SIMULATION KEY UNLOCKS PROBLEMS OF REDUCING IN-PROCESS INVENTORY AND IMPROVING MANUFACTURING FLOW

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INTRODUCTION

This study describes a General Purpose System Simulator (GPSS) model created to determine the acceptable minimum inventory levels and the dynamic effects of a conveyor system proposed for the unit record manufacturing area at International Business Machines Corporation's Poughkeepsie, New York, plant. Because of the model's complexity, it was run on a multi-processor operating system with 512K bytes of storage.

THE PROBLEM

The first step in constructing the GPSS model was to build a basic manufacturing flow chart (Figure 1). This Figure represents a progressive, mixed-model, multiple-station, manufacturing process which encompasses assembly, test, rework, and quality control operations. After the unit's card transport is assembled through progressive operations, a quality control test is performed. Next, the IBM 029 Cardpunch, the IBM 059 Verifier and the various other punches go to their respective final assembly and test areas. Then, a final quality control test is performed, and the units go to shipping.

To construct the manufacturing flow chart, data about the manufacturing process was gathered. It included:

1. Production schedules.
2. The number of operations.
3. Work stations/operation.
4. Average actual and variance time/machine/operation.
5. The units in float.
6. The units in quality control.
7. Quality control acceptance and rejection statistics.

The last data gathering step was to construct a manpower versus operation matrix (Figure 2). In the matrix, each employee was assigned a unique number. The department manager also listed each employee according to his skills on each operation. (The lower the row number, the greater the employee's skill level on a particular operation.)

After gathering the data and before running the model, it was possible to see previously unapparent relationships among the variables. Therefore, even the early steps in developing a simulation model, before the full sensitivity of the variables is determined, can be beneficial.

MODEL DESIGN

In any simulation, it is necessary to specify a definite time period for which to construct the model. The manufacturing process for the fourth quarter of 1967 was modeled so that the ground rules could be validated against actual production data.

The model's basic parameters included:

1. Up to 49 possible machine-feature combinations.
2. Two shift operation was allowed with unique manpower pools available on each shift (see matrix).
3. Manpower assignment determined by skill levels.
4. Manpower assigned to multiple operations at different skill levels.
5. Output provided to determine the use of manpower by operation.
6. Multiple stations allowed at each operation.
7. Variable float area capacities between operations.
8. Priorities set on individual machines as a function of the float status preceding each operation.
9. Operation times randomly selected about uniformly distributed average actual times.
10. Machine lots accepted randomly at quality control operations based on current acceptance rates.
11. Variable order releases into the model.
12. Average work in-process inventory for each operation calculated, priced and printed out.

SIMULATION RESULTS

The GPSS model verified suspected problem areas in the manufacturing process when it was matched against actual production schedules. This indicated the manufacturing process had been modeled correctly. The next step was to simulate the impact of parameter changes in the model without physically changing the manufacturing process.

One of the first changes simulated in the model was modification of the order release procedures employed by the production control and manufacturing departments. This strategy had been to release and build a group of 029 orders, 059 orders and other punches at the beginning of each day in the card transport assembly area. The time per machine was different for each operation, thereby causing bottlenecks to occur within the process. Releasing the units in a given sequence, such as two 029's, three 059's, one other punch, . . . , showed that the bottlenecks could be reduced.

Another change made in the model was in the allocation of manpower to the various operations. Since the model indicated the employee who worked on each operation and the time period involved, it was apparent that more crosstraining was needed on certain operations and less on others.

Probably the most important area where changes were tested was in the number of machines required between the various manufacturing operations and departments. The model indicated a potential reduction of in-process inventory levels of 60 per cent by reducing operation floats. It also showed that a conveyor system moving a limited number of machines between successive operations could function efficiently and allow production schedules to met.

Using the simulation study, evaluation was done to determine how much it would cost to reduce high in-process inventory levels.

The first area examined was the conveyorized base assembly area. Here, the decrease in in-process inventory levels was not large enough to warrant costly changes to the existing conveyor system. The second area examined was the other punch final assembly and test area. Here it was determined a conveyor system would be too costly to design and install. However, the float areas between these operations were reduced by management control. The third area evaluated was the 029/059 final assembly and test operation. Here production volume was high and it was economical to design and install a conveyor system.

An expanded GPSS model could be used as a manufacturing tool with which managers could analyze their department's efficiency with regard to manpower allocation, skill levels, inventory, number of work stations and production schedules.

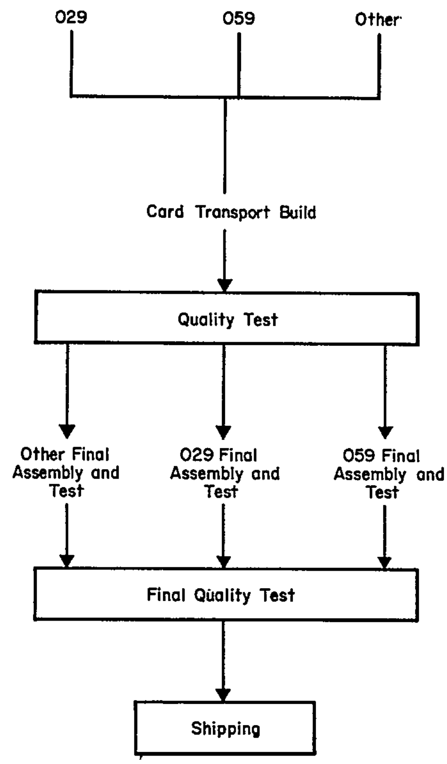

Figure 1. Unit Record Manufacturing Flow Chart

Operation Number	1	2	3	4 40
Man Number Allocation	1	6	3	7
	2	5	4	8
	5	2	7	9
	6	9	1	
	8			
	.			
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	300			

Figure 2

Manpower versus Operation Matrix