THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHNICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF BATCHELOR OF ENGINEERING

NOVEMBER 2002

DESIGN FOR MANUFACTURE (2046)

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

Information for Candidates
Candidates are encouraged to spend the first ten (10) minutes reading the examination paper
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 (40 Marks)

Question 1
Briefly and succinctly answer each of the following parts using suitable diagrams where appropriate. Each question is worth 8 marks. Suggested time for each is 5 minutes.

(a) Explain the major difference between lightweight and heavyweight managed product development teams and provide an example where each would be used.

(b) What is concurrent engineering and how does this approach improve the product development process?

(c) What is the meaning of time to market and why is it so important to be on time when developing and launching a new product?

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(d) Explain the relationship of the product mapping process to technology development.

(e) Explain why it is normal engineering practice to conduct an FMEA for a new product design or a new manufacturing process.

(f) With the aid of a neat sketch explain the Taguchi Quality Loss Function and how the improvement in the reduction of variation of a process can reduce cost.

(g) How is the Quality Function Deployment (QFD) used to ensure that the product being developed will be competitive in the market place?

(h) Explain why the control limits on a SPC chart have no relationship to the tolerance of the part being produced.

Section Two. (60 Marks)

Answer three (3) of the four (4) following questions. Each question is worth 20 marks Suggested Time One Hour Twenty Minutes

Question 1

An automated measuring system has been introduced to check the quality characteristic of a part as it is produced by an automated machining process. Use the data from the output of the measuring system to design, construct and plot the results on the necessary charts that will monitor the quality of the part. Comment on what you have found and state any action if any, that should be taken. (Please construct your charts on the graph paper supplied.)

Data

Sample Number	Size (mm)	Sample Number	Size (mm)
1	3.75	14	3.00
2	3.80	15	3.80
3	3.70	16	3.40
4	3.20	17	3.60
5	3.50	18	3.10
6	3.05	19	3.55
7	3.50	20	3.65
8	3.25	21	3.45
9	3.60	22	3.30
10	3.10	23	3.75
11	4.00	24	3.50
12	4.00	25	3.40
13	3.50		

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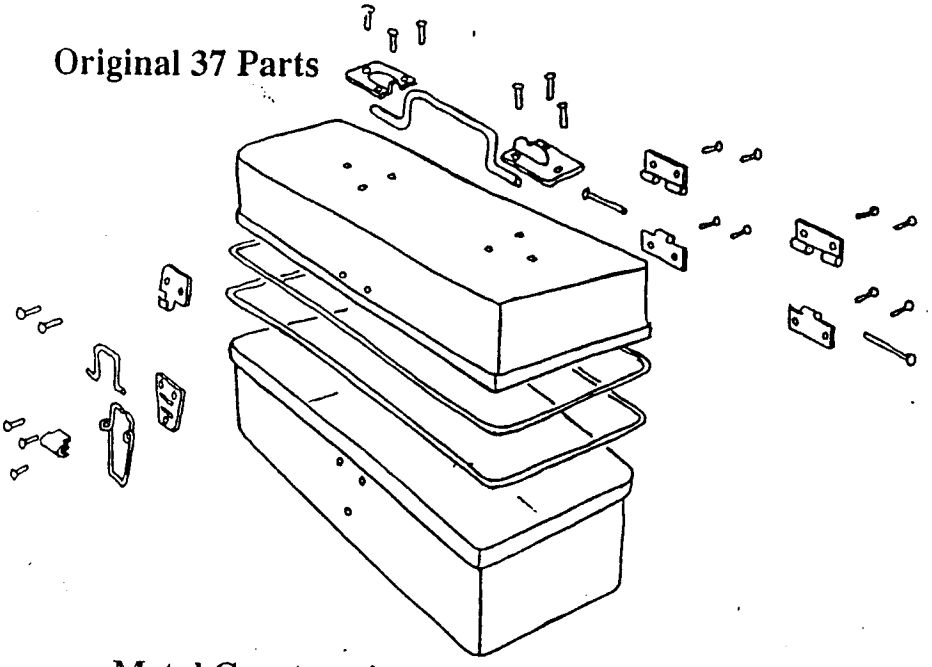
Question 2

List the principles of Design for Manufacture and Assembly (DFMA) and apply these to simplify the design of the fabricated metal lunch box shown. Tabulate a simple functional analysis to identify essential and non essential parts for the redesign of the product and use this functional analysis to assist with a new design. Compare the design efficiency, feeding and fitting ratios of both designs and identify the basic processes required for the manufacture of the new design. List all assumptions made but you may assume that the feeding or pick-up time and the fitting time for the parts of the original box were both 80 seconds.



Metal Construction

Question 3

An objective of design for manufacture and assembly is to reduce manufacturing time and cost through the minimization of parts that make up the product, and the ease of manufacture and assembly without reducing the functionality of the original design intent. It is normal practice to estimate the cost of manufacture for alternative designs based on:

$$C = VC_{mv} + P_cR_c$$

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Where	C	=	Cost
	V	=	Volume of material input into 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 tolerances.

Analyze all the elements in this expression and fully explain the variables that control cost and suggest how minimum cost can be achieved and the trade offs that are involved.

Question 4

The steel components produced by a sand casting process require various amounts of fettling. (Removing of unwanted material by hand grinding) An experiment was designed to evaluate and reduce the percentage of castings that required the fettling operation. Seven variables of the casting process were identified which were thought to affect the process. The interactions that might be present were not considered as being important so an L8 orthogonal array was used for the design.

Using the data and the L8 array provided, determine:

(a) The effects of all the variables on the casting process measured by the percentage of parts to be fettled and present in a graphical form.

(b) The settings of the variables that will provide the optimum output

(c) The action to be taken to further improve the process. (Explanation only, no calculations are required.)

Variables selected for the experimental design

Variable	Low Level	High Level
A Sand compaction	50 mm	60 mm
B Sand temperature	Normal	50 C
C Clay additives	13 kg	30 kg
D Mould hardness	Level 1	Level 2
E Mixing time	5 min	7 min
F Mould coating additives	1.3 kg	3 kg
G Sand additives	0	30 kg.

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The L8 Orthogonal Array

Test No.	A	B	C	D	E	F	G	Result %
1	-	-	-	-	-	-	-	89
2	-	-	-	+	+	+	+	55
3	-	+	+	-	-	+	+	38
4	-	+	+	+	+	-	-	44
5	+	-	+	-	+	-	+	83
6	+	-	+	+	-	+	-	16
7	+	+	-	-	+	+	-	66
8	+	+	-	+	-	-	+	55

End of Examination Paper