

UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

Department of Mechanical & Industrial Engineering

FINAL EXAMINATION, APRIL 2001

MIE 460S - Manufacturing and Production Systems

Exam Type: C

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1. Floortex manufactures a self-adhesive tile used in the finishing of new floors and in the renovation of old floors. The equipment paced line flow production system consists of single machine stations and is almost balanced in that station process rates are nearly equal. A manufacturing engineer has estimated the bottleneck rate of the line to be 2000 cases of tiles per 16 hour day and the raw process time to be 30 minutes. The line has averaged 1700 cases per day and cycle time has averaged 3.5 hours.

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- a) Estimate the average WIP level.
- b) Estimate the throughput rate under MVA and compare it with the average throughput rate.
- c) What is the effect on line throughput if the capacity of a non-bottleneck station is increased while the WIP is held constant at its current level?

2. The process technology manager of a firm, which manufactures plastic packaging materials, wants to upgrade the equipment used in its operator-paced line flow production system. This production system provides the order winning level of performance for the many products the firm produces.

15 The firm requires a payback period of less than four years for this type of investment. The financial group assessed the project and found that it was acceptable on all economic criteria except that of payback which was estimated to be 6.5 years. To reduce the payback to four years, production volume would have to increase by 90 percent. Manufacturing agreed to attempt this, and the \$5 million proposal was approved. Changes were made to win more orders. Some products were standardized and their prices were dropped. More orders were produced but problems in capacity management arose due to scheduling and balancing the standard, high volume products with the regular non-standard, medium volume products. Profit margins started to shrink because the low prices on the standard products were barely able to cover their cost of production. Other changes were implemented to further increase volume and reduce product variety but the accumulated changes resulted in having an adverse effect on the order winning level of performance and subsequent profit margin.

- a) Why does the operator paced line-flow production system provide high levels of performance compared with other traditional production systems?
- b) How did the changes made to increase volume affect the firm's intended strategy?
- c) Which strategic criteria could have been useful in performing a more rigorous evaluation of this investment?

3. BACH Autoparts manufactures a product family of stamped-steel steering brackets, which it supplies on a daily basis to State Street Assembly for installation to new car chassis. The steering bracket holds the steering column to the car body. This product family is very narrow and is manufactured on a kanban controlled line, which consists of two workcentres. The operation at the first workcentre spot welds the bracket components together. At the second workcentre special machined fittings are attached to the bracket for securing it to the steering column and to the car body.

20 Currently a single card kanban system is in use but because of the distance between the two workcentres and the fact that a component supplier will deliver parts, just-in-time, to both workcentres, a two-card kanban system has been proposed. There will be an inbound and outbound stock point at each workcentre as well as a stock point on the factory floor for use by the supplier to enable delivery directly to the manufacturing operation.

Each workcentre has an effective process rate of 80 units per hour and this rate must be maintained to provide a daily shipment of 1200 brackets to State Street Assembly. The containers (both production and move) are the same containers that were used in the single card kanban system and hold 20 units each. The time to move an empty container to the first workcentre, fill it with completed parts and move it back to the second workcentre is 1/2 hour.

- a) Develop a sketch of the layout and container flow paths of the proposed system. Show both inbound and outbound stockpoints and distinguish between the flow of move and production containers.
- b) Find the number of production containers require at the first workcentre to protect against shortages during production time. Use a safety factor of 0.20.
- c) Using a safety factor of 0.25 find the number of move containers to protect against shortages during move time at the first workcentre.
- d) Determine the maximum WIP at the first workcentre using the values obtained in b) and c).
- e) Calculate the equivalent values of the production during average lead time and the order quantity, for the two-card kanban design, which correspond to the reorder point system (s, Q).

4. A paced transfer line has 20 workstations and operates with an ideal cycle time of 0.5 minutes. All stations have an equal probability of failure, i.e., $p=0.01$. When failures occur the average downtime is 5.0 minutes and the upper-bound approach applies. A proposal has been made to divide the line into two independent stages, each stage having ten stations, with buffer storage between the stations. The proposal indicated that each stage could operate independently and this would lead to an increase in production rate of the overall line. For a storage buffer with a capacity of 25 units it is estimated that the line operating costs would increase by \$12.00 per hour. The cost to operate each station is \$4.80 per hour per station with or without the buffer. Ignore material and tooling costs in this problem.

15 Note that the ideal proportion of the time when stage 1 is down that stage 2 could be up and operating is given by

$$\frac{B}{B+1} + L \frac{T_c}{T_d} \frac{1}{(B+1)(B+2)}.$$

- a) Determine the average production rate per hour and the cost per unit of production for the current station line.
- b) Calculate the average production rate per hour and the cost per unit for the proposed two-stage system.

5. With the new JIT production system implemented at Applicon, production scheduling is no longer done at the subassembly level nor are workorders generated by the MRP system as was the case for the traditional system. Eliminating workorders and achieving very short lead times made the old system of inventory tracking, based on detailed transactions generated by MRP, obsolete. The totally revised MPS is now stated in saleable item terms and has standard available-to-promise capability. These MPS quantities then become the new MRP gross requirements when the system is regenerated.

Describe the production scheduling and control system that was implemented at Applicon from the viewpoint of:

- a) shopfloor control
- b) materials planning
- c) order release.

6. Ace Industries, an industrial air cleaning equipment manufacturer wants to increase sales by obtaining a larger share of the market. Ace makes a standardized family of products in low to medium volumes using a batch flow production system with functional layout. The current manufacturing subsystems have an industry average level of capability, i.e., level 2. Ace hopes to increase sales by adding two new advanced features but still believes that delivery is the order winning output which was born out by a recent market survey. The market qualifying outputs are performance, cost, and quality. Ace Industries believes that steady growth in sales is desirable rather than trying to achieve abrupt changes with the resulting stress which would be placed on the production system. Develop an appropriate strategy for Ace Industries and justify your recommendations.