MANUFACTURING ENGINEERING TRIPOS PART II

Wednesday 21 April 2010 9 to 12

PAPER 1

*Answer not more than **four** questions.*

Answer each question in a separate 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
8 page answer booklet x 4
Rough work pad

SPECIAL REQUIREMENTS
Engineering Data Book
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: mjp

1 The use of ‘carbon-fibre reinforced plastic’ (CFRP) is increasing in the automotive and aerospace industries. It has been argued that the potential for automotive applications is huge, but the market is still dominated by aerospace.

(a) Describe the overall process by which continuous carbon fibres are made. What problems are involved in increasing production volumes for this raw material? [30%]

(b) Explain, with specific examples, why CFRP is potentially so valuable for aerospace and automotive applications. What materials might it replace? [20%]

(c) Outline the processes used to make aerospace components from long-fibre CFRP. What are the environmental impacts of the use of CFRP? Include in your discussion aspects from the manufacture, use and end-of-life phases. [20%]

(d) Compare and contrast the barriers to increased use of CFRP in:

(i) the automotive sector;

(ii) the aerospace sector. [30%]

2 (a) Micro-manufacturing is the manufacture of very small scale components. Describe two examples of micro-manufacturing processes. In each case, discuss the difficulties which result from the reduction in product size. [30%]

(b) A recent US report stated that, “micro-manufacturing is a transforming technology that will redistribute manufacturing capability from the hands of a few to the hands of many – micro-manufacturing becomes a cottage industry”. Discuss this statement, including in your answer examples of at least two further processes in addition to those covered in part (a). [30%]

(c) Describe process routes which would be suitable for manufacturing the following:

(i) a batch of 30 nickel gear wheels, 1 mm in diameter, for a satellite control mechanism;

(ii) a batch of 10,000 nylon gear wheels, 1 mm in diameter, for a medical device.

In each case, give reasons for your chosen route and discuss what further information would be needed to evaluate the suitability of the material and process route for the particular application. [40%]

3 Performance benchmarking is an important issue for process manufacturers.

(a) What is performance benchmarking and why is it helpful? [30%]

(b) Fig. 1 presents a typical performance benchmarking chart for a process industry company. Describe and discuss the elements and structure of this diagram and how it is intended to be used. [40%]

(c) Comment on the particular performance issues that arise from this example. [30%]

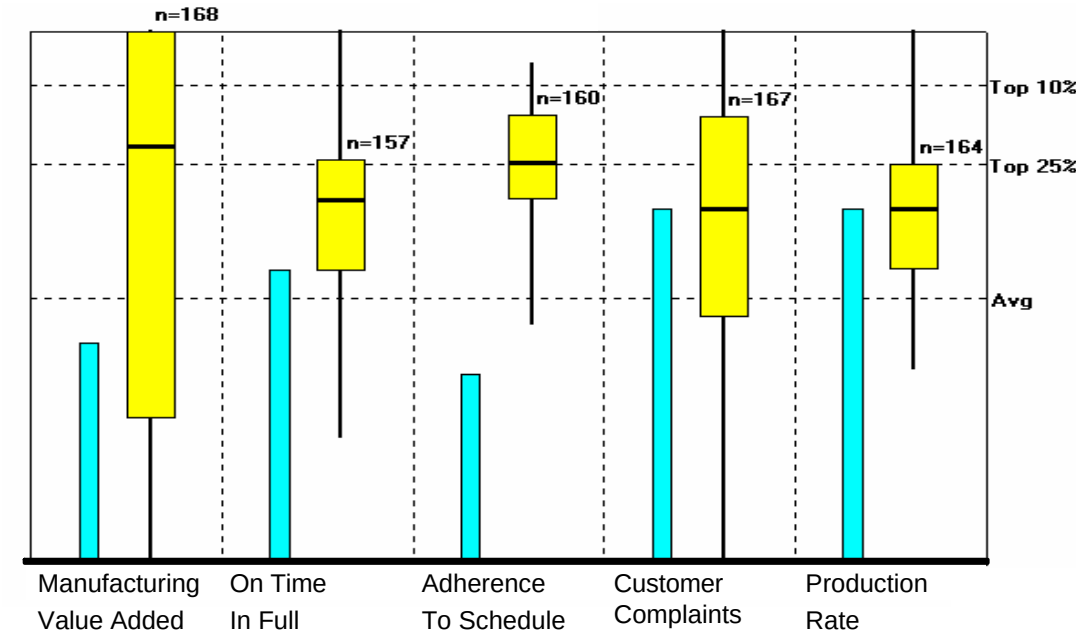

Fig. 1

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4 Plant maintenance is a key activity in the operation of any process plant. Good practice has been developed at Esso, Fawley, and has become widespread ExxonMobil practice. In this context, response maintenance describes a particular strategy for maintenance in the oil industry.

(a) Briefly describe what is meant by:

(i) 'programmed' maintenance;

(ii) 'response' maintenance. [40%]

(b) Response maintenance requires either an 'imperative' or 'standard' response. Describe and contrast the two. [40%]

(c) What is a 'hurdle rate' in this context, and how is it determined? [20%]

5 Over the last 60 years, consumer electronics products have been transformed by developments in component, process and embedded software technologies.

(a) Summarise the key changes over this period under the following headings:

(i) Electronic circuit components; [20%]

(ii) Electronics assembly process technologies. [20%]

(b) Discuss the developments in science and materials that underpin these changes, and any future trends that might be expected. [30%]

(c) Discuss the factors a manufacturer should consider when deciding whether to develop embedded software for such a product in-house, or to sub-contract this task to a software development company. [30%]

6 (a) Discuss the state of the art in CNC machine tool and robot technology, which enables the short lead time, automated manufacture of customised, machined components in small batches. [70%]

(b) Identify the problems that might arise in integrating an advanced CNC machine tool with a robot performing the part loading, unloading and ancillary operations (e.g. deburring). Discuss how these problems might be solved. [30%]

END OF PAPER