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The Effects of Machine Load Situations on Performance of Job Shop and Group Scheduling

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I.ABSTRACT

Performance of job shop and group scheduling ndermulti-batch work input environment was examined against two machine load (light and high load) situations.

In order to conduct the analysis, a deterministic computer simulation program was written and used.

A job shop (JS) model is applied to the shop floor area and compared with a simulation of a similar proposal except that group technology (GT) model was used in the shop floor area instead.

Detailed analysis of the results from applying different machine load situations and different models were assessed according to the performance criteria of order tardiness, work-in-progress and machine utilisation.

KEY WORDS: Simulation, Computer Simulation, Group Technology, Job Shop, Scheduling, Machine Load.

II. INTRODUCTION

It has been recognized that machine load situation is important problem in the area of scheduling for manufacturing systems.

Traditionally, a job shop scheduling problem occurs when the technical order of the jobs on several machines is not necessarily the same, and also the number of operations required for each job may not be the same. The problem is to determine the jobs or parts are to be produced within limited amounts of production resources such as facilities capacity, production times, etc.

Production scheduling associated with a group technology cell is called "Group Scheduling"[1]. One of the essential requirements for full utilization of group technology is to adopt appropriate operations scheduling methods. So, in manufacturing with group technology, the sequence of groups and the sequence of jobs in each group should be determined prior to actually starting production within the cell.

Various industry reports indicate that implementation of group technology concepts leads to remarkable improvements in efficiency. However simulation experiments that have been performed seem to yield results that do not completely support these reports from industry[2].

Recently four group scheduling and four job scheduling procedures were tested for a group technology flow-line cell in a simulation study by Wemmerlov and Vakharia[3]. It was concluded that the group scheduling procedures perform better than job scheduling procedures. However, they stressed the need for further research in the area of family scheduling.

The literature provides a full sellection of different scheduling rules and heuristics[1], [4], [5], [6], [7), [8) and yet no universal solution has been found [9), [10]. Complexity of scheduling arises not only from practical operational difficulties, but also from the diversity in production systems and procedures.

In this study, hypothetical factory models of group technology and job shop have been developed to test the effectiveness of the models by applying them to real life situation. These two simulations can be used in evaluation.

III. THE SIMULATION PROGRAM

The simulation program was written in TURBO PASCAL 7.0. The modular and deterministic nature of the program permitted to identify all system entities: machines, jobs, groups and cells.

Two simulation models have been developed to meet the objective. These are group technology and job shop models. The two models involve six basic functions, which are summarised as follows:

a) Generation of customer orders of final product.
b) Generation of forecast demand for manufactured parts.
c) Explosion of customers' orders against the bill of materials.
d) Determination of schedules of order releases using forward loading procedures.
e) Generation of completed parts from the shop floor.
f) Recording the results of the simulation for perfo mance analysis.

IV. PERFORMANCE MEASURES

Three performance measures were used for performance evaluation. these included percentage tardiness of orders, work-in-progress (WIP) and machine utilisation.

The first criterion examined is the timeliness of order delivery. The aim of adopting this criterion is to demonstrate the capability of the models in achieving their promised delivery dates.

The second performance criterion is work-in-progress. Generally, WIP is measured in terms of average value of WIP items over the total simulation time. However. in this study, WIP is measured in terms of waiting cost on the shop floor.

The third performance criterion is the mean utilisation factor of all the machines. Machine utilisation factor is defined as being the percentage of actual productive capacity over the total capacity per annum. The performance criteria were calculated using the formulas in [11].

V. SIMULATION EXPERIMENTS

The simulations were carried out to compare two models using two load situations. The experiments aimed to satisfy the following goals:

i) The first experiment aims to analyze the behaviour of the group technology model with light load.

ii) The second experiment is similar to experiment number 1, but the model used is job shop.

iii) The third and fourth experiments are similar to the first and second experiment respectively but now using a high load.

A series of experiments were planned and executed to examine the affects of machine load situations on both model.

The results of the experiments were collected. These results were the values of the perfo mance analysis for the two different models. These results were then analyzed using the statistical student distribution (t) test on the basis of 5% level of significance.

The variables in the experiments were:

. Type of manufacturing layout (i.e. group technology or job shop).
. Whether machines are high loaded or light loaded.

The perfo mance of the models were sensitive to the load situations examined. In the case of high load situation, the significant effect of percent tardiness of orders can be seen in table.1. Light load situation, the significant effect percent machine utilisation can be seen in table.3. Light and high load situations, there is no significant effect of work-in-progress on the models can be seen in table.2.

Table.1. Percent Tardiness of Orders

Load	MRP/GT Mean Std	MRP/IS Mean Std	Significance at level of 5%
Low	1.6 2.0	5.8 9.0	not significant
High	8.5 4.0	27.2 17.0	significant

Table.2. Work-In-Progress

Load	MRP/GT Mean Std	MRP/IS Mean Std	Significance at level of 5%
Low	17100 2748	17931 4539	not significant
High	41204 15021	43101 13566	not significant

Table.3. Percent Machine Utilisation

Load	MRP/GT Mean Std	MRP/IS Mean Std	Significance at level of 5%
Low	42.5 2.0	44.5 1.0	significant
High	55.0 4.5	55.5 4.0	not significant

VI. CONCLUSION

In te ms of tardiness of order delivery, percentage tardiness of orders with light load, there seems to be no significant difference between the two models. When load is high, GT model has shown a third lower tardy order rate than Job Shop model. Group Technologv model can therefore be recommended as an alternative to job shop model. Generally GT model aims at increasing the flow of parts and components, whereas in the job shop model this can be very difficult to achieve. In the light load environment, the results have shown only a slight difference between the performance of the two models. The difference in performance between the models increases when a highly loaded environment is being dealt with. The computer simulation can be effectively to *assess* the effect of different operational strategies.

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