

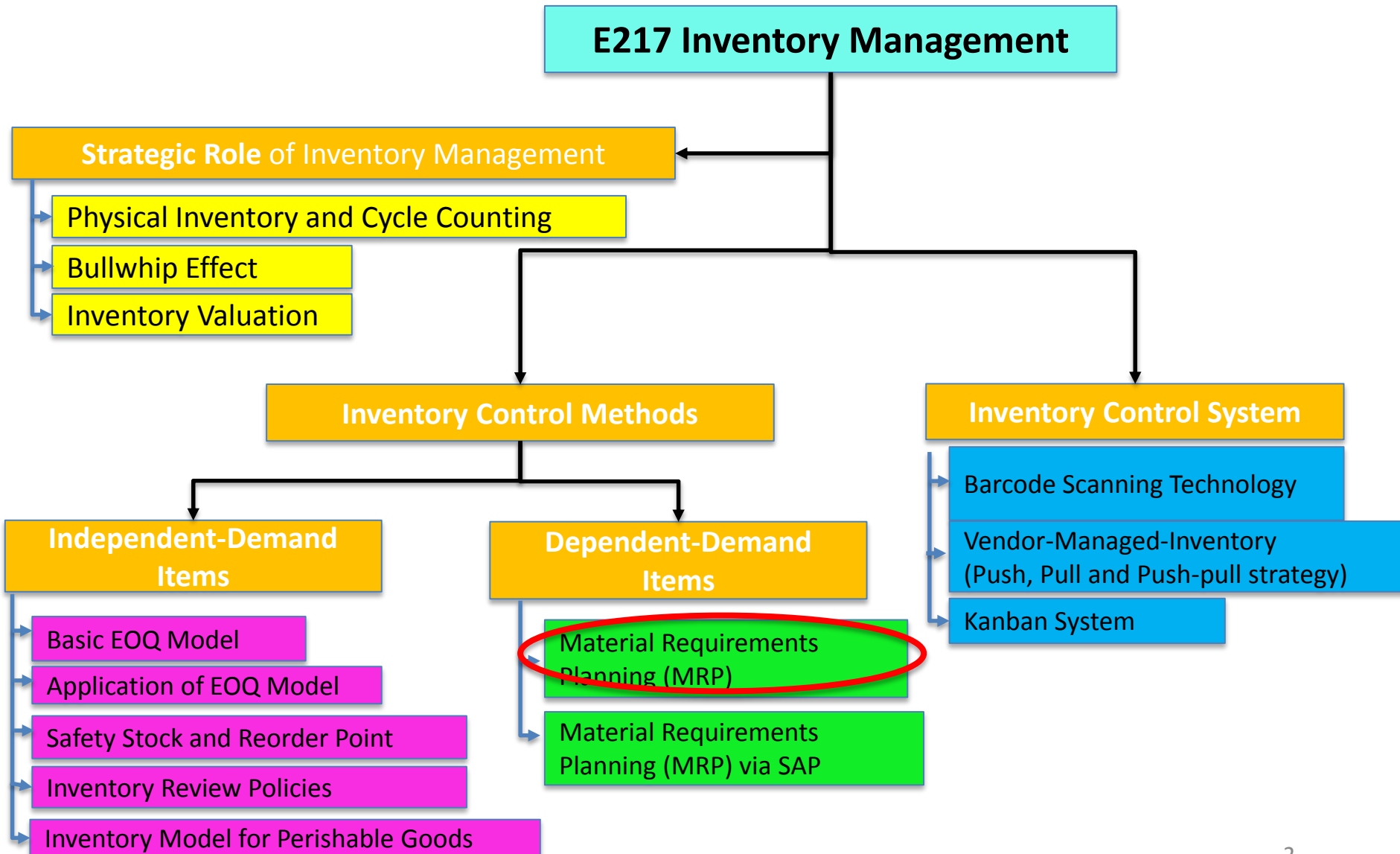
Problem 09

Plan to Buy

E217 – Inventory Management

SCHOOL OF
ENGINEERING

E217 Inventory Management Topic Tree



Need of Planning

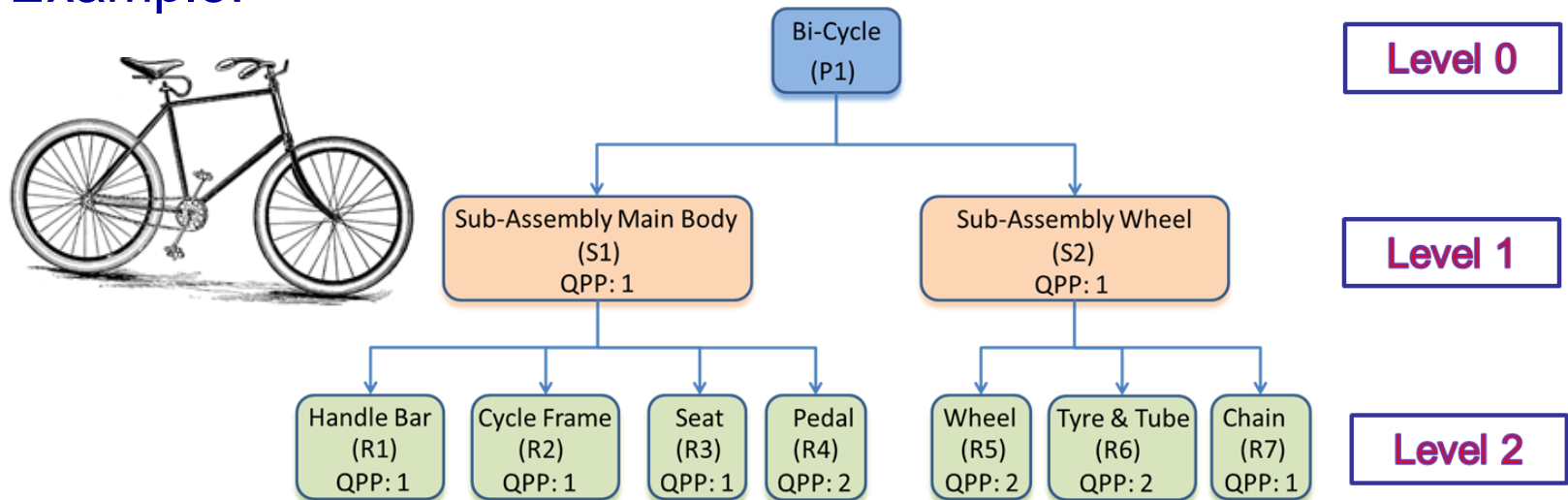


- Making business operations as efficient as possible is the key to economic advantage.
- To make operations as effective as possible, one area to focus on is the cost reduction and operations optimization.
- A big part of optimization processes depends on how manufacturing companies plan their operations, control inventory and organize logistics.
- To help companies make better decisions in these areas, material requirements planning (MRP) has been introduced in the 1960's.
- It helps manufacturers to plan and schedule their production operations in such a way that it will not require any excessive inventory.

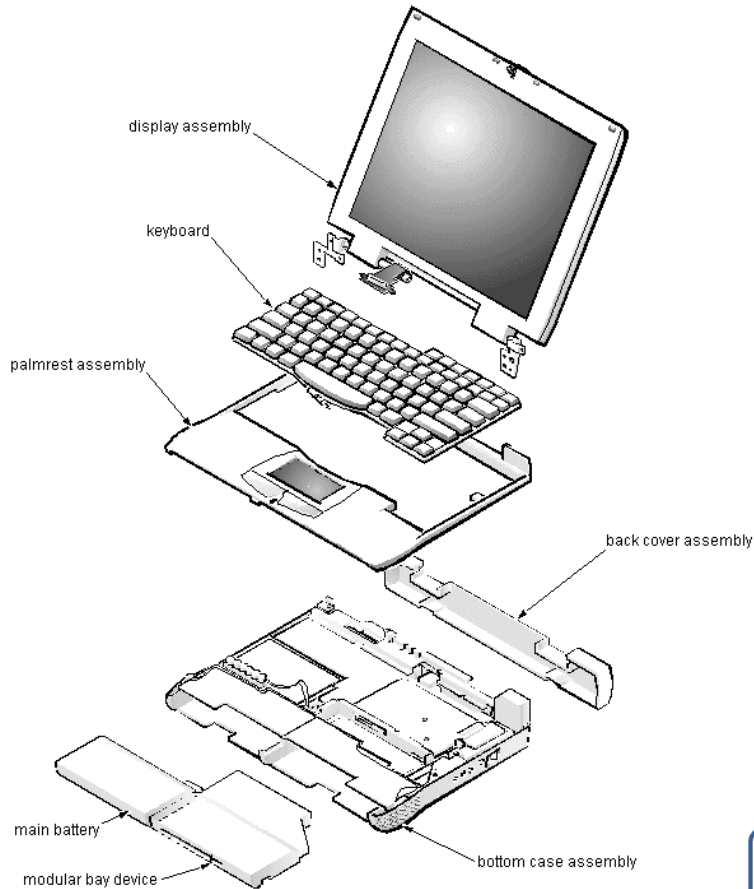
Bill of Materials (BOM)



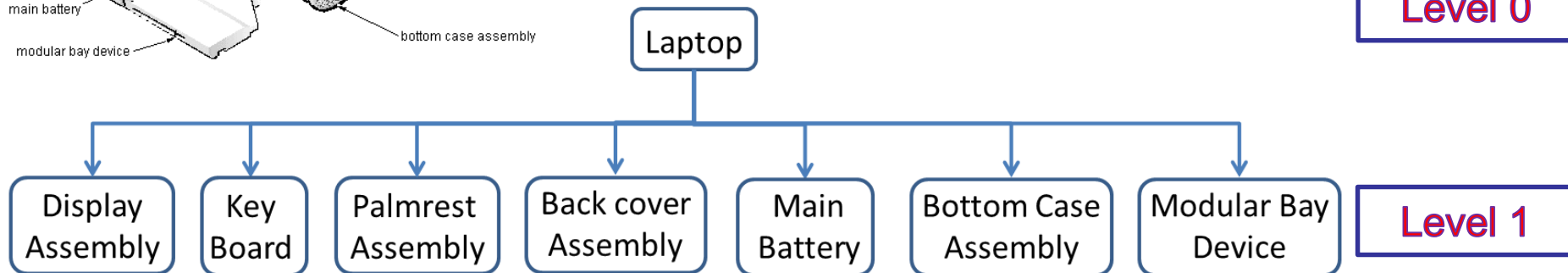
- A structured list of the components which make up a product (finished product) or assembly (sub assembly).
- The list contains each component as well as the quantity.
- Parent item (finished product) shown at highest level or level zero, parts that go into parent item are called level 1 components and so on
- Example:



BOM for Laptop



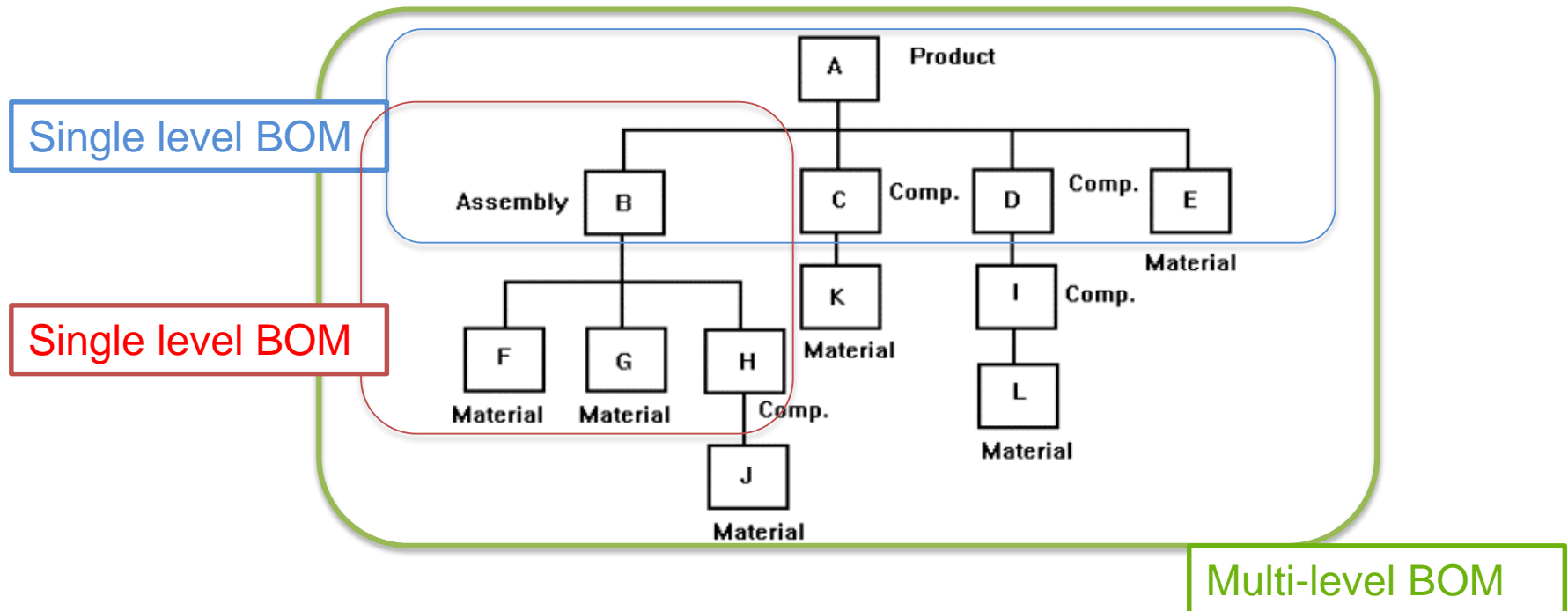
<u>Components</u>	<u>Quantity</u>
Display Assembly	1
Key board	1
Palmrest Assembly	1
Back cover Assembly	1
Main battery	1
Bottom case Assembly	1
Modular Bay device	1



Bill of Materials (BOM)



- Single level bill of material: A bill of material that lists the materials, parts and labor required to make another part.
- Multi-level bill of material: A bill of material that lists the components, assemblies, and materials required to make a part, the components, assemblies, and materials required to make each component and assembly of the part, and so forth.

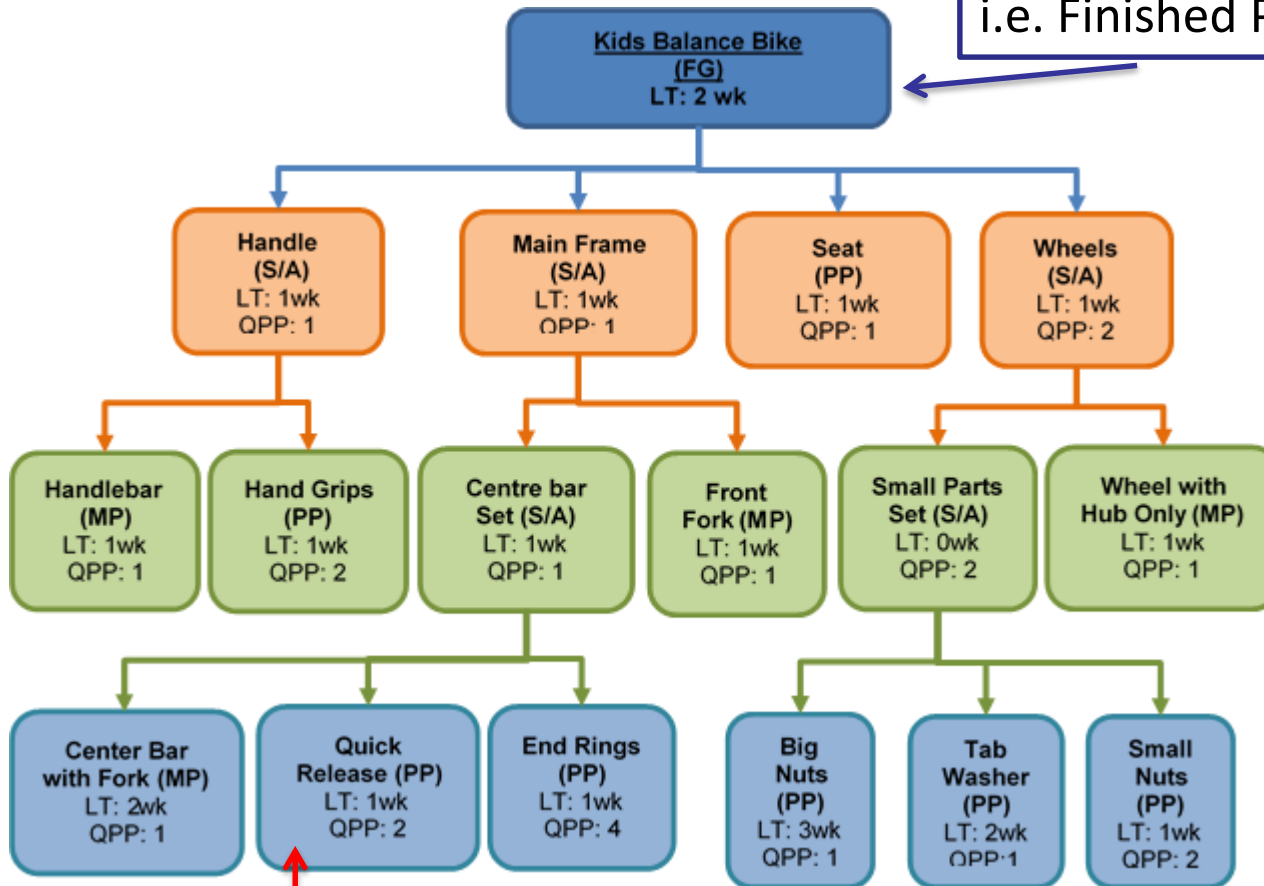


BOM for Kids Balance Bike



Independent Demand
i.e. Finished Product

Level 0



Level 1

Level 2

Level 3

Dependent Demand

i.e. raw materials,
components, subassemblies

MPS & MRP



Master Production Scheduling (MPS)

- A statement of how many finished items are to be produced and when they are to be produced
- What, when and how many
- MPS outputs are the gross requirements for components' MRP calculations



Material Requirements Planning (MRP)

- Translates end-product requirements from MPS into individual component requirements.
- It calculates the exact quantity, need date & planned order release date for each subassemblies, components & raw materials required to manufacture the end product.
- MRP output is a schedule for obtaining raw materials, detailed manufacturing schedule, and financial information.

The main theme of MRP is “getting the right materials to the right place at the right time”.

MRP Assumptions



- Production of all the products finish at the **end** of each period (week, month, etc.)
- All the components/raw materials are used at the **beginning** of each period.
- No inventory cost for the products at the period that they are produced.
- No inventory carrying cost occurs when an item comes to stock and gets consumed in the same period.



MRP Terminology

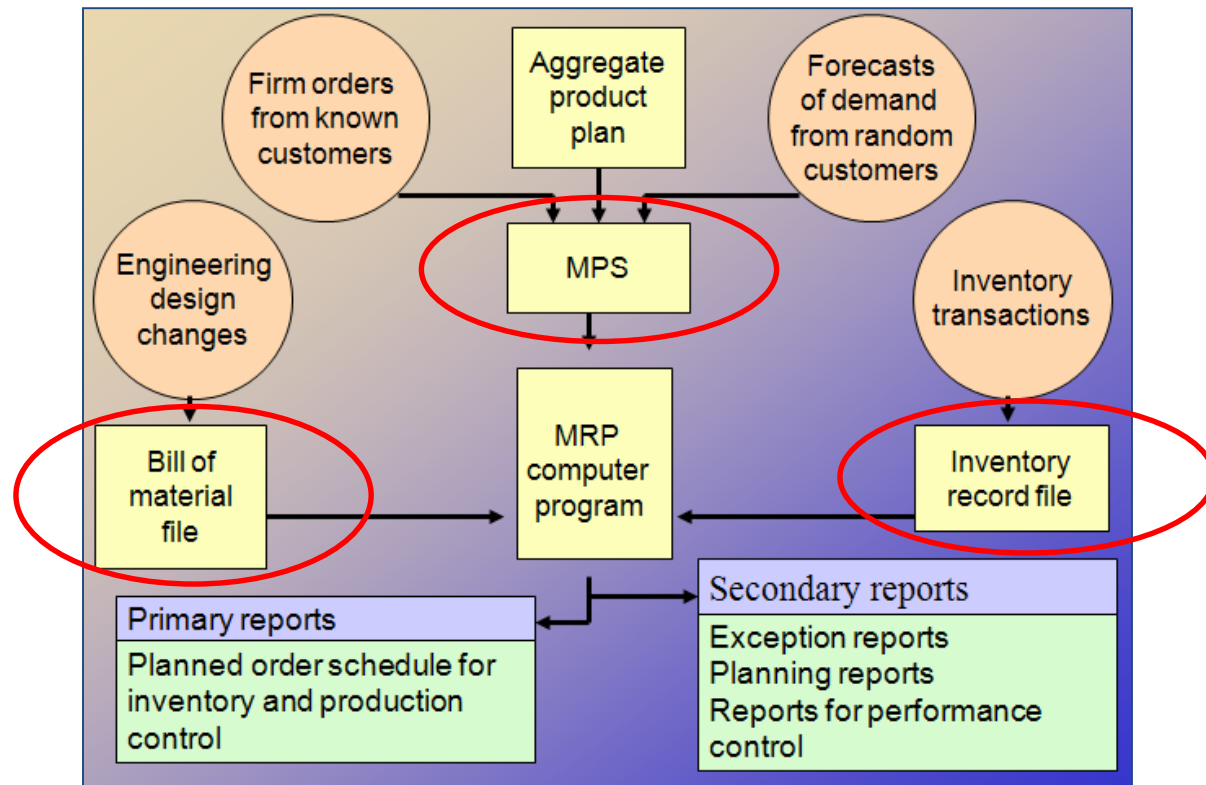


- **Gross requirement** is based on MPS and exploded BOM
- **Scheduled Receipts**: open orders scheduled to arrive
- **On hand inventory** is the stock available at the **end** of the period
- **Net requirements** = gross requirements – on hand inventory – scheduled receipts
- **Planned receipts**: quantity expected to received at the beginning of the period offset by lead time to meet net requirement
- **Planned order releases** - Authorization for the execution of planned orders
- **Lot sizing**: determine the batch size to be purchased or produced

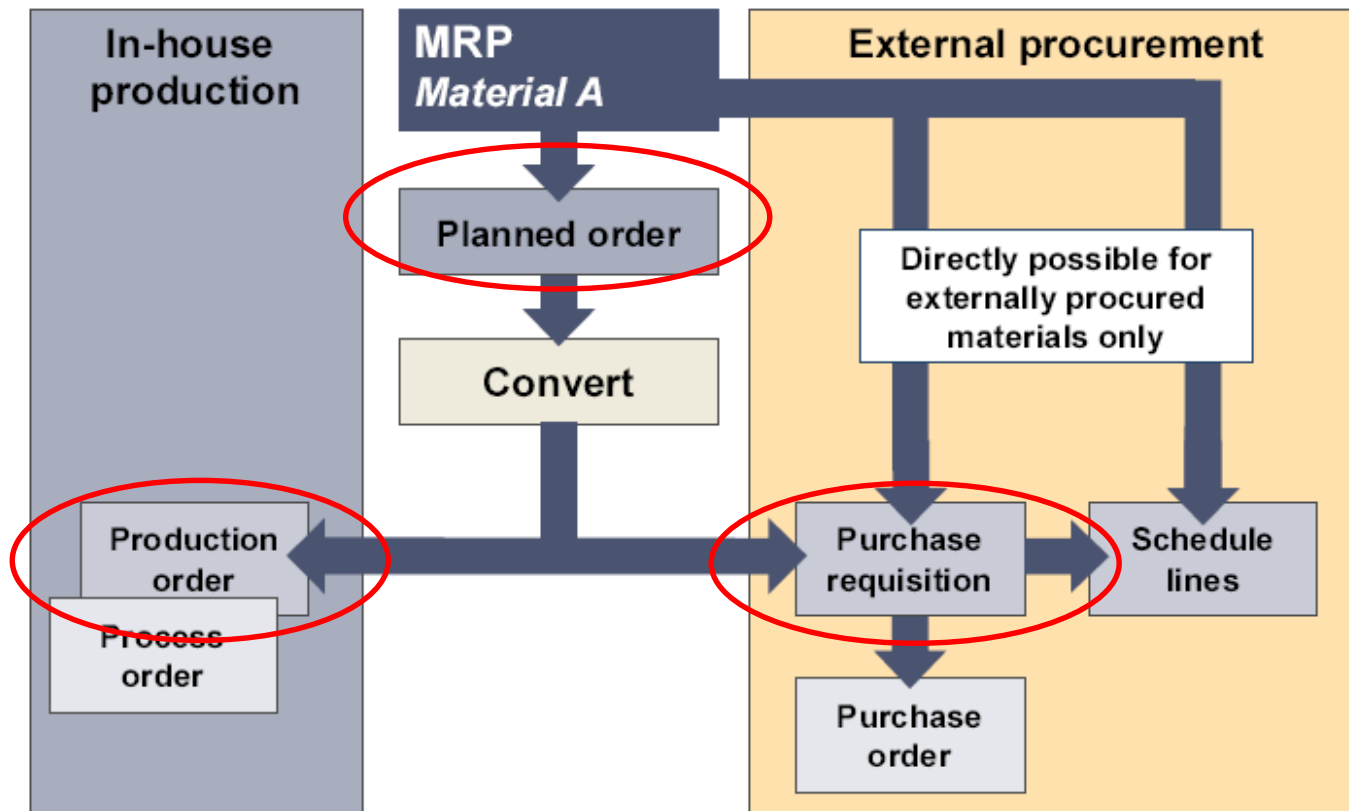
Inputs to MRP



- MRP takes the end product requirements from the MPS and breaks them down into their component parts and subassemblies to create materials plan.
- This plan specifies when production and purchase orders must be placed for each part and subassembly so as to complete the products on schedule.



MRP Outputs



- The output of MRP is either a planned order or a purchase requisition.
 - *Planned order can be converted into either a Production Order or a Purchase Requisition.*
 - *Purchase Requisition can also be converted into a Purchase Order.*

Lot-Sizing



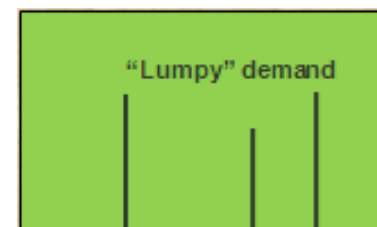
- **Lot Size:** The amount of a particular item that is ordered from the plant or a vendor.
- Determine the batch size to be purchased or produced.
- Lot size decision affects inventory levels, setup & ordering costs, capacity requirement & availability.
- The benefits of using lot-sizing techniques properly:
 - *Reduced expenditures associated with ordering or setting up*
 - *Lower charges for carrying the resulting inventory*



Lot for Lot (LFL)



- The most straightforward and simple application of discrete lot sizing. The lot size is equal to the requirement in each period.
- No extra on-hand inventory
- It results in variable order quantities and a new setup is required for each run
- Use when setup costs are low and inventory carrying costs are high.
- Very effective for lumpy demands and when the goal is to minimize inventory investment.
- Very effective when demand patterns have periods of no requirements and the item is very expensive.
- Ideally, there is no inventory carrying cost with this approach since the quantity receipt and consumption of the items occurs in the same period.



Fixed Order Quantity (FOQ)



- FOQ uses a fixed order size for every order or production run

$$q_t = Q$$

q = Order quantity in number of units

Q = Fixed/Constant quantity

t = Period index

- The order quantity of FOQ can be determined by:
 - ❖ EOQ
 - ✓ A type of Fixed Order Quantity (FOQ) that determines the amount of an item to be purchased or produced at one time.
 - ✓ Wish to minimize the combined cost of ordering and carrying inventory
 - ❖ Quantity Discount
 - ❖ Truckload Capacity
 - ❖ Minimum Purchase Quantity
 - ❖ For manufacturing, the batch size for certain machines



Using EOQ to Determine the Lot Size



- 8 weeks' demand = 1360 units
- Weekly Average Demand = $1360/8 = 170$ units/week
- Ordering cost is \$90/order
- Holding cost is \$0.3 per unit per week
- $EOQ = \text{SQRT}(2 \cdot 90 \cdot 170 / 0.3) = 319.37 \sim 320$ units (round up)
- Note: order a multiple of EOQ if net requirement exceeds 320

Small Nuts	Lead time 1				Lot size FOQ Determined by using EOQ				
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	320	440	320	280	0	0	0
Scheduled Receipt		300	0	0	0	0	0	0	0
On Hand Inventory	200	500	180	0	0	0	0	0	0
Projected On Hand Inventory		500	180	60	60	100	100	100	100
Net Requirements		0	0	260	260	220	0	0	0
Planned receipts		0	0	320	320	320	0	0	0
Planned orders		0	320	320	320	0	0	0	0

Examples of MRP Calculation



On-hand inventory is the stock available at the **end** of the week

Kids Balance Bike	Lead time	2	Qty Per Product	1	Lot size	LFL	LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements		50	60	50	30	45	55	40	35
Scheduled Receipt		40	70						
On Hand Inventory at the end of the week	60	50	60	10	0	0	0	0	0
Net Requirements		0	0	0	20	45	55	40	35
Planned receipts		0	0	0	20	45	55	40	35
Planned orders		0	20	45	55	40	35	0	0

Gross requirements for Seat is **1** time of the planned orders for the Bike, QPP = 1

Seat	Lead time	1	Qty Per	1	Lot size	LFL	LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	20	45	55	40	35	0	0
Scheduled Receipt		0	0						
On Hand Inventory	25	25	5	0	0	0	0	0	0
Net Requirements		0	0	40	55	40	35	0	0
Planned receipts		0	0	40	55	40	35	0	0
Planned orders		0	40	55	40	35	0	0	0

Planned orders will be released by a period of lead time (2 weeks ahead for bike, 1 week ahead for seat)

Examples of MRP Calculation



Handle	Lead time 1		Qty Per Product 1		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	20	45	55	40	35	0	0
Scheduled Receipt									
On Hand Inventory	0	0	0	0	0	0	0	0	0
Net Requirements		0	20	45	55	40	35	0	0
Planned receipts		0	20	45	55	40	35	0	0
Planned orders		20	45	55	40	35	0	0	0

Gross requirements for Hand Grips is **2** times of the planned orders for Handle, QPP = 2

Hand Grips	Lead time 1		Qty Per Product 2		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	40	90	110	80	70	0	0	0
Scheduled Receipt		30	0	0	0	0	0	0	0
On Hand Inventory	30	20	0	0	0	0	0	0	0
Net Requirements		0	70	110	80	70	0	0	0
Planned receipts		0	70	110	80	70	0	0	0
Planned orders		70	110	80	70	0	0	0	0

MRP Calculations – Other Level-1 items



Main Frame	Lead time 1		Qty Per Product 1		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	20	45	55	40	35	0	0
Scheduled Receipt									
On Hand Inventory	0	0	0	0	0	0	0	0	0
Net Requirements		0	20	45	55	40	35	0	0
Planned receipts		0	20	45	55	40	35	0	0
Planned orders		20	45	55	40	35	0	0	0

Wheels	Lead time 1		Qty Per Product 2		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	40	90	110	80	70	0	0
Scheduled Receipt									
On Hand Inventory	50	50	10	0	0	0	0	0	0
Net Requirements		0	0	80	110	80	70	0	0
Planned receipts		0	0	80	110	80	70	0	0
Planned orders		0	80	110	80	70	0	0	0

MRP Calculations – Other Level-2 items



Centre Bar Set	Lead time 1		Qty Per Product 1		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	20	45	55	40	35	0	0	0
Scheduled Receipt									
On Hand Inventory	30	10	0	0	0	0	0	0	0
Net Requirements		0	35	55	40	35	0	0	0
Planned receipts		0	35	55	40	35	0	0	0
Planned orders		35	55	40	35	0	0	0	0

Small Parts Set	Lead time 0		Qty Per Product 2		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	160	220	160	140	0	0	0
Scheduled Receipt									
On Hand Inventory	0	0	0	0	0	0	0	0	0
Net Requirements		0	160	220	160	140	0	0	0
Planned receipts		0	160	220	160	140	0	0	0
Planned orders		0	160	220	160	140	0	0	0

MRP Calculations – Level-3 items



Quick Release	Lead time 1		Qty Per Product 2		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	70	110	80	70	0	0	0	0
Scheduled Receipt		45	0	0	0	0	0	0	0
On Hand Inventory	70	45	0	0	0	0	0	0	0
Net Requirements		0	65	80	70	0	0	0	0
Planned receipts		0	65	80	70	0	0	0	0
Planned orders		65	80	70	0	0	0	0	0

End Rings	Lead time 1		Qty Per Product 4		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	140	220	160	140	0	0	0	0
Scheduled Receipt		85	0	0	0	0	0	0	0
On Hand Inventory	60	5	0	0	0	0	0	0	0
Net Requirements		0	215	160	140	0	0	0	0
Planned receipts		0	215	160	140	0	0	0	0
Planned orders		215	160	140	0	0	0	0	0

MRP Calculations – Level-3 items



Big Nuts	Lead time 3		Qty Per Product 1		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	160	220	160	140	0	0	0
Scheduled Receipt		150	200	0	0	0	0	0	0
On Hand Inventory	100	250	290	70	0	0	0	0	0
Net Requirements		0	0	0	90	140	0	0	0
Planned receipts		0	0	0	90	140	0	0	0
Planned orders		90	140	0	0	0	0	0	0

Tab Washer	Lead time 2		Qty Per Product 1		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	160	220	160	140	0	0	0
Scheduled Receipt		85	105	0	0	0	0	0	0
On Hand Inventory	100	185	130	0	0	0	0	0	0
Net Requirements		0	0	90	160	140	0	0	0
Planned receipts		0	0	90	160	140	0	0	0
Planned orders		90	160	140	0	0	0	0	0

Small Nuts	Lead time 1		Qty Per Product 2		Lot size LFL		LFL: Lot for Lot		
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Gross requirements	0	0	320	440	320	280	0	0	0
Scheduled Receipt		300	0	0	0	0	0	0	0
On Hand Inventory	200	500	180	0	0	0	0	0	0
Net Requirements		0	0	260	320	280	0	0	0
Planned receipts		0	0	260	320	280	0	0	0
Planned orders		0	260	320	280	0	0	0	0

Planned Order Summary



- Planned order will be compiled and served as a forecasted order which will be given to suppliers for their production planning.
- This plan will update weekly based on the MPS and MRP result

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Seat	0	40	55	40	35	0	0	0
Hand Grip	70	110	80	70	0	0	0	0
Quick Release	65	80	70	0	0	0	0	0
End Rings	215	160	140	0	0	0	0	0
Big Nuts	90	140	0	0	0	0	0	0
Tab Washer	90	160	140	0	0	0	0	0
Small Nuts	0	260	320	280	0	0	0	0

MRP and Lot Sizing



- Based on a master production schedule, a MRP system:
 - Creates schedules identifying the specific parts and materials required to produce end items
 - Determines exact numbers needed
 - Determines the dates when orders for those materials should be released, based on lead times
- MRP is not a demand planning tool, input quantities are production quantities, not demand
- MRP is deterministic, all input numbers are known
- Lot Sizing needs to be done on all components of the finished product

Learning Objectives



- Describe where and when MRP is used
- Describe the inputs to MRP
 - Master Production Schedule, Bill of Materials, Inventory Master File
- Calculate the outputs from MRP
 - Planned order release in terms of order quantity and schedule
- Describe the importance of Lot Sizing decisions
- Know the various MRP Lot Sizing techniques and perform calculations for a given case-study:
 - LFL
 - FOQ (EOQ)

E217 Inventory Management Topic Flow

