

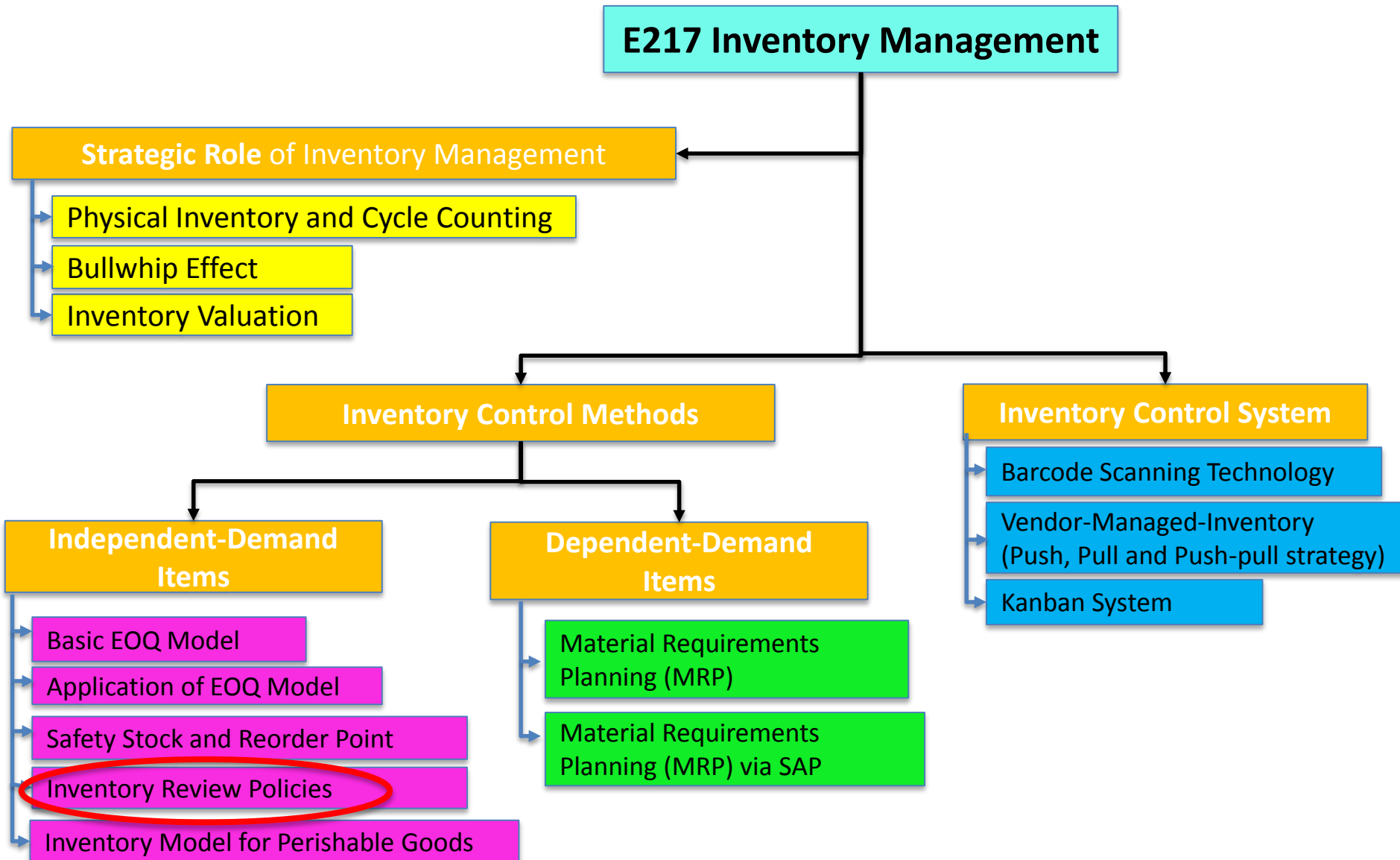
P04

How to Review

E217 – Inventory Management

SCHOOL OF
ENGINEERING

E217 Inventory Management Topic Tree



Inventory Decision Rules



Order Quantity

Order Frequency	Variable (s)	s, Q	s, S
	Fixed (P)	R, s, S	R, S

- **(s, Q) :** Continuous review, reorder point (s)
Fixed order quantity (Q)
- **(s, S):** Continuous review, reorder point (s)
Order-up-to level (S)
- **(R, S):** Periodic review, review period (R)
Order-up-to level (S)
- **(R, s, S):** Combination of (s, S) and (R, S)

- Q = order a fixed quantity, Q can be approximated by an EOQ
- S = order up to a fixed expected opening inventory, S
- s = place an order when the inventory balance drops to s
- R = place an order every R periods



Continuous Review System



- Continuous monitoring of Inventory status
- Either manually or by using computerized systems
- An action on replenishment can be made immediately when the inventory level declines to any preset value
- Costly, may replenish at irregular intervals
- If a firm deals with a large number of items, it may not be feasible to review all items continuously
- Better customer service with lower safety stocks
- Order quantity is fixed
- Time between orders varies

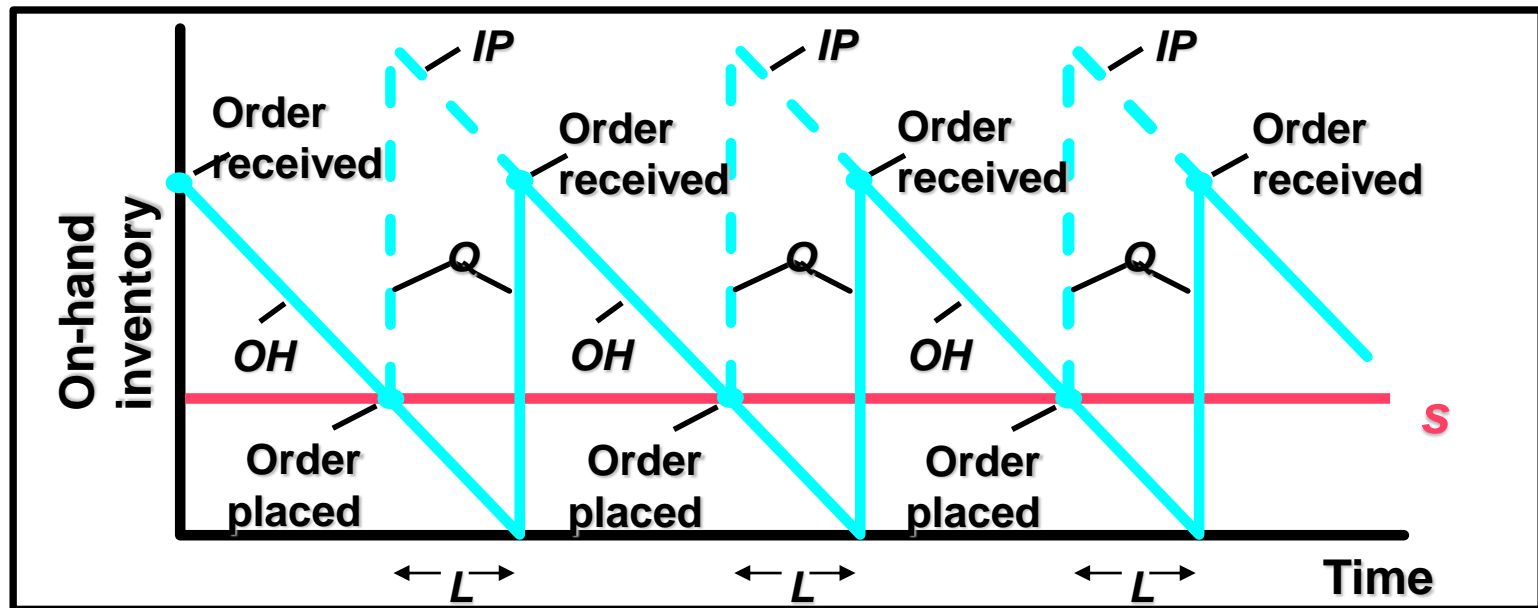


Example: in a wafer fabrication facility, running out of a critical part may lead to hours of costly downtime

Continuous Review System (s, Q)



- A fixed quantity Q is ordered every time the inventory position drops to the reorder point ' s '.
- Simple to understand, errors are less likely.



OH: on hand inventory (physically on the shelf, stock to satisfy customer directly)

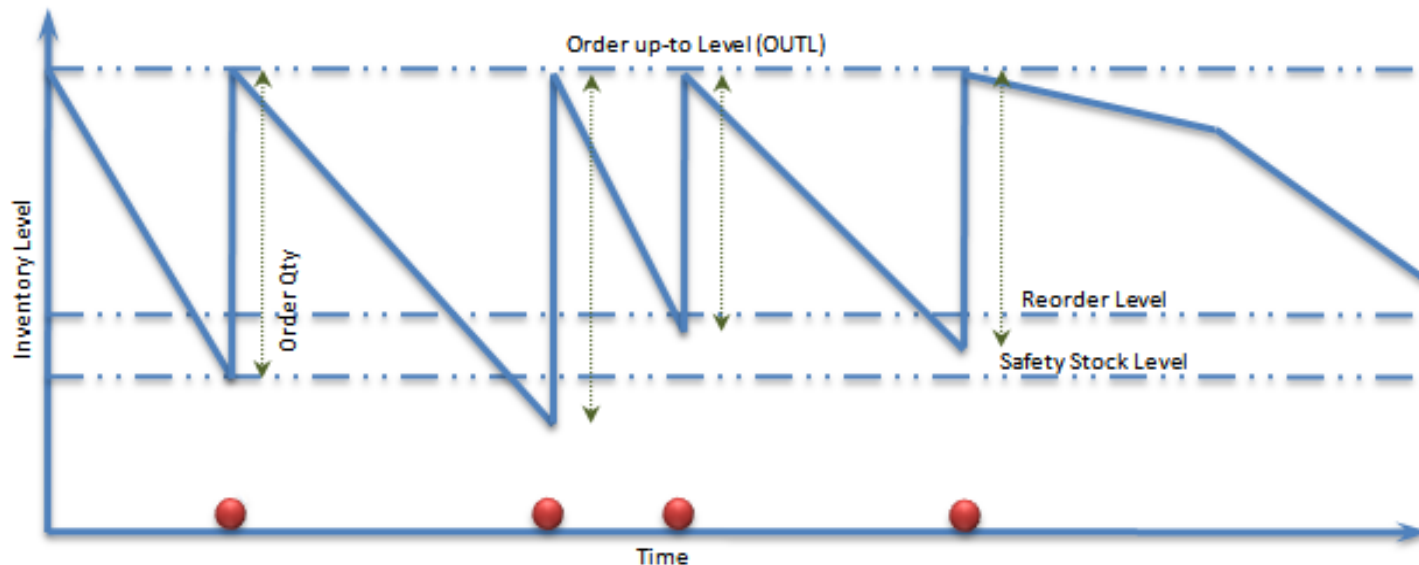
IP: inventory position = (Net stock) + (On-order stock) – (Committed stock)

where Net stock = (On-hand stock) – (backorders)

Continuous Review System (s, S)

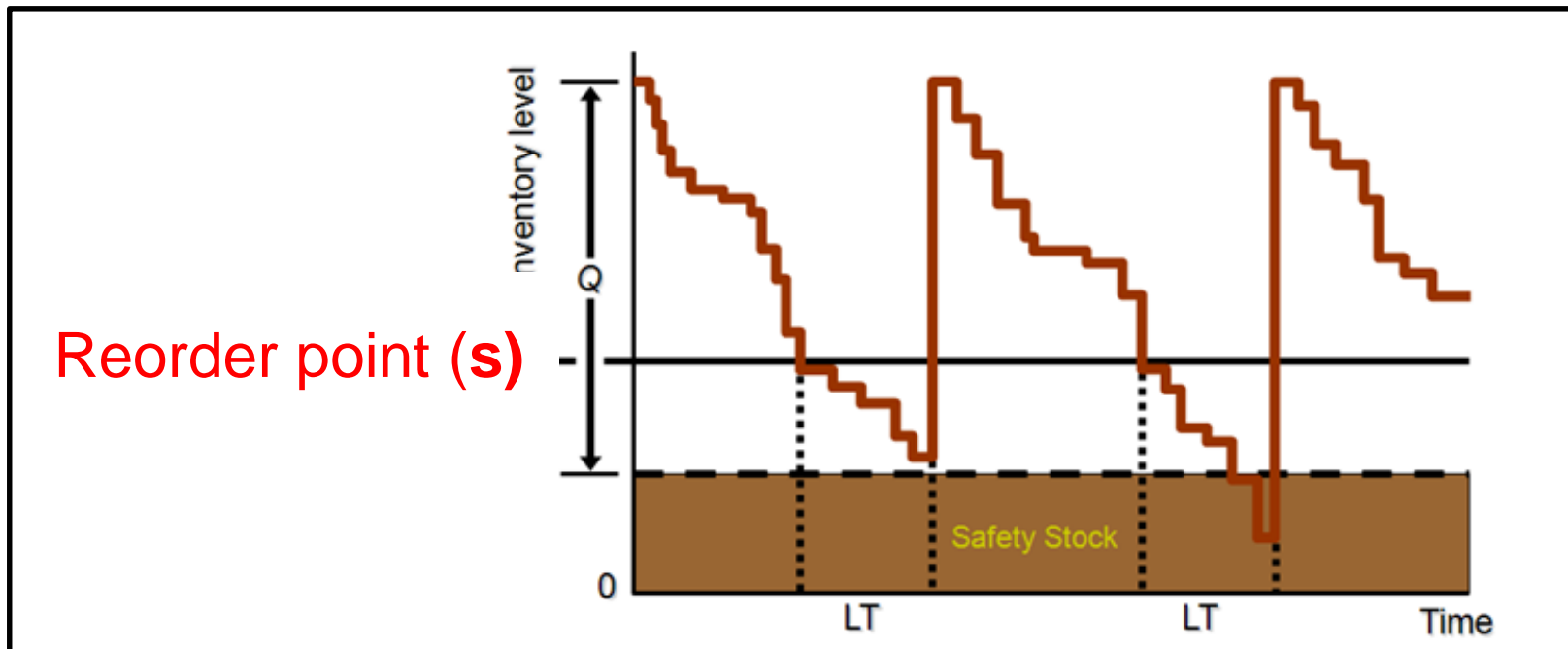


- Also known as a min-max system
- A variable quantity ($S-s$) is ordered every time the inventory position drops to the reorder point s .
- Best (s, S) policy is better than best (s, Q) policy in terms of total costs.
- Computational effort to find optimal (s, S) policy is substantial.
- Useful for items with large orders (that may take the stock level well below the reorder level)



Reorder Point (s) for Continuous Review System

- When demand is **certain**
Reorder point (s) = Average demand during lead time
- When demand is **uncertain**
Reorder point (s) = Average demand during lead time
+ **Safety stock**



Periodic Review System



- Inventory status is reviewed only every R time units.
- Order quantities vary, but intervals fixed
- Ordering is often on a weekly or monthly basis
- Items may be grouped and ordered on the same day
- Easier multi-unit review and ordering
- Demand variability may cause huge backorders between orders or during review period
- Good for coordination of replenishments of several items



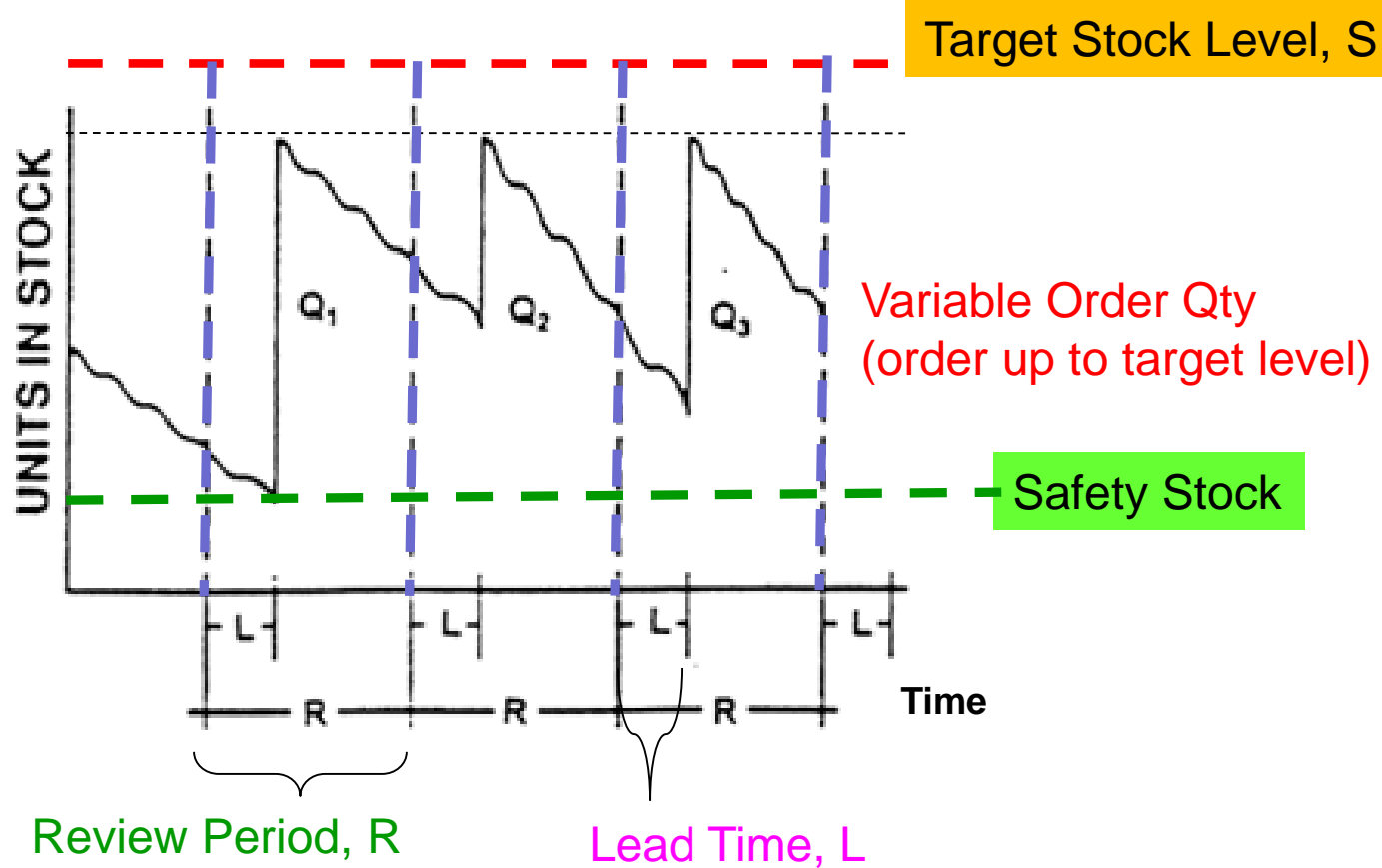
Periodic Review System (R, S)



- Sufficient quantity is ordered in each replenishment cycle (R time units) to raise the inventory to level S .
- Common use, particularly in companies not using computer control.
- Preferred if a joint replenishment policy is used.
- Offers opportunity to adjust S to respond to changing demand pattern.



Periodic Review System (R, S)



Periodic Review System (R, S)



- The quantity on hand must last until the next shipment is received

$$\begin{aligned} S &= \text{Target level (TL) or Order-Up-To-Level} \\ &= \text{Demand during lead time} + \text{Demand during review time} + \text{Safety Stock} \\ &= D(L + R) + SS \end{aligned}$$

Where:

TL = Target Level

D = Demand per unit of time

R = Review Period

L = Lead Time



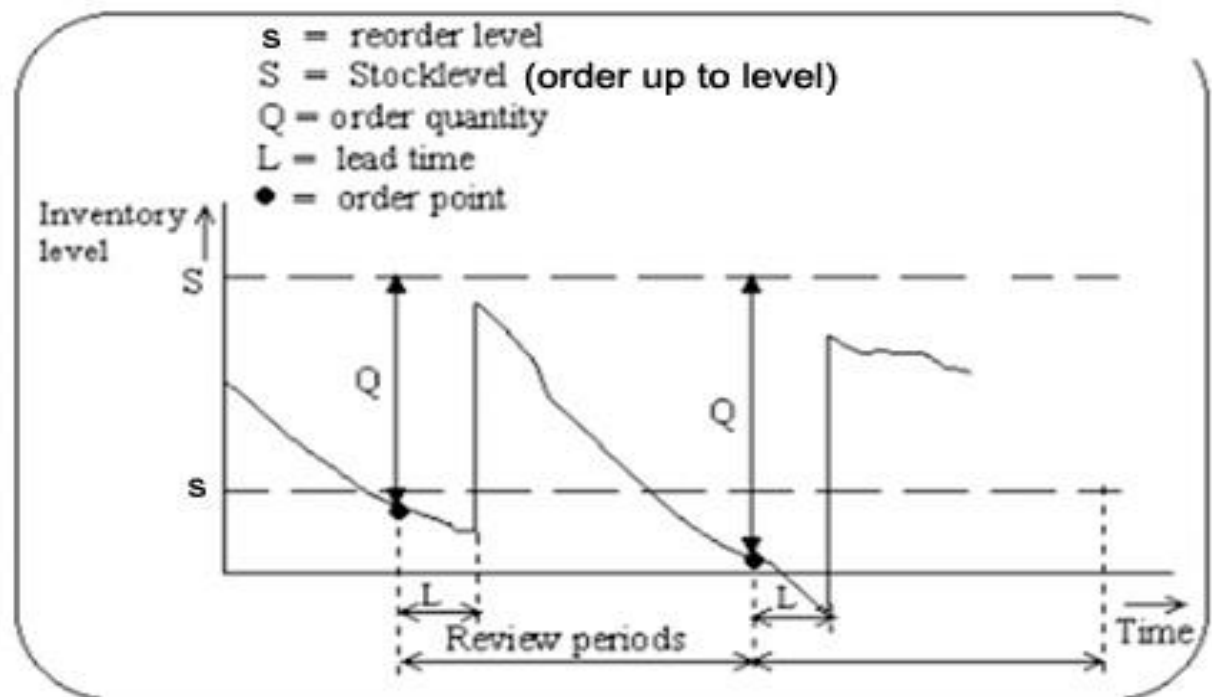
- Order Quantity = Target level – Current Inventory Position

(R, s, S) Review System



- A combination of (s, S) and (R, S) systems.
- Every **R** units of time we check the inventory position.
- If it is **at or below** reorder point **s**, we order enough to raise it to **S**.
- Best overall in terms of total replenishment, carrying and shortage costs.
- Computationally very difficult. Also, difficult to understand.
- Special cases:

$R = 0 \rightarrow (s, S)$ system
 $s = S-1 \rightarrow (R, S)$ system



Continuous Versus Periodic Review System



Continuous Review System

- Able to provide same level of service with less safety stock (hence, lower carrying cost)
- Fixed lot sizes may make it easier to obtain quantity discounts
- Individual review of items is used and this may be desirable for expensive items

Periodic Review System

- Less time consuming and less expensive to maintain
- Allows combining orders to the same supplier
- Good for coordination of replenishments of several items
- Allows reasonable prediction of workload of staff

Using Continuous Review System (s, Q)

- Safety Factor, $z = \text{NORMSINV}(0.98) = \underline{2.0537}$
- **Annual** Average Demand
= Monthly Average Demand X No. of months in a year
= $9000 \times 12 = \underline{108000}$
- Optimal Order Quantity, Q
= $\text{SQRT}(2 * \text{Fixed Ordering Cost} * \text{Annual Average Demand} / \text{Holding Cost per Unit per Year})$
= $\text{SQRT}(2 * 2000 * 108000 / 20) = \underline{4648 \text{ Units (roundup)}}$
- Safety Stock, SS
= $z * \text{Monthly Demand Standard Deviation} * \text{SQRT}(L)$
= $2.0537 * 900 * \text{SQRT}(1/4) = \underline{925 \text{ units (roundup)}}$
- Reorder Point, s
= **Weekly** Average Demand*(L) + Safety Stock
= $2250 * 1 + 925 = \underline{3175 \text{ Units}}$



Note: convert from weeks to months

Using Periodic Review System (R, S)



- Given that Isaac wishes to review the inventory status every 4 weeks and achieve the same customer service level of 98%.

- Weekly** Average Demand

= Monthly Average Demand/ number of weeks per month

$$= 9000/4 = 2250$$

- Safety Stock

= $z * \text{Monthly demand Standard Deviation} * \text{SQRT}(R+L)$

$$= 2.0537 * 900 * \text{SQRT}((4+1)/4) = \underline{2067 \text{ units (roundup)}}$$

(Note: Safety Stock in (s, Q) system = 925 units)

Note: convert
from weeks to
months

- $S = \text{Target Level}$

= Average Weekly Demand*(R+L) + Safety Stock

$$= 2250 * (4+1) + 925 = \underline{13317 \text{ units}}$$

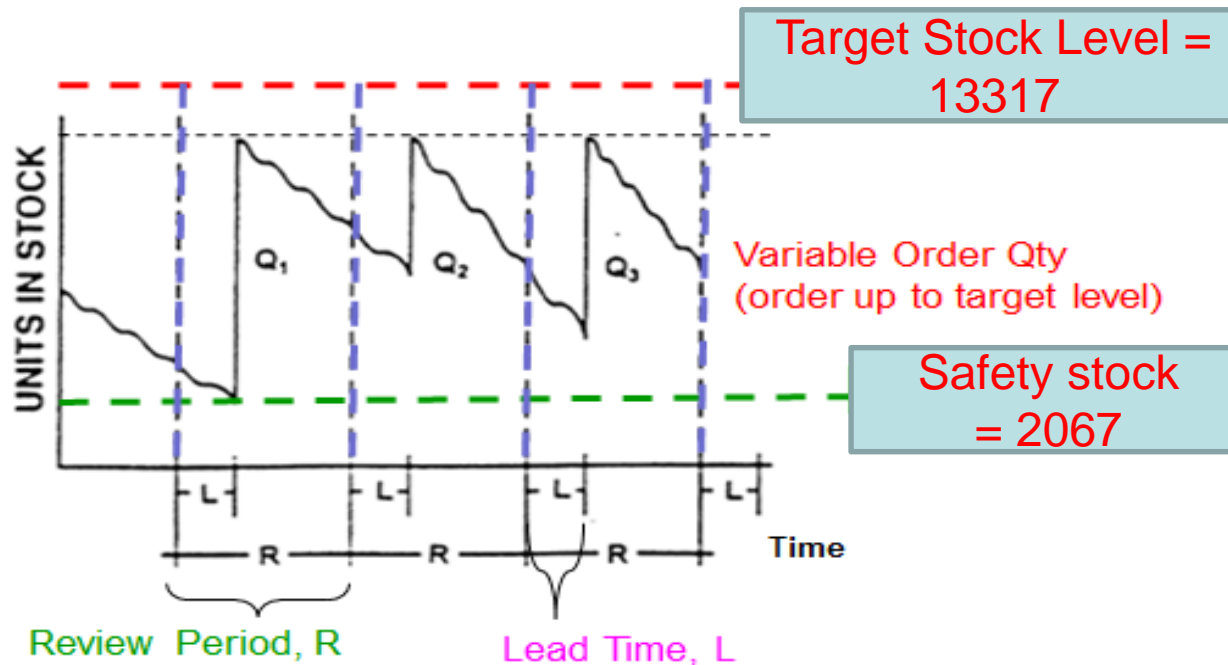
More Safety stock
required in periodic
review system!

- ❖ This means that Isaac should place an order every 4 weeks, so as to raise the inventory level to 13317 units
- ❖ This target level is also known as the Order-Up-To-Level, S

Using Periodic Review System (R, S)



- Isaac reviews the inventory every 4 weeks. The quantity that he should order every time is found by:
Order Quantity = Target level – Current Inventory Position
- If current inventory is 8388 units, order quantity = $13317 - 8388 = 4929$ units
- The “Current Inventory Position” may vary in every review time, hence the order quantity is variable.



Recommendations to Isaac



- Current reorder point (by past experience) was not effective when the demand was not constant. However, the safety stock can provide buffer against stock-out to certain extent.
 - *Reorder point should take into account safety stock and average demand during lead time, when the demand is not constant.*
- If the review period is set to be too long (i.e. monthly in this case), he might run out of stocks even before he does the review.
- A continuous review model is recommended to accurately and closely monitor the inventory level to prevent from stock-out. i.e. When the stock level hits the reorder point, he should place the order for the product.



Overall Recommendations



- For *slow moving items*, he can continue to use the periodic review system with an appropriate review period (not too short).
- For *fast moving/ high profit/ high value items*:
 - He may want to invest in technology that enables him to continuously monitor the stock levels, thus enabling him to use the continuous review system (s, S).
 - If using periodic review system, he can implement (R, S) but set a shorter review interval; or even the (R, s, S). The difficulty with (R, s, S) is that it is not easy to obtain the best value for the 3 parameters. It is more complicated than other review systems.
- General rule:
 - If the stockout of an item is especially costly for the firm, or the more critical the item, the more pressing the need to adopt a continuous review system

Learning Objectives



- Describe the characteristics of a Continuous Review System
 - ❖ Reorder Point, Order Quantity (s, Q) system
 - ❖ Reorder Point, Order-Up-To-Level (s, S) system
- Describe the characteristics of a Periodic Review System
 - ❖ Periodic-Review, Order-Up-To-Level (R, S) system
 - ❖ (R, s, S) system
- Perform calculations for a Continuous Review System (s, Q)
- Perform calculations for a Periodic Review System (R, S)
- Identify the appropriate inventory review system to be used for today's problem



E217 Inventory Management Topic Flow

