

FACULTY OF APPLIED SCIENCES
DEPARTMENT OF APPLIED MATHEMATICS
APPLICATIONS OF QUANTITATIVE ANALYSIS

DEC 2002

Time : 3 hours

Candidates should attempt **ALL** questions.

A1. Air Zimbabwe is establishing a new telephone system for handling flight reservations. During the 10.00 am to 11.00 am time period, calls to the reservation agent occur randomly at an average of one call every 3.75 minutes. Historical service time data show that a reservation agent spends an average of 3 minutes with each customer. The waiting line model assumptions of Poisson arrivals and exponential service times appear reasonable for the telephone reservation system.

Air Zimbabwe's management feels that offering an efficient telephone reservation system is an important part of establishing an image as a service-oriented airline. If the system is properly implemented, Air Zimbabwe will establish good customer relations, which in the long-run increase business. However, if the telephone reservation system is frequently overloaded and customers have difficulty contacting an agent, a negative customer reaction may lead to an eventual loss of business. The cost of a ticket reservation agent is \$20 per hour. Thus management wants to provide good service, but does not want to incur the cost of overstaffing the telephone reservation operation by using more agents than necessary.

At a planning meeting, Air Zimbabwe's management team agreed that an acceptable customer service goal is to answer at least 85% of the incoming calls immediately. During the planning meeting, Air Zimbabwe's assistant general manager, AGM, for administration pointed out the data show that the average service rate for an agent is faster than the arrival rate of the telephone calls. His conclusion was that the personnel cost could have been minimised by using one agent and the single agent should be able to handle the telephone reservations and still have some idle time. The AGM for marketing restated the importance of customer care and expressed support for at least reservation agents.

The current reservation system does not allow callers to wait. Callers who attempt to reach a reservation agent when all agents are occupied receive a busy signal and are blocked from the system. A representative of the telephone company suggested that Air Zimbabwe consider an expanded system that accommodates waiting. In the expanded system, when a customer calls and all agents are busy, a recorded message tells the customer that the call is being held in the order received and that an agent will be available shortly. The customer can stay online and listen to background music while waiting for an agent to be available. Air Zimbabwe's management team will need more information before switching to the expanded system.

Prepare a managerial report for Air Zimbabwe analysing the telephone reservation system. Evaluate both the system that does not allow waiting and the expanded system that allows waiting. Include the following information in your report:

- (a) A detailed analysis of the operating characteristics of the reservation system with one agent as proposed by the AGM (Administration). What is your recommendation concerning a single agent system?
- (b) A detailed analysis of the operating characteristics of the reservation system based on your recommendations regarding the number of agents Air Zimbabwe should use and whether system should allow customers to wait.
- (c) What appear to be the advantages or disadvantages of the expanded system? Discuss the number of waiting callers the expanded system would need to accommodate.
- (d) The telephone arrival data presented above are for the 10.00 am to 11.00 am time period, however, the arrival rate of incoming calls is expected to change hour to hour. Describe how your waiting line analysis could be used to develop a ticket agent staffing plan that would enable the company to provide different levels of staffing for the ticket reservation system at different times during the day. Indicate the information that you would need to develop this staffing plan.

- A2. Ncube Trailers, NT, Inc. manufactures a variety of general purpose trailers, including a complete line of lorry trailers. Two of the best-selling lorry trailers are NT-190 and NT-250; the NT-190 is designed for lorries up to 19 metres long and NT-250 can be used for lorries up to 25 metres long in length.

NT would like to schedule production for the next two months for these two models. Each unit of the NT-190 requires 4 hours of production time, and each unit of NT-250 uses 6 hours of production time. The following orders have been received for January and February 2003.

Model	Jan	Feb
NT-190	800	600
NT-250	1100	1200

The ending inventory from December was 200 units of NT-190 and 300 units of NT-250. The total number of hours of production time used in December 6300 hours. The management of NT is very much concerned about being able to satisfy existing orders for the NT-250 for both January and February. In fact, they feel that this is the most important goal they would like to achieve in developing a production schedule. Next in importance is satisfying existing orders for the NT-190. In addition, management does not want to implement any production schedule that would involve significant labour fluctuations from month to month. In this regard, their goal is to find a production schedule that would limit fluctuations in labour-hours used to a maximum of 1000 hours from one month to the next.

Perform an analysis of the NT production scheduling problem, and prepare a report for NT's Chief Executive that summarises your findings. Include a discussion and analysis of the following in your report:

- The production schedule that best achieves the goals as specified by management.
- Suppose NT's storage facilities would only accommodate up to 300 trailers in any one month. What effect would this have on the production schedule?
- Suppose NT can only store up to 300 trailers in any one month. In addition, suppose management would like to have an ending inventory in February of at least 100 units of each model. What effect would both these changes have on the production schedule?
- What changes would occur in the production schedule if labour fluctuations was the highest-priority goal?

- A3. A large corporation has collected data on the reasons both middle and senior managers eventually leave the company. Some managers eventually retire, but these leave the company prior to retirement for personal reasons including more attractive positions with other firms. Assume that the following matrix of 1-year transition probabilities applies with four states of the markov process being retirement, leaves prior to retirement for personal reasons, stays as a middle manager, and stays as a senior manager.

	Retirement	Leaves - personal	Middle manager	Senior manager
Retirement	1.00	0.00	0.00	0.00
Leaves-personal	0.00	1.00	0.00	0.00
Middle-managers	0.03	0.07	0.80	0.01
Senior-managers	0.08	0.01	0.03	0.88