ADELAIDE UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF BACHELOR OF ENGINEERING

NOVEMBER 2001

DESIGN FOR MANUFACTURE (2046)

Time: Two (2) Hours and Ten (10) Minutes

Information for Candidates

Marks for all questions are as indicated and total marks are out of 100
The use of reference material is permitted
Candidates should ensure that all work must bear the student's name and be attached or included in the examination booklet
Section One is compulsory and three (3) of the four (4) questions from Section Two must be attempted

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Section One

Question 1
Briefly answer each part of the question. (5 marks each) Suggested time for each part is 5 minutes

(a) How does QFD assist concurrent engineering?

(b) Define concurrent engineering and what are its outcomes?

(c) What is the purpose of applying DFMA principles to a product design?

(d) List the principle activities that make up the design for manufacture analysis.

(e) Why must a manufacturing process be under control to produce its most economic output?

(f) For statistical process control how do the process capabilities Cpk and Cp differ?

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(g) What is the purpose of applying Design of Experiments or Taguchi arrays to product design or process design?

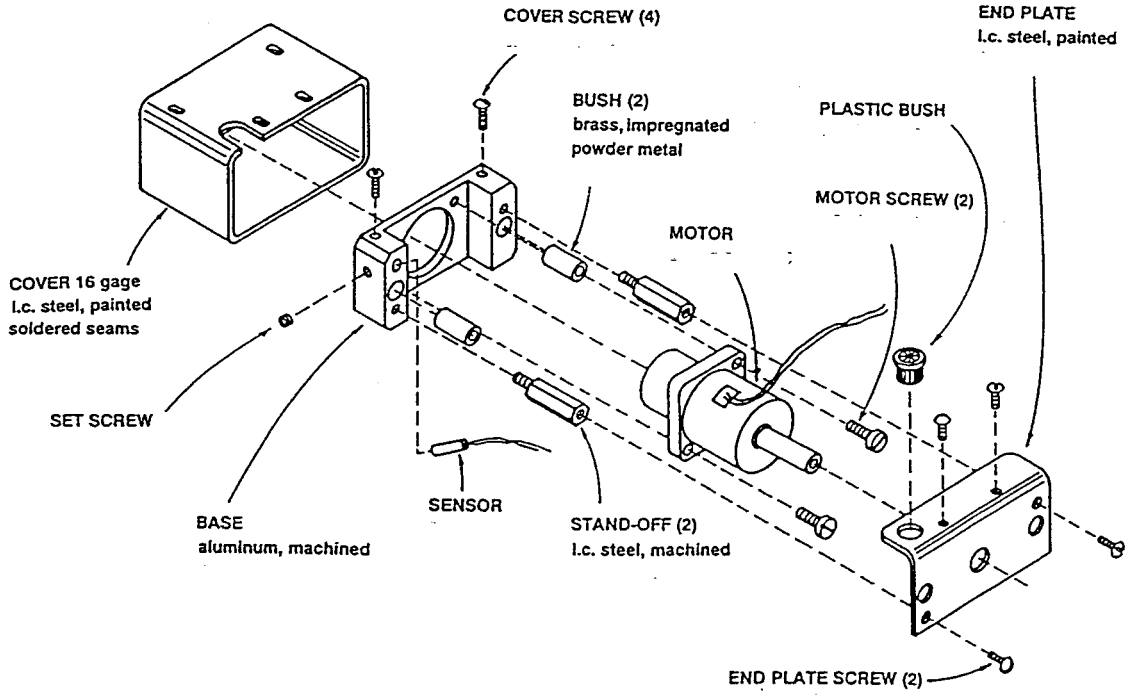
(h) What is rapid prototyping and how is it used in the product development process?

Section Two:

Attempt three of the following questions. Each question is worth 20 marks

Question 1

A motor driven assembly has been designed to sense and control its position on two guide rails as illustrated. The motor has a removable cover for access to the position sensor and a box shaped cover slides over the whole assembly and is held in place by four screws, two for the base and two for the end cover. The configuration is made up of two sub-assemblies, the motor and the sensor plus screws and spacers to make a total of 19 items to be assembled. To reduce cost an alternative design is sought. Explain how you go about this process step by step by using DFMA principles to produce a new design to be made in large numbers that will be easy to manufacture at reduced cost. Use neat sketches were possible to assist your answer. (20 marks)



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Question 2

Explain with the aid of diagrams the Taguchi Quality Loss Function and the purpose for which it is applied in design for manufacture. (8 marks)

Two parts in an assembly have sliding contact with each other and are required to have a nominal surface finish of 125 +/- 15 microns to function effectively. If the surface finish of either part exceeds 145 microns it has to be reworked at a cost of $3.29.

(a) Determine the constant k for the Taguchi Loss Equation (5 marks)

(b) If the surfacing finishing process is in control, normally distributed and centered at the nominal value with a Cpk value of 1.2, what would be the average loss per assembly? (7 marks)

Question 3

A 2^3 factorial design was used to study the possible effects of the temperature, time and pressure on the yield of a plastic forming process. The data from the experiment are shown below.

	Variable	Low Level	High Level
1	Temperature	80	100
2	Time	5	7
3	Pressure	120	140

Test	1	2	3	Yield
1	-	-	-	10
2	+	-	-	20
3	-	+	-	4
4	+	+	-	10
5	-	-	+	8
6	+	-	+	18
7	-	+	+	6
8	+	+	+	12

(a) Calculate all of the effects
(b) Show graphically the main effects of the variables
(c) Formulate a mathematical model for the process
(d) From the mathematical model (neglecting insignificant values) determine the direction of change of the variables to improve the yield.

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Question 4

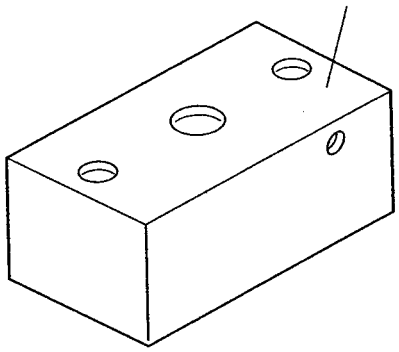
In a design for manufacture analysis it is normal practice to estimate the cost of manufacture for alternative designs. If the estimated manufacturing cost is based on

$$C = VC_{mv} + P_c R_c$$

where C = cost ($)
V = volume of material input to the process
C_{mv} = cost of material per unit volume
P_c = basic processing cost for an ideal part
R_c = cost coefficient for the part design that takes into account shape, complexity, material workability, section thickness surface finish and tolerance

Explain how each of the components in the above expression will contribute to the final cost and the steps that can be taken to reduce these costs when applied to the product shown. Make sure that you consider the design function, quantity to be produced and the ease of forming the shape to the desired dimensional specifications. State all assumptions made. (20 marks)

Cover



Low carbon steel cover as used in Question 1
Assume that demand will be of the order of 100,000

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