

RESERVE DESK
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GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1996

AUTOMATION IN MANUFACTURING
EXAM AREA

Assigned Number (**DO NOT SIGN YOUR NAME**)

-- Please sign your name on the back of this page --

Manufacturing Automation Qualifying Exam

Enigmatic Technology Corp. (ETC) is a small manufacturer of high tech mechanical devices for the electronics manufacturing industry. The products are made in small batches to supply assembly lines of a variety of companies. While the products made fall into some well defined categories the mix of products is great. The machines used include assembly stations, multi-axis machining centers, electro-discharge machining, turning centers and metal forming machines as well as the material handling system that serves them. In addition to orders for new equipment a sizable replacement part business must be serviced.

(a) What structure (organization) of the manufacturing line seems most suitable to ETC? What are some options? Why is the one you chose most appropriate.

(b) The selection of equipment for expansion is to be done based on your analysis of the alternatives. You can draw on considerable historical records with several equipment suppliers. Among the variables are machine reliability and repair. Supplier A builds equipment that is more reliable while Supplier B has faster service time. **What type analysis should be done so that the "most appropriate" selection can be made based on the historical mix of production?** Be as specific as possible. You want results that are useful, practically obtainable, and will result in the success of ETC. Clearly state the information needed and the measures of performance that will be determined and why they are relevant. What type of analysis can be made and what approximations and assumptions are necessary. Is the software or other tools readily available?

Please be concise but thorough in your answers.

Consider you are asked to design an automatic tool failure monitoring system using a Motorola M68HC11EVB board. The main function of the board is to sample the signal from an accelerometer attached close to the bearing for on-line analysis of rotational imbalance. A typical frequency spectrum (but obtained using a high speed spectrum analyzer of 10MHz bandwidth) from the accelerometer is shown in Fig. 1.

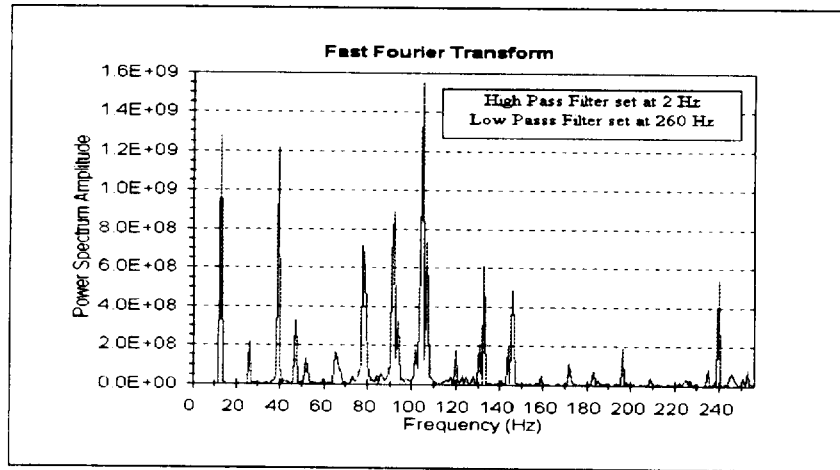


Fig. 1 Frequency spectrum obtained from the accelerometer

The nominal speed of the tool spindle is approximately 15Hz. Tool failure can be determined within six times the frequency of the nominal spindle speed. Other high frequency noises, however, were observed at frequencies higher than 240Hz. Discuss how would you design the system with a Motorola M68HC11EVB board operated at a clock frequency of 2MHz. What are the hardware components needed for implementing the design and explain their functions? Sketch a flow chart illustrating any routines (both the main program and the interrupt service routines) needed for sampling of the data $a(t=kT)$. How time is measured and at what rate should the data sampled? State any assumptions made.

A sporting club has 3 treadmill machines. The average time that each person uses the machine is 18 minutes. People join the common queue for the machines every 6 minutes if there are no more than 2 other people in the queue. Formulate the process as a Markov chain and draw the corresponding state transition diagram. Also, compute

- a) Average waiting time in the queue for each person that enters it.
- b) The steady-state probability that the queue is empty.
- c) The mean utilization of each machine.