Module 3E10

OPERATIONS MANAGEMENT FOR ENGINEERS

Crib

QUESTION I

(a) Identify the bottleneck:

A: (10+0.05*75) =13.75 min/batch,

B: (20+0.1*75) = 27.5 min/batch,

C: (14+0.2*75) = 29 min/batch,

D: (10+0.1*75)=17.5 min/batch.

Therefore, C is the bottleneck at 29 min per batch.

Daily Capacity in parts = (7.5*60)/29 * 75 = 1,164 units.

(b) The external process performance objectives are:

- Quality: doing things right, to a standard
- Cost: price competitiveness
- Speed: time to satisfy order
- Dependability: reliable delivery when promised
- Flexibility: ability to change what is delivered

Competing on quality:

- Examples: Rolls-Royce, Etihad
- High quality services companies demonstrate:
    - Superior product features
    - Excellent customer service
    - Consistent delivery
    - Process quality – error free delivery

Competing on cost:

- Examples, ASDA, Ryan Air, etc.
- Offering product at a low price relative to competition
- Typically high volume products
- Often limit product range & offer little customization
- May invest in automation to reduce unit costs
- Can use lower skill labour
- Low cost does not necessarily mean low quality

Competing on speed/dependability:

- Examples: UPS, Amazon
- Rapid delivery
  - Focused on shorter time between order placement and delivery, minimal wait times
- On-time delivery
  - Deliver product exactly when needed every time
- Availability
  - Convenient and readily available when customer requires

Competing on flexibility:

- Example: Dell
- Easily customize product/service to meet specific requirements of a customer
  - Ability to ramp capacity up and down to match market demands

(c) Bullwhip effect: variance in demand increases from downstream to upstream in a supply chain.

Drivers of the bullwhip effect:

- Rationing/overstatement of requirement
- Delay/mismatch of speed of information and products
- Batch sizing

There are several steps that can be taken to reduce its impact on the supply chain:

1. **Coordinating Information**: sharing sales information with other supply chain members.
2. **Inventory Policies:** offering constant prices, removing price promotions that encourage customers to place large orders, and reducing lead time
3. **Cooperation Among Supply Chain Members:** sharing information and cooperating to set policies that benefit the entire supply chain involves the development of a high degree of trust between partners.

(d)

(i)

Week	1	2	3	4	5	6	7	8	9
Gross Requirements				20	70	60	150	190	30
Scheduled Receipts		100						30	
Net Requirements	0	0	0	0	0	50	150	160	30
Planned Order Release				50	150	160	30		

(ii)

Week	1	2	3	4	5	6	7	8	9
Gross Reqs for C					40	20	60	120	20

H(1) = 1000/40 = £25
*H(2) = (1000 + 20*15)/60 ≈ £22* ***STOP.***
*H(3) = (1000 + 20*15+ 60*15*2)/120 ≈ £26*

Order 60 units in period 5 for periods 5 and 6.

H(1) = 1000/60 ≈ £17
*H(2) = (1000 + 120*15)/180 ≈ £15* ***STOP.***
*H(3) = (1000 + 120*15+ 20*15*2)/200 ≈ £17*

Order 180 units in period 7 for periods 7 and 8.

H(1) = $1000/20 = £50

(iii) It is a simple heuristic; easy to understand and implement. It is a good alternative to EOQ when demand is not stationary. However, does not look ahead while making decisions, therefore, can lead to suboptimal solutions as seen in the previous example.

QUESTION II

(a) The key features of a lean organization are as follows:

1. Lean organisations specify what creates *value* from the customer's perspective
2. They identify all steps across the whole *value stream*
3. They make those actions that create value *flow*
4. They only make what is *pulled* by the customer just-in-time
5. They strive for *perfection* by continually removing successive layers of waste

How much should Toyota be afraid of copycats?

- It is possible to copy the shop-floor techniques by themselves
- Some improvement in productivity and quality will result
- Lack of flexibility in adjusting to change will persist
- System will not able to learn autonomously
- Continuous improvement needs to be driven by workforce, cannot be dictated by management

(b) Simple exponential smoothing:

- Exponential smoothing forecasts contain information on all previous demands, each demand is given a weight that is decreasing exponentially back in time.
- Smoothing constant: $0 < \alpha < 1$
- The general formula for exponential smoothing is:

$$S_t = \alpha \cdot x_t + \alpha \cdot (1-\alpha) x_{t-1} + \alpha \cdot (1-\alpha)^2 x_{t-2} + \alpha \cdot (1-\alpha)^3 x_{t-3} + \ldots$$

- S_t is based on all (available) data up to period t to forecast x_{t+1}
- It copes OK with step changes in demand
- It does not cope well with linear trends or seasonality

Triple exponential smoothing:

- Triple exponential smoothing takes seasonality factors and trends in demand into account by using three smoothing equations and the forecasting equation.
- Basic idea is to introduce a trend estimate and a seasonality estimate
- Need to choose three smoothing rates, α, β, and γ
- Also called Winter's Linear and Seasonal ES model
- Forecasts are only good for a short term

When demand exhibits seasonality and trend simple exponential smoothing will not be able to predict the demand effectively, and triple exponential smoothing should be used.

(c) Use Little's formula to answer this question:

$$0.0082 = L = \lambda * W = \frac{0.061}{2} * W$$

Therefore, W = 0.2688 hours

(d) See below.

i. The economic order quantity and the resulting annual setup cost are:

$Q^* = ((2*200*1{,}600)/4)^{.5} = 400$ units
Setup Cost = (200*1,600)/400 = £800

ii. The optimal reorder point is (Be careful about the time unit when multiplying, they should be the same):

Reorder point = (1/52)*1,600 = 30.8 ~ 31 units

iii. The optimal order quantity and the total annual holding cost

$Q^* = ((2*200*1{,}600)/(4*(1 - 1{,}600/8{,}000))^{.5} = 447.2 \sim 447$ units

Total annual holding cost = 4 * (447/2) * (1 – 1,600/8,000) = £715.20

iv. The maximum inventory level:

Maximum inventory level = (1 – 1,600/8,000) * Q* = 358 units

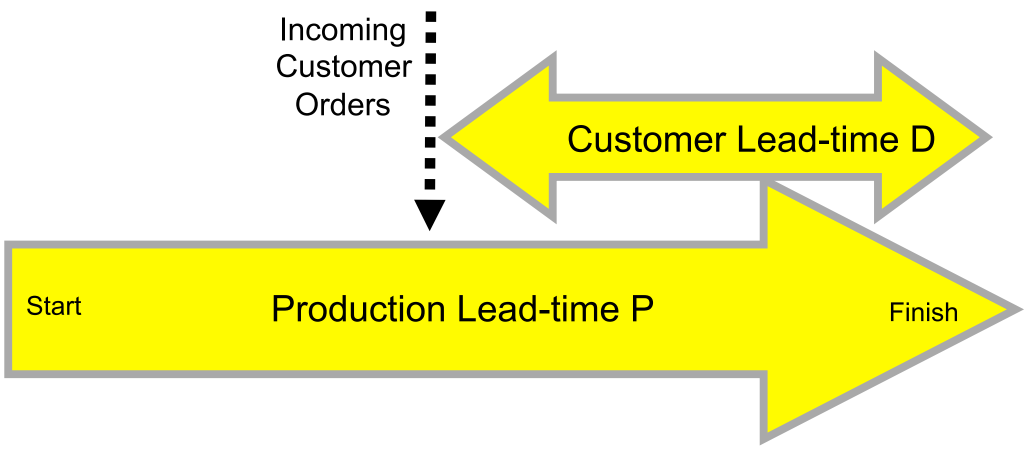
v. The length of time required to produce a lot (in years):

Time to produce a lot = 447/8,000 = .056 years

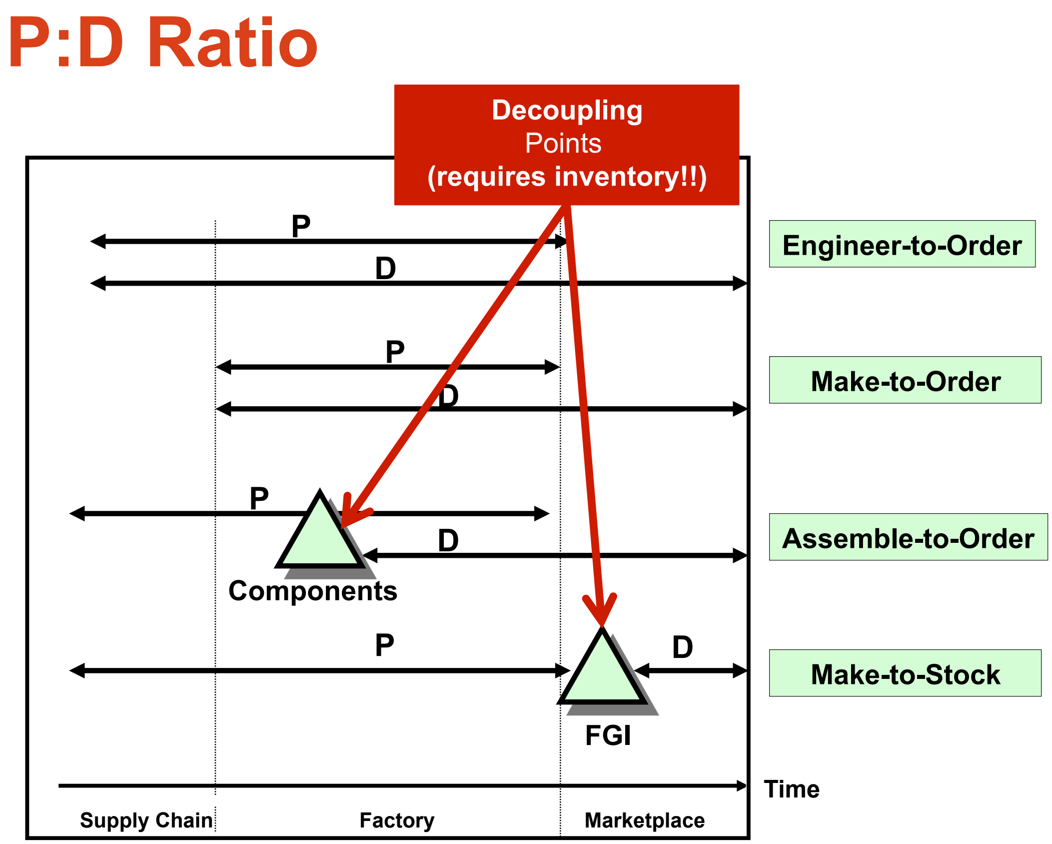
QUESTION III

(a) A service shop is a service operation that is capable of producing a wide degree of customization with high customer contact. Examples of service shops include hospitals, auto repair shops, and restaurants.

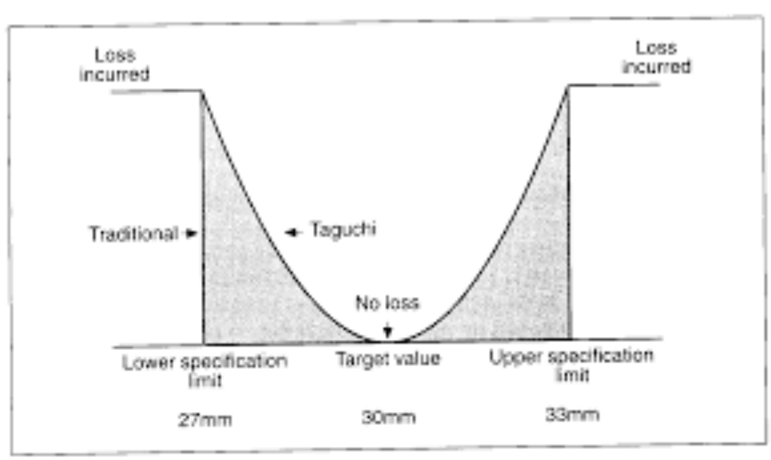
(b) Production Lead-time P: How long does it take to make the product?
Demand Lead-time D: How long is the customer willing to wait for the product?



The P:D Ratio

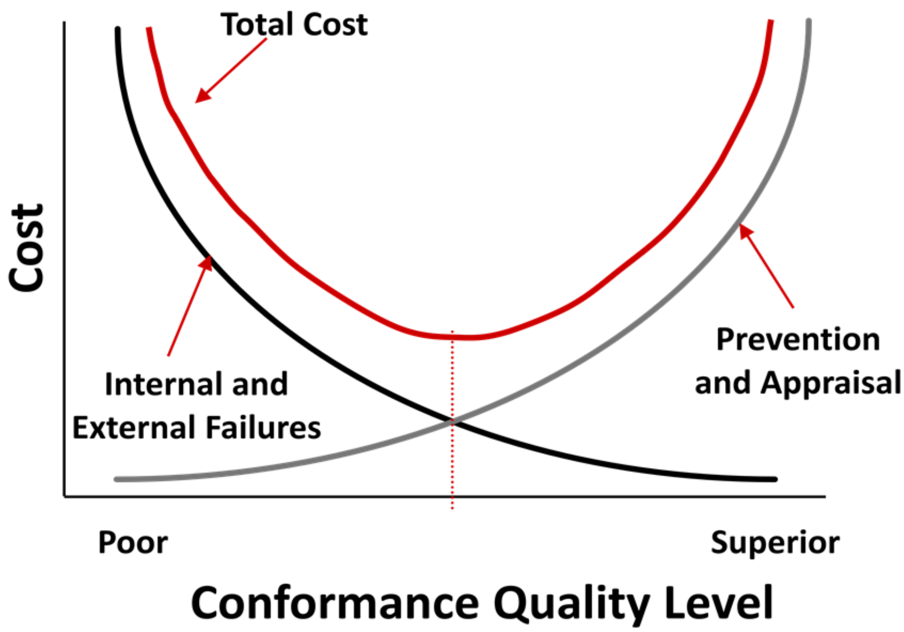


(c) Taguchi said that there is a **loss to society** whenever there is a problem with the quality of a good or service.



He also developed tools to facilitate the design of experiments for building in product quality.

Juran's Cost of Quality (COQ) model balances prevention and appraisal costs against internal and external failure costs and that there is an optimal conformance level based on that balance.



Juran's COQ is about costs to the firm and the trade-off with quality. Taguchi's Loss to Society idea is that, when there are quality problems within the firm, society also suffers. There is no trade-off and the impact of poor quality is much broader than within the firm.

(d)

(i) All jobs that are processed on or before their due date make a full £2500 contribution to profit. Additional jobs that will be late should be accepted and scheduled provided that they make a net contribution to the total profit.

Moore's Algorithm would be used if we solely wanted to minimise the number of late jobs. However, given that we can have some lateness the **Modified Due Date** heuristic should be used for this problem.

The jobs are reordered here by due date (NB this is not essential)

Job	D	A	C	B	F	E
Processing time (days)	1	2	2	5	4	2
Due date (From current day)	4	6	7	8	9	10

Choose jobs with the lowest MDD = max(d_i, $t+p_i$)

At t=0:

Job	D	A	C	B	F	E
Processing time (p)	1	2	2	5	4	2
Due date (d)	4	6	7	8	9	10
MDD	4	6	7	8	9	10

D has the smallest MDD and completes at t=1.

At t=1

Job	D	A	C	B	F	E
Processing time (p)	1	2	2	5	4	2
t+p		3	3	6	5	3
Due date (d)	4	6	7	8	9	10
MDD	X	6	7	8	9	10

A has the smallest MDD and completes at t=3.
MDD schedule now D_1A_3

At t=3:

Job	D	A	C	B	F	E
Processing time (p)	1	2	2	5	4	2
t+p			5	8	7	5
Due date (d)	4	6	7	8	9	10
MDD	X	X	7	8	9	10

C has the smallest MDD and completes at t=5.
MDD schedule now $D_1A_3C_5$

At t=5:

Job	D	A	C	B	F	E
Processing time (p)	1	2	2	5	4	2
t+p				10	9	7
Due date (d)	4	6	7	8	9	10
MDD	X	X	X	10	9	10

F has the smallest MDD and completes at t=9.
MDD schedule now $D_1A_3C_5F_9$

At t=9:

Job	D	A	C	B	F	E
Processing time (p)	1	2	2	5	4	2
t+p				14	14	11
Due date (d)	4	6	7	8	9	10
MDD	X	X	X	14	X	11

E has the smallest MDD so the final MDD schedule is $D_1A_3C_5F_9E_{11}B_{16}$

Now considering lateness and profit for the MDD schedule

Job	D	A	C	F	E	B
Processing time (p)	1	2	2	4	2	5
Due date (d)	4	6	7	9	10	8
Completion date	1	3	5	9	11	16
Lateness	-	-	-	-	1	8
Profit contribution	£P	£P	£P	£P	£P-£750	£P-£6,000

We should accept DACF (and schedule in that order) independent of the value of **P** as these jobs will always be profitable with this schedule.

(ii) Job E will be profitable if the penalty is less than **P** per day.
Job B will be profitable if the penalty is less than **P**/8 per day.