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ON THE USE OF SIMULATION MODELS TO EVALUATE ALTERNATIVE SCHEDULES

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1. INTRODUCTION

In recent years, the attention of the automobile industry has been directed towards its manufacturing operations. Today, I would like to discuss with you some results obtained on manufacturing systems by combining simulation modeling with scheduling algorithms.

In particular, the work presented here today is based on a simulation model of a portion of one of our stamping plants. The presentation begins by briefly describing a typical section of the stamping plant and the scheduling environment in which the plant operates. After describing the reality, I will then proceed to describe the simulation model built and its verification. From there, I will briefly describe three different scheduling approaches. These three algorithms were run to generate a production schedule for a five week period. Each of these schedules were then used to drive the simulation model. The presentation concludes with a summary of the results and some general remarks on the importance of scheduling in the factory of the future.

2. STAMPING OPERATIONS

In the typical stamping operation, steel coils arrive at one end of the plant and are then loaded onto blankers or shears. There, the coils are cut up to the rough size of the desired stampings. The blanks then move through the press lines where the stampings are formed. Depending upon the part, the stampings are shipped directly to an assembly plant or are assembled into a component prior to shipment. For example, the door assembly, on which we shall focus our attention, undergoes ten manufacturing operations prior to shipment.

The demand drivers for the finished door assemblies are the vehicle assembly plants. All cars are built to order. The district sales offices consolidate orders and transmit the information to the scheduling office where it is in turn broken down into 12 day order banks for each of the assembly plants. At the individual assembly plant level, the order bank is then processed to yield weekly and daily breakdowns, and a daily build sequence. These are then submitted to scheduling which then consolidates the build schedules and generates an order tape for the assembly plants' suppliers. In essence, this tape consists of one week of "firm" orders as perceived by the supplier plus three weeks of anticipated orders for planning purposes.

Once the tape is received at the stamping plant, a daily schedule for the week's firm orders is then generated manually. Among other factors taken into consideration are the status of machines and dies, inventory counts, and actual plant manning levels.

Viewed in total, a cyclically operating stamping plant is a rather complex operation, involving intricate interaction between the various operations, varying demand for product, and in-plant material movements which vary in composition, quantities, and destinations. To provide a vehicle for increased understanding of the interaction between the various product and service facilities (i.e. material handling, and die setting), in a stamping plant, simulation modeling has been applied to the stamping plant and assembly lines used to fabricate 10 different door assemblies.

3. SIMULATION MODEL OF STAMPING PLANT OPERATIONS

A network simulation model of the door press and assembly lines was constructed using SLAM-II (Pritsker 1977). These lines produce the outer and inner panels, and the final door assemblies for Escort/Lynx, EXP/LN7, and Mustang car lines. The model simulates the production of racks of stamped panels from two press lines, of racks of completed door assemblies from four assembly lines, and the movement of the racks within the plant. Because the major panels consumed by the door assembly lines are produced primarily by the two press lines, which produce nothing but door panels, the doorlines provide as close to an independent system for modeling as can be expected in a stamping plant.

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The doorline model is a network simulation model which mirrors the actual two press and four assembly lines. The press lines produce the four variations of outer panels and the six variations of inners. Entities representing racks of completed panels are moved from the press lines to in process storage areas until required by the model's assembly lines. The four assembly lines produce the ten door variants produced on the actual lines.

A unique feature of the model is that all production lines are driven by a schedule input by the modeler. In this schedule, lines are directed to build the parts required for each day of the week. The lines then build the parts to a quota or to the completion of the day (or the shift). If scheduled to a quota, the lines shut down or switch to another part upon meeting it. If overtime is required, and permitted by the schedule, the lines will continue to operate past the end of the simulated day. Dies can be changed either on or off-shift at the choice of the modeler, the change time being an input parameter.

Output from the model is in the form of production, shipping, and storage reports which specify in daily and cumulative fashion the number of parts produced, production hours required, and any shortages which occur.

To evaluate the model, it was run with actual production schedules over a five week period. In terms of both pressed panel and total door production over the period the results compare very favorably.

4. SCHEDULING APPROACHES

The simulation model was run using three different scheduling approaches: manual schedule mainly based on Material Requirements Planning (MRP) concepts (Tersine, 1982); a mixed integer programming formulation, and, a commercial software package, RESULT (Baker, 1983). These approaches were then used to generate a five week production schedule constrained to meet the identical demand for end items (finished doors). Schedule quality was evaluted in terms of overtime required and average work-in-process inventory levels. In building the scheduling models, a decision was made to switch from an EOQ (economic order quantity) approach (Wagner, 1975) to one in which demand for varying products substituted for the holding cost, and length of production run for the set-up cost.

5. SUMMARY

A simulation model of a portion of a cycle shop was built and verified. This model was then used to evaluate alternate scheduling approaches. In the process, the importance of scheduling in determing plant productivity was quantified.

REFERENCES

Baker, T. E. (1983) RESULT: An Interactive Modeling System For Planning and Scheduling Proceedings of the TIMS/ORSA National Meeting, Chicago, Illinois, April 25-27, 1983, p. 53.

Pritsker, A.A.B and C. D. Pegden (1979), Introduction to Simulation and SLAM, West Lafayette, Indiana, Systems Publishing Co.

Tersine, R. J. (1982), Principles of Inventory and Materials Management, Second Edition, North Holland, New York, New York.

Wagner, H. M. (1975), Principles of Operations Research, Second Edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.