Name:	
Program:	

PROD 2100
Production and Operations Management
Exam: June 2004

Grading :

Question	1	2	3	4	5	6	7	Total
Grade								
Over	3	4	2	3	3	3	2	20

Time: 2.00 pm – 4.30 pm

N.B. Each answer needs explanations. In case of ambiguity or of lack of information, first state your interpretation/assumption and then answer the question.

Have a good exam !

The Belgian GoldAngelBlue Company: general presentation

Product.

The Belgian GoldAngelBlue Company is a leader on the market with its P product. This product is made by assembling two components: P_1 and P_2 that are manufactured in the factory of the company, located in Brussels.

Raw material : RM_1	Operation A on blue machine 1 → 22 min / unit	Component P_1

Raw material : RM_2	Operation B on green machine 2 → 7 min / unit	Operation C on blue machine 1 → 8 min / unit	Operation D on green machine 2 → 10 min / unit	Component P_2

Component P_1 and P_2	Assemble on red machine 3 → 17 min / unit	Product P

So, for example, one component P_1 is obtained by performing Operation A (on blue Machine 1) on one unit of raw material RM_1. This operation requires 22 minutes.

Operations

The company has thus three machines numbered 1, 2 and 3. The blue machine 1 can perform Operations A and C (but only one at a time), the green machine 2 can perform Operations B and D (but one at a time) and the red machine 3 can perform Operation E. The above table also gives the time (in minutes) required for each operation.

Each machine is operated by a team of two workers.

All the machines are available 40 hours per week. Overtime is currently not possible.

Supply.

The raw material is supplied by a company in the direct vicinity of the manufacturing plant.

Finances

The cost of one unit of raw material is 10 €. The sales prices are 30 € for a component and 60 € for an assembled product P.

The weekly cost of each machine is 400 €. The weekly wage of the operator amounts to 1000 €.

Market.

In addition to the final product P, the company has also the possibility to sell the components P_1 and P_2 separately.

Orders for P products are placed by the customers on Friday evening and are served from the stock. Unsatisfied orders are lost. Unsold products are scrapped.

The demand for P has been rather stable over more than a year. It averages around 60 units on a weekly basis. Here is a record of the sales over the last ten weeks.

57	58	65	55	67
58	67	61	56	56

The demand for the components follows a make-to-order scheme. The customer proposes an order on the beginning of the week and, if the producer accepts it, the delivery should also happen on the following Friday evening.

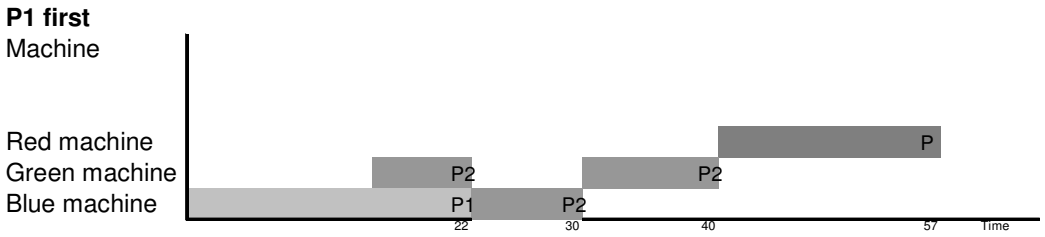
Question 1 (3 points)

If you want to manufacture a single unit of P, two different ways are possible:

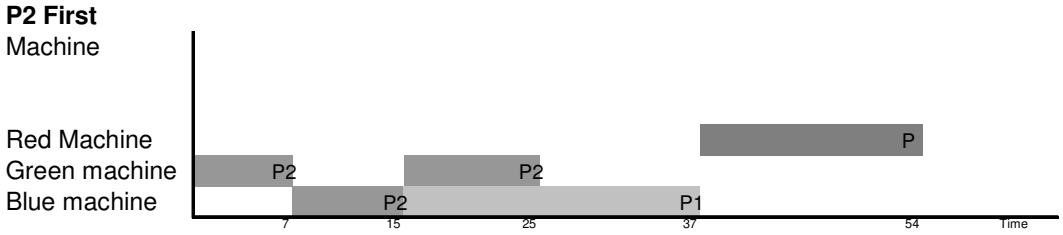
- either manufacture P_1 first, then P_2 as soon as possible and then assemble the two components;
- or start with P_2, proceed with P_1 as soon as possible and then assemble.

With a Gantt chart, determine the quickest way of producing one unit of P and determine how much time it takes.

P1 first ➔ the required time is 57 minutes



P2 first ➔ the required time is 54 minutes



The second proposition is the quickest way of producing one unit of P. It takes 54 minutes.

Question 2. (4 points)

On Monday morning, you have to decide how many units you will manufacture for the week.

- 2.A. How many units of P will you produce if you do not want to experience a stockout more than once every 10 weeks ?
- 2.B. How many units of P will you produce if you aim at the largest profit ?

Explain how you will proceed before starting the calculation.

2A.
D = Weekly Demand
Q = Weekly Production
P(D> Q) = 0,1
$Q = \mu + z*\sigma$
$\mu = 60$
$z = 1,3$
From the past demand, MAD = (3+2+5+5+7+2+7+1+4+4) /10°= 40 /10 = 4
$\sigma \cong 1,25 *MAD = 5$

$Q = 60 + 1,3* 5 = 66,5 \rightarrow 67$

2B.
A marginal analysis is realized. The quantity to produce is increased until the probability to gain money is equal to the probability to lose money.
Cost of raw material = 20
Sales price = 60
(Sales price - Cost of raw material)*Probability to gain = (60-20) * P(D>Q)
Sales price * Probability to lose = 20*P(D<Q) = 20*(1-P(D>Q))
(60-20) * P(D>Q) = 20*(1-P(D>Q))
P(D>Q) = 20/60 = 1/3
z = 0,4
Q = 60 + 0,4*5 = 62

Question 3. (2 points)

Assume you decided, this Monday morning, to produce 60 units of P. In addition, there are three orders for components:

Order X 30 P1 at 30€ each
Order Y 30 P2 at 30€ each
Order Z 30 P2 at 20€ each

Which one(s) do you accept ?

REQUIRED CAPACITY to produce 60P

Machine	LOADING for 60P	CAPACITY	REMAINING TIME
Red Machine	60*17 min = 1020 min	40h*60 min = 2400 min	1380 min
Blue Machine	60*30 min = 1800 min	40h*60 min = 2400 min	600 min
Green machine	60*17 min = 1020 min	40h*60 min = 2400 min	1380 min

1) First, we produce the second order: 30P2 at 30euros (P2 requires the smallest time at the blue machine)

Machine	LOADING for 30P2	CAPACITY	REMAINING TIME
Red Machine	0 min	1380 min	1380 min
Blue Machine	30*8 min = 240 min	600 min	360 min
Green machine	30*17 min = 510 min	1380 min	870 min

2) Two alternatives can be chosen:
2A) To partly produce the first order of 30P1 at 30 euros. Given the 360 remaining minutes at the blue machine, only 16 P1 can be produced.

Machine	LOADING for 16P1	CAPACITY	REMAINING TIME
Red Machine	0 min	1380 min	1380 min
Blue Machine	16*22 min = 352 min	360 min	8 min
Green machine	0 min	870 min	870 min

Sales prices = 30
Cost of raw material = 10
GAIN to produce 16 P1= (30-10)*16 = 320 euros

2B) To produce the third order of 30P2 at 20 euros and to use the remaining time to produce partly the first order of 30 P1 at 30 euros

Machine	LOADING for 30P2	CAPACITY	REMAINING TIME
Red Machine	0 min	1380 min	1380 min
Blue Machine	30*8 min = 240 min	360 min	120 min
Green machine	30*17 min = 510 min	870 min	360 min

Sales prices = 20
Cost of raw material = 10
GAIN to produce 30P2 = (20-10)*30 = 300 euros

Given the 120 remaining minutes at the blue machine, only 5 P1 can be produced.

Machine	LOADING for 5P1	CAPACITY	REMAINING TIME
Red Machine	0 min	1380 min	1380 min
Blue Machine	5*22 min = 110 min	120 min	10 min
Green machine	0 min	360 min	360 min

Sales prices = 30
Cost of raw material = 10
GAIN to produce 5P1 = (30-10)*5 = 100 euros

GAIN to produce 30 P2 at 20 euros + GAIN to produce 5P1 at 30 euros = 300 euros + 100 euros.
➔ This second alternative is more profitable.
SOLUTION: PRODUCE 30P2 at 30euros + 30P2 at 20 euros + (possibly) 5P1 at 30 euros.

Question 4. (3 points)

Your boss expects a raise of the demand next year. He thinks to replace the blue machine and maybe also the green machine if needed. He has two options.

Option 1. He buys a much faster new machine. However, there is a set-up time of about one hour to switch from operation A to C and vice versa.

Option 2. He buys two machines. One is able to perform Operation A, the other to perform Operation C. This option is a little bit more expensive.

Of course, the cost and the productivity of each option have to be determined. However, besides these criteria, how would you characterize the two options?

OPTION 1
Job shop organization
High lot size
Long flow time
Less flexible
Polyvalence

OPTION 2
Line organization
Lot size can be low
Short flow time
More flexible
Specialization

Question 5. (3 points)

Your boss wonders to change to a new supplier. The current supplier is located in Belgium. The new supplier is cheaper and is located in Asia. Discuss qualitatively the possible consequences of such a decision on your inventory levels?

Higher Pipeline stock : higher Lead Time
Higher Cycle stock : higher order cost
Higher Safety stock : higher Lead Time and maybe less reliability
No change Anticipation stock if production processes and quality supplier specifications are unchanged.

Question 6. (3 points)

Explain how the answers to the questions 4 and 5 could be linked to the manufacturing strategy.

Strategy manufacturing :
Question 4 : organization processes
Question 5 : location problem
These decisions depend on the Order winners and the Order Qualifiers.

Question 7. (2 points)

Your supplier has decided to design a quality control mechanism for his production of raw material. Give an example of the specifications you will notify him for such a plan. In other words, what typical target do you want his plan to meet ?

Consumer target : Consumer does not want that the raw material supplier accepts bad lots (consumer risk). ➔ Risk B of having LPTD quality of worse accepted

Distribution normale N(0,1)

z = nombre d'écarts types

P(z) = Prob [x ≥ z]

E(z) = nombre moyen de manquants = $\int_z^{\infty} (x - z)\ p_{N(0,1)}(x)\ dx$

z	P(z)	E(z)	E(-z)
0,0000	**0,5000**	**0,3989**	**0,3989**
0,1000	0,4602	0,3509	0,4509
0,2000	0,4207	0,3069	0,5069
0,3000	0,3821	0,2668	0,5668
0,4000	0,3446	0,2304	0,6304
0,5000	0,3085	0,1978	0,6978
0,6000	0,2743	0,1687	0,7687
0,7000	0,2420	0,1429	0,8429
0,8000	0,2119	0,1202	0,9202
0,9000	0,1841	0,1004	1,0004
1,0000	**0,1587**	**0,0833**	**1,0833**
1,1000	0,1357	0,0686	1,1686
1,2000	0,1151	0,0561	1,2561
1,3000	0,0968	0,0455	1,3455
1,4000	0,0808	0,0367	1,4367
1,5000	0,0668	0,0293	1,5293
1,6000	0,0548	0,0232	1,6232
1,7000	0,0446	0,0183	1,7183
1,8000	0,0359	0,0143	1,8143
1,9000	0,0287	0,0111	1,9111
2,0000	**0,0228**	**0,0085**	**2,0085**
2,1000	0,0179	0,0065	2,1065
2,2000	0,0139	0,0049	2,2049
2,3000	0,0107	0,0037	2,3037
2,4000	0,0082	0,0027	2,4027
2,5000	0,0062	0,0020	2,5020
2,6000	0,0047	0,0015	2,6015
2,7000	0,0035	0,0011	2,7011
2,8000	0,0026	0,0008	2,8008
2,9000	0,0019	0,0005	2,9005
3,0000	**0,0014**	**0,0004**	**3,0004**
3,1000	0,0010	0,0003	3,1003
3,2000	0,0007	0,0002	3,2002
3,3000	0,0005	0,0001	3,3001
3,4000	0,0003	0,0001	3,4001
3,5000	0,0002	0,0001	3,5001
3,6000	0,0002	0,0000	3,6000
3,7000	0,0001	0,0000	3,7000
3,8000	0,0001	0,0000	3,8000
3,9000	0,0001	0,0000	3,9000
4,0000	**0,0000**	**0,0000**	**4,0000**