MANUFACTURING ENGINEERING TRIPOS PART II

Wednesday 23 April 2008 9 to 12

PAPER 1

*Answer not more than **four** questions. Answer each question in a separate script paper booklet.*

All questions carry the same number of marks.

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

There are no attachments.

STATIONERY REQUIREMENTS	SPECIAL REQUIREMENTS
8 Page Script Paper Booklet x 4	Engineering Data Book
Rough work pad	CUED approved calculator allowed

You may not start to read the questions printed on the subsequent pages of this question paper until instructed that you may do so by the Invigilator

Version 3

1 You have recently been appointed the Manufacturing Director of a medium sized (300 employees) factory which develops and produces small domestic appliances such as kettles, hair dryers and food mixers. The business sells its products internationally and faces stiff competition. You are responsible for product design and development, as well as assembly operations.

You are concerned that the current products are difficult to assemble and offer poor value to the customer, compared to competitors' products. Assembly methods are manual, apart from some mechanical assistance from jigs and tools. Given this situation, you decide to systematically review the design and assembly methods of all products, both those currently in production and those under development.

(a) Describe the approaches you could take to improving the design of current and future products. Explain which approach(es) is/are more suited to current or future products and why. Discuss the advantages and limitations of your proposed approaches. [40%]

(b) Discuss which factors you would take into account when evaluating the viability of assembly automation as a possible means to improve business performance. [30%]

You next consider adding software functionality to future product generations in order to enhance the customer appeal of what have hitherto been electro-mechanical products.

(c) Explain how you would set about deciding whether to develop the software in-house, or to sub-contract the work to a software supplier. [30%]

2. (a) The pre-production stage in the development and introduction of a new product is vital to the trouble-free transition to full production. Outline the processes which need to be achieved before full production commences, and the problems which may arise if the process is not carried out properly. You should include specific examples from the aerospace sector and other industries, as well as from your own experience. [35%]

(b) Carbon-fibre reinforced plastic (CFRP) has properties which are potentially valuable for the automotive industry, but its market penetration is currently small. With reference to both long-fibre and chopped-fibre CFRP:

(i) Give examples of applications within the automotive sector for which it might be suitable, indicating its advantages over conventional materials. [20%]

(ii) Discuss the barriers to its introduction to the automotive sector. [30%]

(iii) What would be the environmental implications of using CRFP instead of steel or aluminium for mass-market automotive bodies? [15%]

3 (a) Discuss the factors affecting accuracy when using a robot to perform an assembly task and explain the steps you would take to improve accuracy. [30%]

(b) Discuss how 'intelligent' sensing can improve the capability, and/or simplify the programming task for assembly robots. [40%]

(c) Discuss the advantages and disadvantages of a SCARA robot compared with an anthropomorphic robot, giving example of the tasks more suited to each type. [30%]

4 (a) What are the advantages and disadvantages of JIT as compared with MRP as a means to control inventory in production systems? [30%]

(b) A factory makes spur gears for automotive transmissions for six different customers, five from the mass production car market and a small volume make-to-order back hoe digger manufacturer. For each customer there is a dedicated machining cell. All cells have the same layout and equipment, differing only in size to cope with the differences in volumes from the different customers. Performance of the cells is measured in terms of volume output and on time delivery. The digger cell does not perform well, having high levels of work in progress, a backlog of orders and poor customer delivery. For the five good cells, batch sizes are large and orders from the customer predictable. For the digger cell, as digger purchasers can specify customized combinations of power plant and transmissions, there is a large variety of gears ordered in small batches of between 5 and 50 items. It is not possible to forecast this volume and variety for the digger cell. All cells are currently run by an MRP system.

Sawn steel bar blanks are supplied to the cells from a large central bar stock. A typical gear manufacturing process is given in Table 1 below:

Operation Number	Task	Work Centre
1	Bore out central hole	CNC Borer
2	Turn outside diameter	CNC Lathe
3	Rough mill gear teeth	CNC Mill
4	Heat treat	
5	Finish bore	CNC Borer
6	Cut keyway	CNC Mill
7	Final mill gear teeth	CNC Mill
8	Grind teeth	Gear Grinder
9	Inspect and ship	

Table 1

Heat treatment is carried out by a central facility for all six cells. Ovens in the facility are sized on the automotive cell batch size of approximately 1000 parts, only run when full and take 12 hours to process a batch. Each machining operation requires a setup roughly equivalent to the machining cycle time of 20 components.

(i) How can computer simulation help you establish the process bottleneck? What additional information would you require to build the simulation model? [15%]

(ii) Suggest actions that could be taken to improve the digger cell's volume output performance. Justify your choices. What effect would you expect these actions to have on delivery performance. [25%]

(iii) How might the company invest capital in the digger cell to improve its overall performance? [10%]

(c) For the manufacturing situation described in part (b), discuss the implementation factors the factory manager should take into account when choosing between an MRP or a JIT production system. [20%]

5 (a) You are the new manager of a soft drinks company. It is clear from an initial assessment that the company is not delivering goods to the customer on time and in sufficient volume. Describe the basic elements of your supply chain and give a detailed description of the various performance measures that you need to implement in order to provide an improved response to the demands of the retailer. [70%]

(b) Sales of soft drinks often depend on seasonal variation in weather. Figure 1 shows the data that you have generated over a previous summer. It depicts sales forecasts and actual sales over a 16 week period between June and September. What strategy would you use to reduce the variation between Actual Sales and Forecast Sales? [30%]

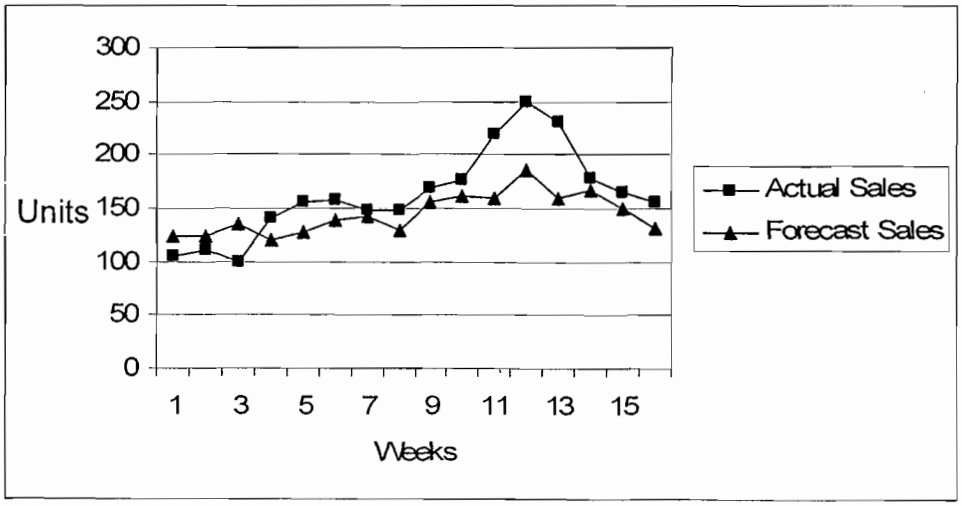

Fig. 1

6 The oil industry is an example of a process industry that converts raw materials into a primary form. It is characterised by very large capital investments. The cost of a typical processing plant such as an oil refinery is of the order of £100 million and the plant will be operational for decades. Such long term horizons require detailed consideration of current and future uses of the plant.

(a) Provide a schematic overview of the oil industry detailing the upstream and downstream activities which are required to deliver oil products to market. [20%]

(b) The price of oil products has been very volatile in recent years and this has a number of implications for national and international economies. Discuss the factors that affect the price of crude oil. [30%]

(c) Describe the four key processes that an oil refinery must implement in order to produce a range of oil based products. [20%]

(d) Given that manufacturing operations are migrating from high value economies to low value economies, discuss whether oil refinery operations are also likely to be subject to global migration. [30%]

END OF PAPER