appearance of smoothly connected operations. an object-based, discrete event simulation tool. It was used to model, experiment with, and analyze facility layout and process flow. It provided visualization and data import/export capabilities. This simulation application was used to construct the simulation model of the production line which was then populated with pre-built sub-models that were generated as described in the proceeding sections. The process of incorporating workstation sub-models into the discrete-event simulation model was basically simple. Initially, the workstation operation was played and recorded in the graphical modeling application. Similarly, the scripts associated with a human carrying a bin of components or subassemblies between stations were determined. Simulation Control Language (SCL) was used to more accurately program the display of the actions of material handling and workstation operations by the same operator.

Conclusion

The proposed solutions provided opportunity to significantly improve the production line design, This paper has demonstrated a method of designing a manufacturing process from a prototype of the product. The simulation model has been constructed. An approach that can speed up the modeling process and simplify this process would be desirable. Current simulation systems do not provide standard formats for reading product attributes, processing times, and material quantity requirements from data files or other data sources. In the same way, we would like to be able to read and write external, process-specification data files that would drive the simulation of the assembly of the product. Neutral formats for reading these types of data would be very useful. One can also imagine a situation where an operator at a station can not only read assembly instructions from a file but also be able to intelligently learn and adapt to different situations and products. As such, it should be possible that the logic that controls the simulation and directs interaction between various elements of the model is read from outside of the model. This would make it easier to investigate different scenarios and interaction rules between elements during the experimental phase. It would be useful to create an environment that integrates and facilitates planning, visualization, validation, documentation, and training production workers on the manufacturing process.

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