Manufacturing Facility Layout Design and Optimization Using Simulation

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The present paper deals with the design of manufacturing facilities layout with the consideration of downtime of facilities and space utilization. Facility layout refers to the arrangement of physical facilities such as machines, equipment, tools, furniture etc. in such a manner so as to have quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the receipt of raw material to the delivery of the final product.

Keywords: Facility layout, optimization, ABC analysis, simulation, FLEXSIM.

1. INTRODUCTION

The plant layout is a very critical part of running an efficient and cost effective business. All work areas, production lines, material storage facilities, etc. should be designed to perform to the highest rate and the corresponding shortest cycle time. When designing a plant layout it is necessary to take into account all the functions within the business. The design must include not only the needs for the present business levels but should also have provisions for future expansion. This is included to avoid frequent and costly changes to the design as demand increases.

Plant Layout is the physical arrangement of equipment and facilities within a plant. i.e. the grouping of equipment and operations in a factory for the greatest degree of efficiency. The Plant Layout can be indicated on a floor plan showing the distances between different features of the plant. Optimizing the layout of a plant can improve productivity, safety and quality of Products. Unnecessary efforts of materials handling can be avoided when the Plant Layout is optimized. This is valid for:

1. Distances through which the material has to move
2. Distances equipment has to move
3. Distances operators have to move
4. Types of handling equipment needed
5. Energy required to move items against resistance (i.e. gravity).

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2. METHODOLOGY FOLLOWED FOR ANALYSIS OF THE PROBLEM

2.1. Raw Material Requirement
Total raw materials are divided according to their weights and this data is used for ABC analysis. From this we come to know the importance of each type of material. This data is helpful to decide raw material policy.

2.2. Understanding of Existing Process Sequence
To design an efficient plant layout understanding of process sequence is necessary. For this the existing manufacturing processes are studied in sequence. The critical operations in each process are observed carefully. This will help in redesigning the process sequence.

2.3. Time Study
The time study has to be carried out at each processing stage. It is done manually using a stop watch and readings are recorded in time study sheet. The time study helps in finding out the time required for each process in the sequence. This data will be useful in deciding the capacity planning for a new plant. From the time study we also come to know the bottlenecking stage.

2.4. Layout Designing and Simulation
After studying the process sequence and the time required for each process, the layout designing is done. The layout is designed by taking into consideration the available space, interrelation between two successive departments, the importance of each process and the capacity required to achieve the desired output rate.

After designing the layouts, they are simulated using simulation software FLEXSIM. The capacity of each workstation and the bottlenecking locations are understand by observing the simulation results. From these results a decision is taken, whether to revise the capacity or not. The revised plant layout is again simulated. The revision is applied in a progressive manner. After comparing the throughput of each layout, the one having maximum throughput rate is selected and is proposed to the company for implementation.

3. SIMULATION OF FACILITY LAYOUTS
Simulation means process of testing an existing or new invention for modification or use by means of a prototype. Plant designers generally have only two choices: either physically change the layout of an existing facility and then measure results, or model the system and measure results to develop the final facility design before making changes. Plant layout simulation is a tool that uses data to evaluate a current facility layout and show potential improvement areas. The same data is then used to objectively evaluate various layout alternatives for new construction, additions, and/or re-organizations.

3.1. Need of Simulation
Facility layout problems are rather difficult in terms of analytical modeling. When the number of departments is large, the material flow volumes between departments are
random, and a flexible layout is desired, the problem becomes much more complex and usually intractable analytically. Therefore, simulation has been used as a modeling alternative to determine a good layout among a very large number of alternatives.

4. EXPERIMENTAL DESIGN AND RESULTS

Simulation software is a powerful analysis tool that helps engineers and planners make intelligent decisions in the design and operation of a system. With the help of simulation software, we can build a 3-dimensional computer model of a real-life system, and then study that system in either a shorter time frame or for less cost than with the actual system.

The simulation software should have the capabilities so that it can be successfully used to:

1. Improve equipment utilization.
2. Reduce waiting time and queue sizes.
3. Allocate resources efficiently.
5. Minimize negative effects of breakdowns.
6. Minimize negative effects of rejects and waste.
7. Study alternative investment ideas.
8. Determine part throughput times.
9. Study cost reduction plans.
10. Establish optimum batch sizes and part sequencing.
11. Resolve material handling issues.
12. Study effect of setup times and tool changeovers.
13. Optimize prioritization and dispatching logic for goods and services.

4.1. Simulation of Proposed Plant Layout Using Simulation Software (FLEXSIM)
4.2. The Simulation Results are as follows

Figure 1  Pie Chart of Queue before Tack

Figure 2  Pie Chart of Full Welding Station

Figure 3  Pie Chart of Tack Welding
After observing the simulation results we don’t find any stacking of components in the queue of full welding and finishing workstations. That means the capacity of full welding and finishing workstations are sufficient.

In the above layout two tack welding workstations are proposed, but by observing the simulation results of the queue which supplies components to the tack welding workstations, it is found that there is a stacking of components. 143 components are joining the queue and only 32 components are being processed at tack welding workstation (i.e. 111 components are to be processed). It indicates that the only bottlenecking station is tack welding operation. So one more tack welding workstation is introduced to remove bottlenecking and to increase the throughput.

After revision the new plant layout is as follows.

4.3. Revised Plant Layout
4.4. The Simulation Results of Revised Plant Layout are as follows

![Pie Chart of Queue before Tack Welding](image1)

**Figure 5** Pie Chart of Queue before Tack Welding

![Pie Chart of Full Welding Station](image2)

**Figure 6** Pie Chart of Full Welding Station

After observing the simulation results, it is found that the bottlenecking before tack welding is reduced considerably and throughput rate is also increased.

The same procedure is repeated for three different layouts and they are simulated using software. The one which is giving maximum throughput rate is selected for implementation.

5. CONCLUSION

By observing the simulation results the layout which gives desired throughput rate can be selected. The simulation provides the data which helps in the decision making
before costly changes or investments are made. It also maximizes the chances of successful implementation.

References


