ISSN (Online): 2231-5268
www.ijcsms.com

MATERIAL HANDLING IN FLEXIBLE MANUFACTURING SYSTEM

Mr. Neeraj Nirmal[1], Mr. Neeraj Dahiya[2]

[1]M.Tech. Scholar, S.B.M.N. Engineering College
Rohtak, Haryana, (India).
neeraj_nirmal86@yahoo.co.in

[2]M.Tech. Scholar, PDM College of Engineering
Bahadurgarh, Jhajjar, Haryana, (India).
neerajdahiya99@yahoo.com

Abstract

The objective of this study is to analyze the system performance of a flexible manufacturing system cell. The study gives information on production potential of the cell by grouping common parts. To complete this, computer simulation models are developed using the SIMAN simulation language. Initially no material handling is provided to the manufacturing system to get an upper bound estimate of production output. Next, we explore the impact that an automatic guided vehicle (AGV) has on system performance with manufacturing system. The final analysis is performed in which a conveyor is implemented for the material handling. The performance result with comparison is presented in the form of confidence intervals. After examine the simulation results, we recommend to implement a conveyor system for material handling. Use of AGV in the flexible manufacturing system creates a bottleneck which causes a dramatically decrease in the production: as compare to a conveyor as the material handling system which does not limit the daily production output of the manufacturing cell.

Keywords: *Computer simulation, AGV installation, SIMAN language, Material handling by computer.*

1. Introduction

The first part of this is to provide a description of the flexible manufacturing cell which is modeled as per the experiment. The next section presents the three material handling system models developed for our analysis for the experiment. The third part of the paper contains results obtained by the comparison of various simulation runs. Our recommendation makes a path for the fourth section of the paper. Finally, we present a discussion that how the SIMAN simulation language simplify the model development so that we gives suggestions for future efforts.

2. Description of the Flexible Manufacturing System

The flexible manufacturing cell consists of six machines modeled as stations. The study of cell design is done from the production operation of a major manufacturer of gears. The number of different types of parts processed within the cell is high relative to the overall volume of production. The layout of manufacturing cell is shown in Figure 1. This type of system has been analyzed before but neither author makes a focus on the material handling or on the case study; as we do in this paper. Parts must be available to the flexible manufacturing cell system when they appear at input queue.

Table 1: Families of parts and their production steps

Family	% of Mix	Production Sequence
1	10%	1 , 2 , 3 , 5 , 6
2	15%	2 , 3 , 4
3	25%	5, 2, 3, 1, 4, 6
4	15%	4, 1 , 2 , 5 , 3
5	30%	5 , 2 , 1 , 3, 5, 6
6	5%	3, 4, 2, 1 , 5, 6

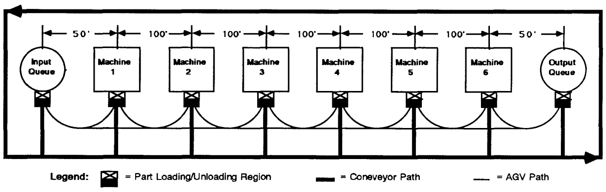

Figure 1: Layout of the flexible manufacturing cell. The proposed paths for the AGV and conveyor system are indicated in the cell layout. Spacing is given in feet.

The incoming of parts to the input queue occurs at an interval of 20 or 22 minutes, distributed uniformly. All calculations of distribution fitting used in this paper follow statistical techniques.

The types of parts produced and their production steps are detailed in Table 1. Since the total number of parts may exceed 1,000; so a classification is necessary for this system.

Production time has been determined from grouping the statically data. This data was obtained from process planning sheets of the machines and parts modeled.

Table 2 gives detail of the mean values and associated standard sample deviations of production time based on type and work station.

Part family	1	2	3	4	5	6
1	10,1.5	15,2.25	20,3		16,2.4	24,3.6
2		23,3.75	30,45	21,3.15	-	-
3	11,255	30,4,5	18,2.7	16,2.4	21,3.15	29,4.35
4	6,.9	6,.9	12,1.8	12,13	12,1.8	
5	24,3.6	24,3.6	15,2.5		15,2.5	23,3
6	9,1.35	8,1.2	10,1.5	10,3	14,2.1	29,4.35

Our objective to determine system performance is:

I. Maximizes the production output of the manufacturing cell.

II. Meet the production mix percentage targets.

III. Minimize the average time a part spends in the manufacturing cell.

IV. Don't constrain production throughput by implementation of an automated material handling system.

V. Validation of the simulation models and their associated output was accomplished by seeking the appraisal of experts. As presented by Cochran (1987), this approach is an available technique for testing the validity of a simulation model.

3. MODEL DEVELOPMENTS

3.1 Production Potential without an Explicit Material Handling Device

The initial simulation model of the flexible manufacturing cell uses a general distribution for modeled part movement. This allows through-out determination of cells that is not restricted by a material handling device. To determine maximum through-put various strategies of parts are implemented. The results of the baseline model are used for assessing the impact of material handling systems.

Historical data indicates that between 3.0 and 6.5 minutes, is required to load or unload a part from a machine. Generally part movement between machines takes between 3.0 and 6.5 minutes.

The output is analyzed using the method of batch (a batch size of 24 hours Determination of steady-state conditions, and run length are accomplished by standard means of analysis.

The results indicate that the production output of the flexible manufacturing facility is approximately 68 parts per day.

The use of simulation for searching the job shop scheduled rules. We use a number of strategies in determining our results. By running different combinations of machine part selection rules, we determined the following rule for maximum output:

- Machine 1 - select first part from waiting area
- Machine 2 - select the part with the lowest processing time
- Machine 3 - select first part from waiting area
- Machine 4 - select first part from waiting area
- Machine 5 - select first part from waiting area
- Machine 6 - select first part from waiting area

Not only this strategy obtain the most of production output, also maintains the requirement of the production.

Our analysis indicates that machine 2 is the first to make system of production level; it is in use 100% of the time.

3.2 Production Impact of AGV Installation

The simulation model is the second in our study. Its purpose is to analyze the impact of an automated material handling vehicle on the production potential of the manufacturing cell.

The material handling system consists of a automated guided vehicle (AGV) capable of transporting one part at a time. The AGV moves at an average speed of 183 feet per minute. To load or remove a part from the AGV a uniformly distributed 45 and 75 seconds, required. The AGV is used on a first-in, first-out strategy, based on an availability of transport.

The model of this system is a kind of modification in initial simulation, but now an AGV system is incorporated. This model uses the same procedure of product release and machine part selection that determine maximum output in the initial study. This allows us to statistically calculate the impact the AGV system

The simulation was run at steady-state for 5.5 batches. Each batch means a day. Total calculated simulation time is 7,920 minutes (5.5 batches x 24 hours x60 minutes = 7,920 minutes).

Analysis shows that using an AGV as the material handling device causes output to be reduced to 43 parts per day. Initially we thought that cell output would decrease as a function of the additional burden for limited material handling resource, but not with such dramatic results.
The analysis indicates that the AGV is a bottleneck for the flexible manufacturing cell. There are on average a large number of parts waiting for transport by the AGV. Currently AGV utilization is 100%. The addition of a second AGV is a logical solution to the problem of excessive utilization, but due to cost inefficiencies it was not considered as a viable alternative.

3.3 Production Impact of AGV Installation Simulation Result:

This model of the flexible manufacturing cell implements a non-accumulation conveyor system in place of the AGV. The model for this system is again a modification of the initial simulation model. To be able to determine the impact of the conveyor system on system performance, this model incorporates the same product release procedure and part selection rules that determined maximum output in the previous studies.
The conveyor-based material handling system consists of a single, uni-directional, closed-loop, non-accumulating conveyor. The conveyor moves in the direction indicated in Figure 1. Since the conveyor moves in one direction, a move from machine 4 to machine 3 will require traversing the loop from 4-5-6-OQ-IQ-1-2-3.
The conveyor is designed to move at a speed of 60 feet per minute. Each part requires between 45 and 75 seconds, uniformly distributed, to be loaded onto or unloaded from the conveyor. The cells on this conveyor are 4 feet wide. This allows any part be placed into a single conveyor cell and still allows 6 inches of freedom between parts. The simulation of the conveyor was run for 20 batches as in the initial study. As previously noted, a run length of this size allows for steady-state results to be analyzed.
Use of conveyor as the material handling system results in production output of approximately 68 parts per day, Production potential obtained by this material handling system is equal to that determined in the initial simulation model.
In terms of different types of conveying systems, a non-accumulating conveyor is all that needs to be considered. An accumulating conveyor system is a more expensive alternative, but will not increase output from the manufacturing cell. Our initial simulation study indicates that the production output from the facility is a maximum of 68 parts per day. With a non-accumulating conveyor, we achieve this potential. As in the initial study, the production output is first limited by machine number 2.

4. Comparisons of Results

The average number of each family type produced per day is summarized in Figure 2 and Table 3. Based on 24 hour averages, the production potential associated with the conveyor system is equal to that of the model implemented with a general material handling time distribution.

Table 3: Average 24 hour production output of the flexible manufacturing cell.

Family Type	No Material Handling	AGV System	Conveyor System
1	6.85	4.18	6.85
2	11.65	8.90	11.60
3	15.75	10.18	15.85
4	10.70	6,18	10.75
5	20.65	11 63	20.55
6	2.65	2.00	2.65
Total	68.25	43.07	58.25

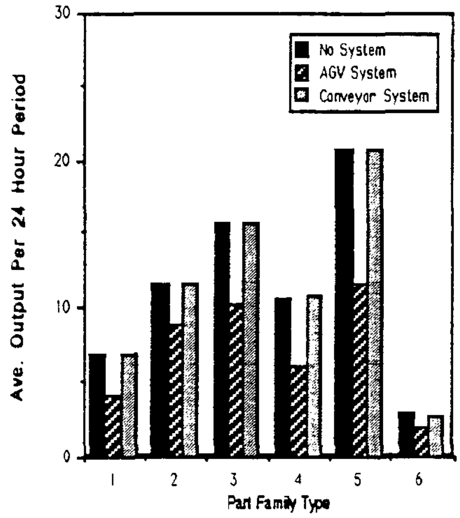

Figure 2: Average production output for a statistically typical 24 hour period. Results are given for the number of each part family type produced by the three simulation models. Note that the conveyor system is equivalent to the system with no material handling device.

Second study indicates that with an AGV, the manufacturing facility outputs an average of 43 parts per day. The production capability of the AGV system is but 63% (43/68) of what is obtained by means of the conveyor.

In Table 4, 95% confidence intervals for the average time a part spends in the manufacturing facility are presented. Figure 3 indicates that the average processing time for a part is between 4 and 5 hours. The addition of a conveyor (as the material handling system) increases the average processing time to be between 5 and 6.5 hours. With an AGV, it takes an average of between 32 and 36 hours to process a part through the manufacturing cell, but this time value is growing unbounded. Depending on the family type, the processing time associated with an AGV incorporated into the system is increased by 5 to 12 times.

The variation for processing times of each family type is summarized in Table 5. The AGV dramatically increases the variability associated with the mean processing time. There are variation increases upwards of 30 times by using a single AGV as the material handling device. The variation of times for the conveyor system is minimized when compared to initial simulation models and in certain instance it is less.

Table 4: 95°/o confidence intervals for the average time (in minutes) that a part is in the manufacturing cell. The table provides the average processing time for each specific family type plus the time associated with an average part.

Part Type	No Material Hanoi System log	AGV System	Conveyor System
1	(184, 196)	(1361, 2093)	(193, 205)
2	C135,271)	(1224, 566)	(165,184)
3	(404, 606)	(2152, 2650)	(521, 803)
4	(136, 144)	(I759,2385)	(231,239)
5	(235, 255)	(2126, 2602)	(331,355)
6	(195, 215)	(1527, 2673)	(287,306)
Average	(247,301)	(1942,2182)	(320, 389)

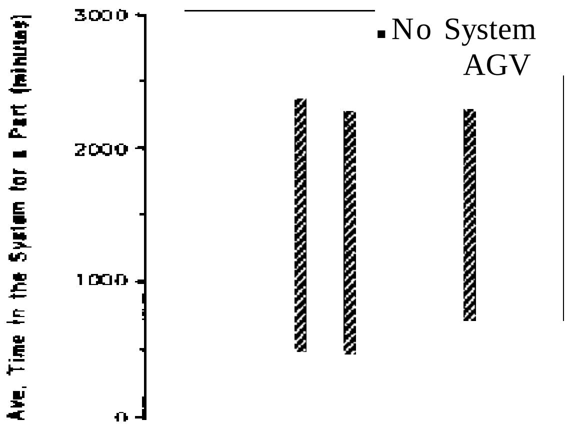

Figure 3: Average time for a part family type to be in the manufacturing cell. Results are summarized for each of the three simulation models.

5. Case Study Recommendations

The simulation study demonstrates the production output of the flexible manufacturing cell is maintained by using a conveyor as a material handling device. With the conveyor, the manufacturing cell has an average output of 68 parts per day. The time a part spends in the manufacturing cell is dramatically reduced. Not only the time is reduced but associated variability of time is also decreased in comparison of AGV system. In addition production mix target are also satisfied.

To achieve maximum production output, the optimum part selection rule for a machine has been determined to be:

- Machine 1 - select first part from waiting area
- Machine 2 - select the part with the lowest processing time
- Machine 3 - select first part from waiting area
- Machine 4 - select first part from waiting area
- Machine 5 - select first part from wing area
- Machine 6 - select first part from waiting area

Utilizing the conveyor system in the facility causes the average time a part spends in the system to be between 5 and 6.5 hours. This compares well to the AGV system in which the average time ranges between 32 and 36 hours. The cycle time for the manufacturing facility is around 5.5 hours with a conveyor system. Cycle times by family type are summarized in the previous section. Analysis indicates that the time between when a part enters and leaves the manufacturing cell is around 4 to 11 times less when a conveyor is used to transport parts versus an AGV.

Before a decision is made to go with the conveyor system, remember that such a system lacks flexibility. There is great expense involved in changing the layout of a conveyor system if the station set-up is modified.

If it can be reasoned that the current station set-up will remain relatively unchanged, our recommendation is to implement a non-accumulating conveyor system for material handling. This conclusion is based on the fact that with a conveyor system, system performance in maximized. That is, production output is maximized, long-term percentage mixes are met, and the average time a part spends in the manufacturing cell is minimized.

6. References:

[1] Cochran, J.K. and Cheng, C.S., "Automating the Procedure for Analyzing Univanate Statistics in Computer Simulation Contexts", Transactions of the Society for Computer Simulation 6:3, pp. 173-188 (1989).

[2] Cochran, J.K., "Techniques for Ascertaining the Validity of Large-Scale Production Simulation Models", International Journal of Production Research 25:2, pp. 233-244 (1987).

[3] Cochran, J.K. and Mackulak, G.T., "Low Cost Artificial Intelligence Can Aid Design and Simulation", CIM Review 3:3, pp. 33-36 (1987).

[4] Cochran, J.K., Crowe, T.J., and Ogle, M.K., "A Generic Simulation Experiment For Evaluation Dispatching Rules in Flexible Manufacturing Systems", Twenty-Second Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, PA (1991).

[5] Cummins, G.F., "Simulation Model to Compare Group technology and Functional Layout", Proceedings of the 1980 Summer Computer Conference, 626-630 (1980).

[6] Hershauer, J.C. and Ebert, J., "Search and Simulation Selection of a Job Shop Scheduling Rule", Management Science, Vol. 2pp. 833-848 (1974).

[7] Kiran, A.S. and Smith, M.L., "Simulation Studies in Job Scheduling-f A Survey", Computers and Industrial Engineering, Vol. 18, pp. 87-93 (1984). Law, A.M. and Kelton, W.D., Simulation Modelinq and Analysis, Me-Graw Hill (1991)