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3E10 Operations Management for Engineers
Final Examination Crib – Academical year 2007-08

Question 1

(a) **(8 marks)** There are three essential elements of Total Quality Management:

(1) Know the customer. To know the customer every more closer and to link that knowledge to the day-to-day activities of the organisation.

(2) Mould the organisation's culture. To mould the culture of the organisation, largely through the deeds of leaders, to foster pride, joy, collaboration, and scientific thinking.

(3) Continuously increase knowledge. To continuously increase knowledge of and control over variation in the processes of work through the widespread use of the scientific methods of collection, analysis, and action upon data.

(b) **(6 marks)** By 'chance causes', Shewhart meant 'unknown causes'. Some causal systems produce effects that obey understandable mathematical, i.e., statistical, laws, and thus permit one to make predictions based on experience. Quality expert Deming used the term 'common causes' for the identical concept.

(c) **(6 marks)** Some causes were not only unknown, but were unpredictable. Processes with these erratic, non-systematic causes are unstable, and the performance could not be well characterised with statistics that implied mathematical regularity, such as averages and standard deviations.

Question 2

(a) **(8 marks)** R = 10,000 per day = 2,500,000 per year. D = 600,000 per year. C_O = £1500, C_H = (0.22 + 0.12)(£3.50) = £1.19 per pound per year. $Q^* = \sqrt{[\,2\,D\,C_O / (C_H\,(1 - D/R)\,]}$ $= \sqrt{[\,2\,(600{,}000)\,(1500) / (1.19\,(1 - 600{,}000/2{,}500{,}000)\,)\,]}$. Thus **Q* = 44,612 lbs.**

(b) **(4 marks)** The length of the entire cycle is Q/D. The length of the production portion is Q/R. Thus the proportion during which production occurs is (Q/R)/(Q/D) = D/R = 600,000 / 2,500,000 = **0.24 or 24 per cent.**

(c) **(4 marks)** The length L_1 of the production portion of the cycle is given by $L_1 = Q / R$. During production, inventory is building up at a rate R - D to a maximum level, which we denote H. This implies: $R - D = H / L_1$. Substituting the expression for L_1 yields, $H = Q\cdot(1 - D/R)$. From (a) and (b), H = (44,612)·(1 - 0.24) = **33,905 lbs.**

(d) **(4 marks)** Annual average cost of holding and set-up $= D\,C_O/Q + (1/2)\,Q\,(1 - D/R)\,C_H$ = **£40,347.**

Question 3

(a) **(4 marks)**
(1) A bottleneck is any resource whose capacity is less than the demand placed upon it. [If the students uses the word 'machine' rather than 'resource', deduct 1 mark.].
(2) Bottlenecks are significant since because they control the *rate* of output for the organisation.

(b) **(4 marks)** We must make sure that the bottleneck only works on *good* parts.

(c) **(8 marks)**
(1) Non-bottlenecks running faster than the bottleneck create excess inventory.
(2) They also reduce capacity that could otherwise be redirected.

(d) **(4 marks)** Any 2 of the following 3 would suffice:
(1) Can cut inventory storage costs
(2) Can free up the plant's hidden capacity.
(3) Can result in smaller batch sizes, which in turn allow for faster processing of batches, resulting in the completed product getting out the door earlier.

Question 4

(a) **(4 marks)** The sequence minimising weighted competition time is **2134** at a cost of **333**. This sequence is unique.

(b) **(4 marks)** You want the jobs with larger weight to finish earlier because for each extra unit of time you delay their completion you are adding the weight to the summation over $w_j t_j$.

(c) **(4 marks)** A job increases the completion time of the jobs which appear later in the sequence. Positioning a long job toward the end of the sequence means it will increase the completion time of fewer jobs than if it were to be positioned near the beginning of the sequence.

(d) **(4 marks)** Based on the two statements above about where to position jobs relative to their weights and processing times. Since the weights multiply the processing time in the objective to be minimised, certainly dividing the weight by the processing time, rather than subtracting, is the sensible criterion. So the correct answer is (2).

(e) **(4 marks)** We can show that (2) is optimal by contradiction. Suppose we have obtained an optimal schedule S which violates (2). Then, in particular, there must be two adjacent jobs, call them x and y, where the rule is violated, i.e., where $w_x/p_x < w_y/p_y$. Assume job x starts at time t. Interchange jobs x and y and call the new schedule S'. The product wj Cj will not be affected for any of the other jobs, just these two. Under S, the total weighted completion times of jobs x and y is: $T(S) = (t + p_x)(w_x) + (t + p_x + p_y)(w_y)$. Under S', the total weighted completion times of x and y is: $T(S') = (t + p_y)(w_y) + (t + p_y + p_x)(w_x)$ However, $T(S) - T(S') = w_y p_x - w_x p_y$, QED.