Schedule a layout for flexible manufacturing layout (fms) using the arena softwar...

Business, Industries

What is Flexible Manufacturing System (FMS)?

Flexible Manufacturing System (FMS) is defined as the flexibility of the manufacturing line or process in order to archive the aim to shorten the lead time to produce a product so that the product can be delivered on time to the customer and also can save cost. It has to be approachable so that the results and effects can be seen and useful for manufacturing line.

An Industrial Flexible Manufacturing System (FMS) consists of robot, Computer-controlled Machines, Numerical controlled machines (CNC), Instrumentation devices, computers, sensors. The use of robots in the section of manufacturing industries provides a variety of benefits ranging from high utilization to high volume of productivity. Each robotic cell will be located along a material handling system such as a conveyor or automatic guided vehicle. The production of each part or work-piece will require a different combination of manufacturing nodes. The movement of parts from one node to another is done through the material handling system. At the end of part processing, the finished parts will be routed to an automatic inspection node, and subsequently unloaded from the Flexible Manufacturing System. They provide better efficiency, flexibility and adaptability which are lacking in traditional manufacturing systems. FMS are designed to combine the advantages of mass production systems (efficiency) and job-shops (flexibility) in one system. (Tunali 1995)

The reason why FMS is very powerful is because of its ability to produce different types of quality products in any order with small-batch sizes without the time consuming changing machine setups. The benefits and drawbacks of implementing FMS is shown in table 1. Although large investment, long planning, development time and automated controller like CNC machines are required, most manufacturers prefer attempt to implement FMS to compete with other manufacturers. Other operational objectives such as the maximization of flexibility, sustainability, reactivity (or the ability to handle contingencies), availability and productivity should also be taken into account in particular for FMS designed to do batch jobs, small and medium-sized series in addition to mass production volumes. Flexibility is a particular important design objective implying that the same production line can be used for different products, either sequentially or simultaneously without major transformation costs.

Benefits

Drawbacks

Reduction in labour costs Very expensive

Requires less space Complicated manufacturing system

Increases efficiency Pre planning activity is substantial

Increases productivity Adaption of product changes is limited

Improves the quality of products

Manufacturing lead time is less

Reduces work in progress inventory.

What is Simulation?

Simulation represents the physical processes of systems on a virtual computer model where the behaviour of such a model resembles as much as possible for the real scenario. Simulation is a very useful tool with increasing importance in the current advanced industrial world. Simulation refers to a broad collection of methods and applications that virtually imitate real life situations, or those which are yet to be real. The more accurate and effective a simulation model is, the more realistic are the results obtained and predictions concluded from that specific simulation model.

In fact, " simulation" can be an extremely general term since the idea applies across many fields, industries, and applications. These days, simulation is more popular and powerful then ever since computers and software are better than ever. Computer simulation deals with models of systems. A system is a facility or process, either actual or planned, such as:

A manufacturing plant with machine, people, transport devices, conveyor belts and storage space.

A bank with different customers, servers, and facilities like teller windows, automated teller machine (ATM), load desks, and safety deposit boxes.

An airport with departing passengers checking in, going through security, going to the departure gate, and boarding; departing flight contending for push back tugs and runway slots; arriving flights contending for runways, gates, and arrival crew; arriving passengers moving to baggage claim and waiting for their bags; and the baggage-handling system dealing with delays, security issues, and equipmentfailure.

An emergency facility in a hospital, including personnel, rooms, equipment, supplies, and patient transport.

A central insurance claims office where a lot of paperwork is received, reviewed, copied, filed, and mailed by people and machines and etc.

Why use Simulation?

In an effort to reduce costs and time consumption, simulation is one of the most powerful analysis tools available for the design and operation of complex processes or systems. This is because a computer simulation can provide the result on how effective a machine can run without the need of high capital investment and long time consumption to build a actual model on the floor plan by just getting the same results. Weaknesses and problems that may occur in the workstation such as material handling, idle of machine, bottleneck situation can be showed by using the simulation. In addition, the improvement of the production layout can be easily done from the simulation output showed in meeting the operating target. Besides that, simulation also helps reduce costs, avoid catastrophes tragedy and improve performance of the system. Furthermore, to make changes of a manufacturing plant in real life is very expensive and performance after the particular changes is not guarantee. Hence, it is always better to simulate the changes and compare the results before implementing it.

Expensive equipment and complicated designs can be modelled using computer software to detect any inconsistency or possible failure modes. This reduces the costs associated significantly as it helps avoid or reduce the expensive and potentially wasted cost of bad designs or wrong equipment. An example to illustrate this would be the complex simulation models created by aviation industries such as Airbus or Boeing. The sustainability and life time of a plane can be modelled by using simulation in order to evaluate the fuselage, performance of engine and other part with differentenvironmentor situation.

In addition to this, some real time product trials might be impossible as they would consume the single possible use of such products. For example, a bomb or missile can only be used once, and as a result, it won't be possible to test every single product of such type by trialling it. Simulation plays an important key role here in modelling and simulating the effect and influence of such products while avoiding the destructive and expensive trials. Furthermore, simulation can be used to improve the current process of a system. In other words, it might be possible to optimize and increase the efficiency of an already running system by implementing some changes suggested by engineers, managers, operators or any personnel involved.

Having obtained an accurate model, those suggested changes can be initially incorporated in the model to investigate and analyze their consequences and whether they would produce the desired effect or not. Upon validation of the results, an educated decision, backed up by facts, can be taken. Therefore simulation is a tool that can be used by management to aid decision-making especially in costly and heavily investments involved.

The othergoalsof the simulation system are to simulate different production tasks on a given FMS and finally to facilitate the evaluation and comparison of different FMS designs for the same tasks. This last target requires to build up several, new simulation models (George L. KOVACS 1997). One of the most challenging issues faced by today's manufacturing industry is heavy global competition. In order to compete in an international market, the manufacturers have to produce varieties of products rapidly and flexibly in order to meet the ever increasing market demand

Project Scope

The purpose of this project is to develop and model a Flexible Manufacturing System (FMS) layout using ARENA software. The author has to develop a Flexible Manufacturing System and will be able to produce simulations for the different scheduling scenarios. To start of modelling a Flexible Manufacturing System in ARENA software, the author have to put a lot efforts in research through different kinds of mass media like internet, journals, magazines, case studyto understand the fundamental concept and technique of FMS. After researches, the author has to build and simulates the model in ARENA software. From the simulation result, the author has to analyze output and recommended it. Last but not least, the model results will be collected and presented in the project report.

Project Aim

The aim of this project is to adopt an existing FMS layout and identify the problem or weaknesses in it and make improvement. In order to do that, author has found a piece of journal which contains an existing FMS layout provided with the route and processing time for each parts and components respectively. These informations will be used to generate the simulation in ARENA to monitor its performance such as the total processing time or waiting time and make improvement to it.

Learning ARENA simulation Software

After few weeks of reading and learning for ARENA simulation software, the author had understood the concept and methodology of simulation using ARENA. In addition, the author had absorbed basic project planning and analysis ideas along with the modelling concepts, which how actual simulation projects ought to proceed. Besides that, the author had familiar with the icons and object about which to used and knew how to generate the animation according to the simulation. Furthermore, author had learnt the varieties of expression or formula such as normal distribution, exponential, triangular, discrete, Poisson distribution.

Project Objectives

The general objectives of this title is to schedule a layout for flexible manufacturing layout (FMS) using the arena software. The layout must be able to achieve and match the FMS requirement.

The main objective can be divided into sub-objective as stated below:

To prepare a literature review and understanding of the fundamental concepts and techniques used for the Flexible Manufacturing System (FMS).

To learn ARENA software in order to simulate the FMS model.

To select a suitable FMS layout to model.

To plan and develop the simulation of the FMS model.

To run the model for different data, arrangement, and also to view and improve the efficiency and effectiveness FMS model.

To analyze the results obtain from the FMS model.

Reproduce the FMS model for improvement.

To re-analyze and finalize the findings and conclusions.

Report Structure

This report divided into seven chapters, reference list, and appendices. The seven chapters consist of introduction, literature review, experimental technique, results and discussion, conclusion, and recommendations for further work.

Chapter two aims to reflect on the some topics related to simulation and lean manufacturing which have been pioneered by previous academics and industrialists. It covers the, seven sources of waste, JIT (Just in Time) manufacturing, kanban, lean manufacturing, types of production lines and scheduling environments, simulation and finally some distributions functions available in the simulation model.

This study has been realized on a model of a hypothetical FMS. By referring to Figure 1, it can be observe that the FMS consists of five multi-purpose CNC machines, each with automatic tool changing capability. Each machine is provided with limited input buffer. Having assumed that each machine will have ample capacity to store the required tools, the issue of tool availability is not considered in developing the model. An important feature of the model is that the machines are not available continuously. They can be subject to unexpected breakdowns. The system is capable of processing more than one part type simultaneously find each part type is associated with a probability of arrival. Each part is processed according to a predetermined sequence of operations. However, the machines that will process these operations are not fixed in advance, rather the routing decisions are made on-line based on current shop floor status data. Job pre-emption is allowed in case of an unexpected machine breakdown. The parts are introduced into the system through the loading station. The unloading station is the exit point for all the parts processed in the system. The system also includes a central Work-In-Process-Area (WIPA) to temporarily store the parts when the associated machine buffers reach the full capacity. The parts are transferred within the system by three AGVs each having one unit loading capacity. The place that the idle AGVs will wait for the next request depends on the AGV control policy employed. The model is developed on a microcomputer-based environment using SIMAN.

As for the experimental conditions, it is assumed that the FMS studied in this paper can simultaneously process 6 types of parts. As it is seen in Table 1, the number of operations for each part ranges from 4 to 6. The three AGVs travel at a speed of 200 feet per minute, The time required for loading and unloading an AGV is one minute irrespective of part and operation type. For each experiment, the performance data on mean flow time is collected for a simulation period of 15360 minutes (16 days with 2 eight hour shifts) by generating 10 independent replications of the model. For each replication, the statistics are collected after a warm-up period of 2880 minutes (3 days with 2 eight hour shifts).

Seven types of waste

The word “ waste” in manufacturing was defined as anything other than the MINIMUM amount of equipment, materials, parts, space and workers’ time, which are ABSOLUTELY ESSENTIAL(to ADD VALUE to the product) (M. K. Khan, 2010). It is an very unlikely event to occur because manufacturing waste does not add value to product. After years of research and improvement job has been done, Toyota identified seven source of waste in manufacturing plant, which is as follow :

Waste from over production:

This is considered as the most common waste found in manufacturing line. Mistakes occurred between marketing department and production department can lead to over production for demand and supply and cause delay for other parts or products.

Waste of waiting time:

Usually it’s easy to identify. Time is wasted when operators just watching the machine to run or waiting for preceding parts to arrive. Bottleneck in production line is also considered as time wasting when all the parts are stacked while waiting to be processed.

Transportation waste:

Bad housekeeping can cause long distance transportation waste or even double or triple material or part handling. Example: raw material stored in warehouse before it is brought to the line.

Processing waste:

Additional process could lengthen a product or part processing time with unnecessary additional process.

Waste of motion:

Waste of motion is whatever time is not spent in adding value to the product should be eliminated. Poor machine or work layout could result to serious waste of motion.

Waste from product defects :

When defects occurred at on station, other waste will also be raised up such as longer transportation time, waiting time, and scrapped or rework product may be produced as well.

Inventory waste:

Inventory is also known as the root of all waste. It hides problems such as poor quality of product, machine breakdown and so on. It also lowers the level of inventory to expose those problems. Therefore, human always try to reduce or think a better way to handle inventory as shown in table 2.

Zero defects Zero setup time

Zero inventories Zero part handling

Zero breakdowns Zero lead time

Lot size of one Match products to customer requirement.

JIT, Kanban and Lean Manufacturing

Just in Time (JIT)

The basic approach to the “ Just-in-Time” (JIT) production system is to reduce product costs through the elimination of waste. In a production facility waste can be defined as defects, stockpiles, queues, idleness and delays. The manufacturingphilosophyof JIT is well defined by the following analogy. Inventory is depicted by water, covering a bed of rocks in a lake. The rocks and the lakebed are representative of problems and the manufacturing floor, respectively. Lowering the water level will expose the rocks on the lakebed (Riggs, 1987). This is the basic theory behind the JIT production system. By eliminating inventory stockpiles on a plant floor, operating inefficiencies can be exposed. Therefore, producing or receiving inventory “ just in time” for the next production process can eliminate stockpile inventory. This report will detail the history of the “ Just-in-Time” production system. We will follow the JIT system from its conception in 1940 to its success today. The characteristics and advantages of

the JIT production system will be further outlined. We will also summarize the specific requirements for implementation of this system. Throughout this document we will aim to provide internet links, which will provide more information on the topic. Just-In-Time (JIT) manufacturing is a Japanese management philosophy applied in manufacturing. Essentially it involves having the right items with the right quality and quantity in the right place at the right time. Today, more and more North American firms are considering the JIT approach in response to an ever more competitive environment. The ability to manage inventory (which often accounts for as much as 80 percent of product cost) to coincide with market demand or changing product specifications can substantially boost profits and improve a manufacturer's competitive position by reducing inventories and waste. Just In Time (JIT) is a management philosophy, an integrated approach to optimize the use of a company's resources, namely, capital, equipment, and labor. The goal of JIT is the total elimination of waste in the manufacturing process.

JIT CONCEPT

JIT may be viewed as a production system, designed to improve overall productivity through the

Elimination of waste and which leads to improved quality. JIT is simple, efficient and minimize

waste.

The concept to produce and deliver finished goods just in time to be sold, subassembles just in

time to be assembled into sub assembled and purchase materials Just—in time to be transformed into fabricated parts, is the concept behind JIT. It is dependent on the balance between the stability

of the user's scheduled requirement and supplier's manufacturing flexibility.

GOALS OF JIT

A system whose goal is to optimize process and procedures by continuously pursuing waste reduction.

It consists of 7 W's to pursue the waste reduction. The wastes identified for reduction through

continuous improvements in production process are:

OBJECTIVES OF JIT

The basic objectives include:

- Low manufacturing and distribution cost.
- Reduced labor (both direct and indirect)
- Higher degree of product quality and less defects.
- Effective use of Working capital.
- Decrease in production lead-time.
- Reduced investments for in-process inventory.
- Increased productivity.
- Reduced space requirements.
- Faster reaction to demand. Change i. e. more flexibility to customer demand.

- Reduced overheads.

Simulation Model Development

Chapter three demonstrates the process of preparing and constructing the simulation model. It will then be run and produce the results based on the data or assumption made in the simulation. It also serves as a reference for whoever uses or modifies the model in the future. Every steps will be shown and organized step by step for the ease of reading for reader.

Before starting creating the simulation model, author has spent a significant amount of time to learn how to program and create a simulation model using ARENA based on the data provided in literature review. This involved identifying which machine has the longest processing time and processes the most products. The book that author referred to was “ Simulation with Arena” and listed in the reference list.

After all the data had been collected and gathered, now move to the development of the simulation model using ARENA. Firstly, run the ARENA software and it will show a blank page as shown is figure 1.

Figure 1: Blank page of ARENA

Secondly, drag and place the necessary object into the blank page and arrange it which is shown is figure 2.

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