Operations and Supply Planning
PGDM 2018-20

Material Resources Planning

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Introduction

- Computerised information system
  - Aids in planning of materials in an organization
- Exploits certain unique characteristics of the production items
  - Utilize information on lead time, inventory status and master production schedule to make material available exactly at the time of requirement
- Same logic could be extended to planning of other resources
  - Called generally as **resources planning**

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Two types of inventories

Distribution Inventory
Independent Demand item

Operating Inventory
Dependent demand item

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Characteristics of inventories

Distribution Inventory

- Meant for market consumption
- Considerable uncertainty in demand
- Orders based on forecast
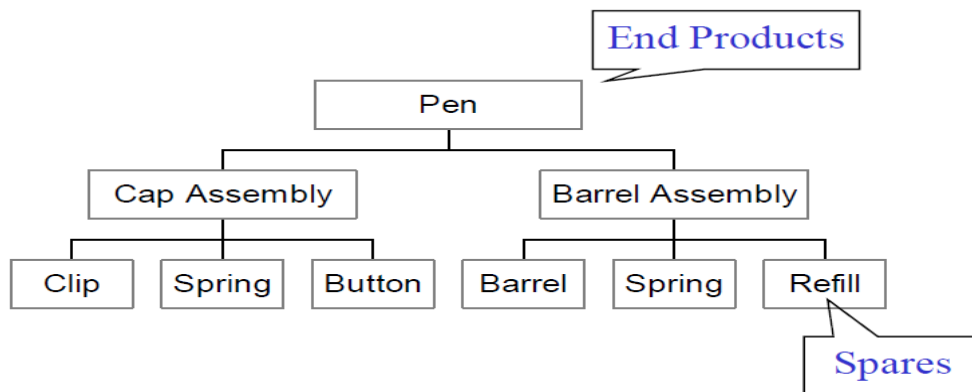- 100% service level not feasible
- Continuous demand

Operating Inventory

- Denotes all the resources (broadly of material and capacity) that are available for the operating system to consume in the production process
- No uncertainty: Parent child relationship
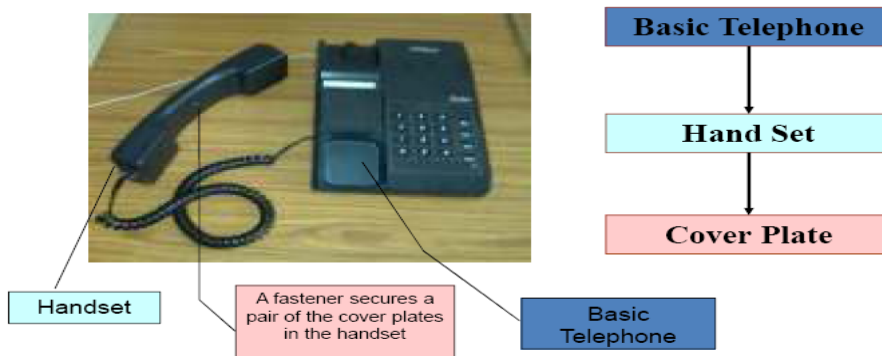- Production planning determines quantity
- Lumpy demand

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Independent – Dependent Demand

Dependency Relationship
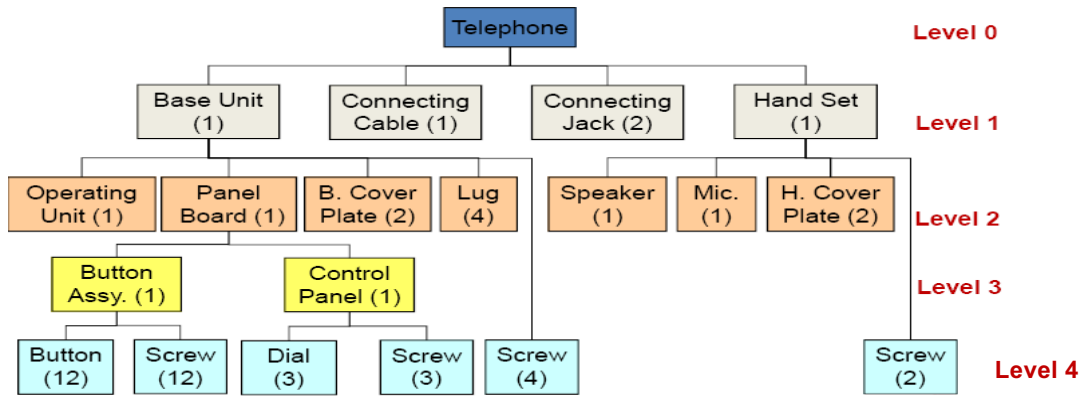
Product structure

Product structure

MRP inputs and outputs

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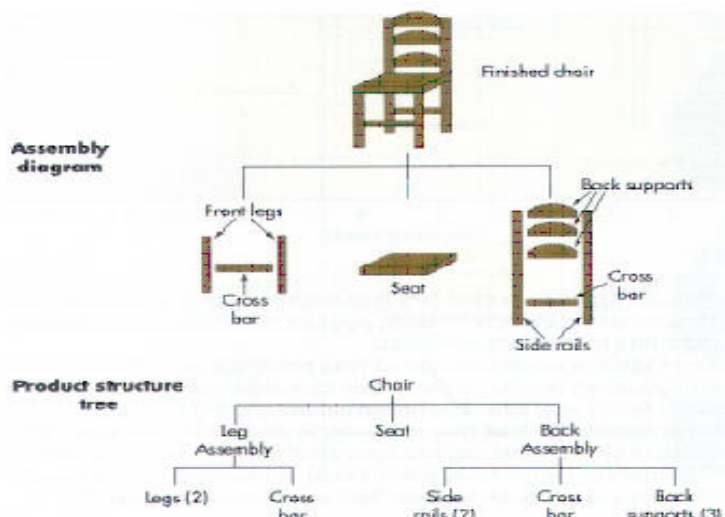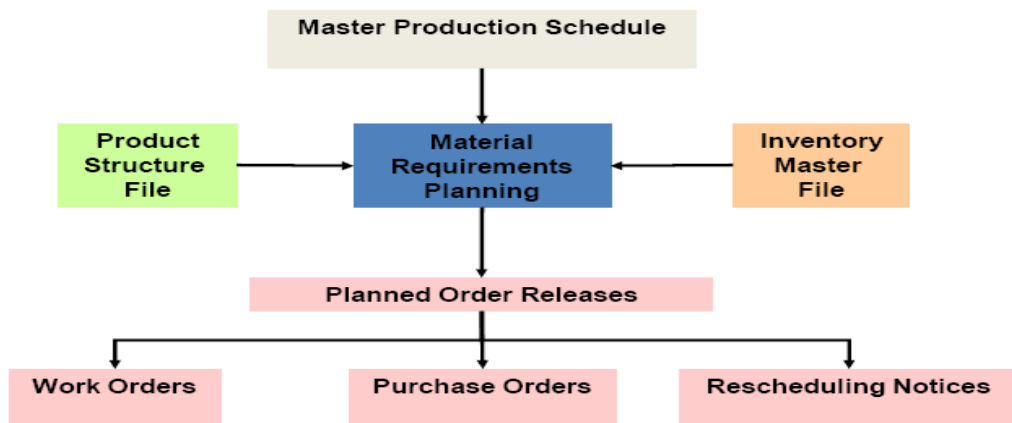
Master Production Schedule

- Drives MRP process with a schedule of finished products
- Quantities represent production not demand
- Quantities may consist of a combination of customer orders & demand forecasts
- Quantities represent what needs to be produced, not what can be produced

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The Aggregate Plan and the Master Production Schedule for Mattresses

- **Master production schedule** (MPS): the time-phased plan specifying how many and when the firm plans to build each end item

Aggregate Production Plan for Mattresses

Month	1	2
Mattress production	900	950

Master Production Schedule for Mattress Models

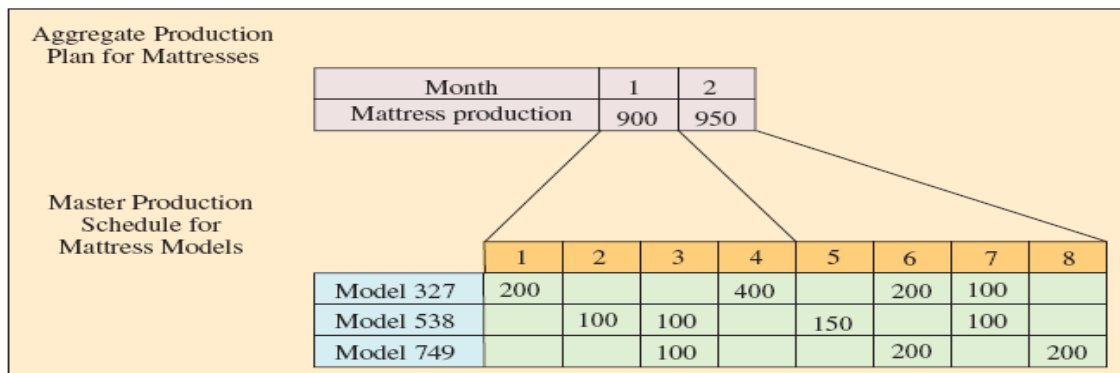|	1	2	3	4	5	6	7	8
Model 327	200			400		200	100	
Model 538		100	100		150		100	
Model 749			100			200		200

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Time Fences

- **Frozen:** anything from no changes to only minor changes
- **Moderately firm:** allow changes so long as parts are available
- **Flexible:** allow almost any variations

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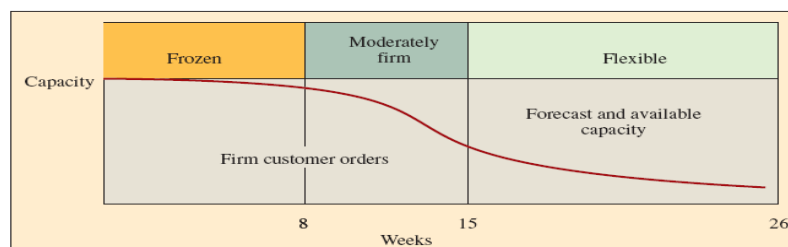
Product Structure

- Product Structure
  - Graphically depicts relationships among various items that make up final product
- Bill of Materials
  - List of all the materials needed to assemble one unit of final product
- Explosion
  - Iterative process of computing all requirements at a level and then moving down the level

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Bill of Materials – Single Level

Item Code	Item Description	UOM	Qty. per product
1000	Basic Telephone	Each	1
1010	Base unit Assembly	Each	1
1020	Handset Assembly	Each	1
1030	Connecting Cable	Metre	1
1040	Connecting Jack	Each	2
1050	Speaker	Each	1
1060	Microphone	Each	1
1070	Receiver cover plate	Each	2
1080	Panel Board Assembly	Each	1
1090	Operating Unit	Each	1
1100	Lug	Each	4
1110	Base Cover Plate	Each	2
1120	Button Assembly	Each	1
1130	Control Panel Assembly	Each	1
1140	Buttons	Each	12
1150	Control Dials	Each	3
1160	Screw	Each	21

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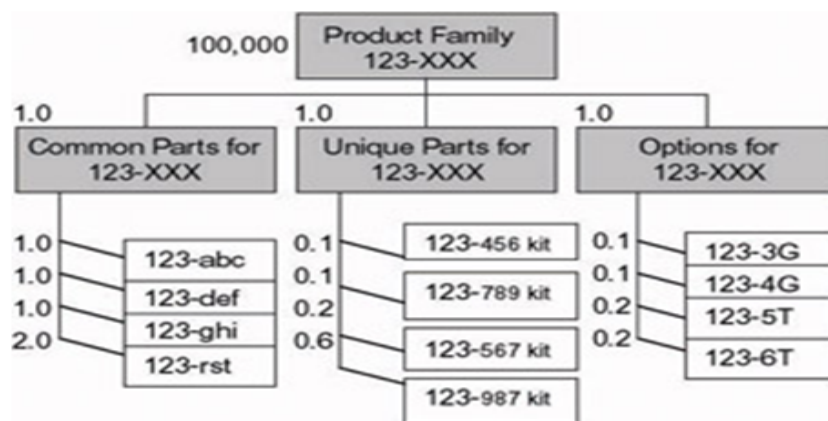...Harnessing Knowledge for Businesses

Indented BOM

Indented BOM for Product 0125
5-Gal Carpet Cleaner

Ind. Level	Part Number	Part Description	Type	Unit	Qty. Per Assembly	Unit Cost	Lead Time	Total Lead Time
0	⊟ 0125	5-Gal Carpet Cleaner	3	Ea	.	9	7	7
1	⊟ 1115	Customer Pack	1	Ea	1	6	7	14
2	– 1959	Instruct Set	2	Ea	1	8	7	21
2	– 6221-1	Bottled Concentrate	2	Ea	1	150	105	119
1	⊟ 2104	5-Gal Tank Assembly	1	Ea	1	30	14	21
2	– 5319	Valve Assembly	2	Ea	1	137	91	112
2	– 5746	Hose	2	In	10	45	28	49
2	⊟ 7350	5-Gal Tank Subassembly	1	Ea	1	25	14	35
3	– 0403	Clamp	2	Ea	1	22	14	49
3	– 1201	Gasket	2	Ea	2	3	7	42
3	⊟ 4209	Painted Tank Top	1	Ea	1	18	14	49
4	– 5640	Steel	2	Lbs	2	115	70	119
3	⊟ 5706	5-Gal Painted Tank Bottom	1	Ea	1	38	21	56
4	– 5640	Steel	2	Lbs	3	115	70	126
1	⊟ 3824	2-Hp Housing Assembly	1	Ea	1	17	14	21
2	⊟ 1198	M-Housing	1	Ea	1	25	14	35

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Modular BOM

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The Inventory Status Record for an Item in Inventory

Item master data segment	Part no.		Description		Lead time		Std. cost		Safety stock
	Order quantity		Setup	Cycle		Last year's usage			Class
	Scrap allowance		Cutting data		Pointers		Etc.		

Inventory status segment	Allocated		Control balance	Period 1 2 3 4 5 6 7 8								Totals
	Gross requirements											
	Scheduled receipts											
	Projected available balance											
	Planned order releases											

Subsidiary data segment	Order details
	Pending action
	Counters
	Keeping track

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Fields of MRP

- Gross Requirements
  - Total expected demand for an item or raw material in a time period
- Scheduled Receipts
  - Open orders scheduled to arrive from vendors or elsewhere in the pipeline
- Project on-hand
  - Expected amount of inventory that will be on hand at the beginning of each time period

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Fields of MRP

- Net requirements
  - The actual amount needed in each time period
  - Net requirements = gross requirements – Projected on hand + Safety stock
- Planned order releases
  - Planned amount to order in each time period
    - Planned order receipts offset by lead time

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Fields of MRP

Week number:	1	2	3	4	5	6	7	8
Item:								
Gross Requirements								
Scheduled Receipts								
Projected on hand								
Net Requirements								
Planned-order receipts								
Planned-order releases								

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Impact of Lead time

Planned Order Release Time = Planned Receipt Time − Lead Time

Manufacture 200 Operating Units

Assemble 200 base units

Assemble 200 telephones

LT for manufacture of Operating Unit

Offset | Offset

Weeks 5 - 6 | Week 7 | Week 8

Manufacture of Operating units begin

Assembly of Base units begin

Assembled Base units arrive

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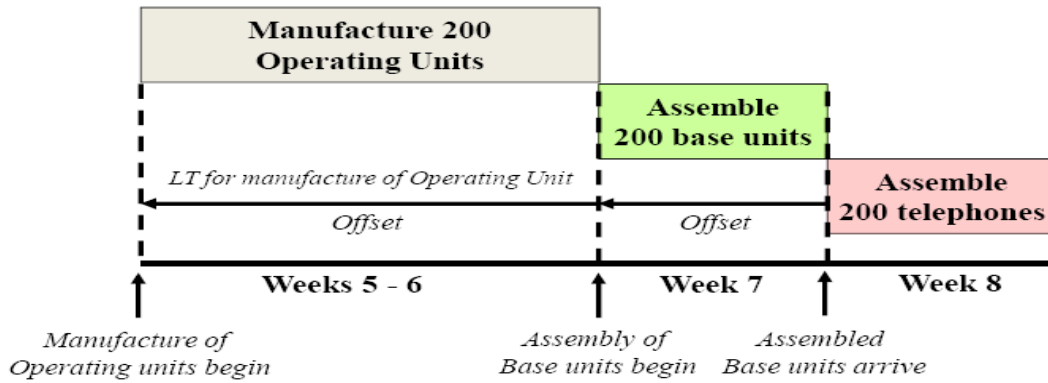
Incorporating lead time

Item: Operating Unit; LT = 2 Wks.	Period (Week)							
Lot size rule: Lot for Lot	1	2	3	4	5	6	7	8
Gross requirements			200		120		130	160
On hand* 50	50	50						
Net Requirements			150		120		130	160
Planned receipts			150		120		130	160
Planned Order releases	150		120		130	160		

* On hand data pertains to the inventory at the end of the period

Planned Order Release Time = Planned Receipt Time − Lead Time

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MRP Lot sizing rules

- Lot for Lot
- Economic Order Quantity
- Least Total Cost
- Least Unit Cost

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Lot-for-Lot

- Sets planned orders to exactly match the net requirements
- Produces exactly what is needed each week with none carried over into future periods
- Minimizes carrying cost
- Does not take into account setup costs or capacity limitations.

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Lot-for-Lot Run Size for an MRP Schedule

(1) Week	(2) Net Requirements	(3) Production Quantity	(4) Ending Inventory	(5) Holding Cost	(6) Setup Cost	(7) Total Cost
1	50	50	0	$0.00	$47.00	$ 47.00
2	60	60	0	0.00	47.00	94.00
3	70	70	0	0.00	47.00	141.00
4	60	60	0	0.00	47.00	188.00
5	95	95	0	0.00	47.00	235.00
6	75	75	0	0.00	47.00	282.00
7	60	60	0	0.00	47.00	329.00
8	55	55	0	0.00	47.00	376.00

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Economic Order Quantity

- Calculate reorder quantity based on EOQ
- EOQ was not designed for a system with discrete time periods such as MRP
- The lot sizes generated by EOQ do not always cover the entire number of periods

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Economic Order Quantity Run Size for an MRP Schedule

Week	Net Requirements	Production Quantity	Ending Inventory	Holding Cost	Setup Cost	Total Cost
1	50	351	301	$15.05	$47.00	$ 62.05
2	60	0	241	12.05	0.00	74.10
3	70	0	171	8.55	0.00	82.65
4	60	0	111	5.55	0.00	88.20
5	95	0	16	0.80	0.00	89.00
6	75	351	292	14.60	47.00	150.60
7	60	0	232	11.60	0.00	162.20
8	55	0	177	8.85	0.00	171.05

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Least Total Cost

- **Least total cost method** (LTC): a dynamic lot-sizing technique that calculates the order quantity by comparing the carrying cost and the setup costs for various lot sizes and then selects the lot in which these are most nearly equal
- Influenced by the length of the planning horizon

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Least Total Cost Run Size for an MRP Schedule

WEEKS	QUANTITY ORDERED	CARRYING COST	ORDER COST	TOTAL COST	
1	50	$0.00	$47.00	$47.00	
1–2	110	3.00	47.00	50.00	
1–3	180	10.00	47.00	57.00	
1–4	240	19.00	47.00	66.00	1st order
1–5	335	38.00	47.00	85.00	← Least total cost
1–6	410	56.75	47.00	103.75	
1–7	470	74.75	47.00	121.75	
1–8	525	94.00	47.00	141.00	
6	75	0.00	47.00	47.00	
6–7	135	3.00	47.00	50.00	2nd order
6–8	190	8.50	47.00	55.50	← Least total cost

WEEK	NET REQUIREMENTS	PRODUCTION QUANTITY	ENDING INVENTORY	HOLDING COST	SETUP COST	TOTAL COST
1	50	335	285	$14.25	$47.00	$ 61.25
2	60	0	225	11.25	0.00	72.50
3	70	0	155	7.75	0.00	80.25
4	60	0	95	4.75	0.00	85.00
5	95	0	0	0.00	0.00	85.00
6	75	190	115	5.75	47.00	137.75
7	60	0	55	2.75	0.00	140.50
8	55	0	0	0.00	0.00	140.05

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MRP Processing

- Takes the end item requirements specified by the master schedule and "explode" them into time-phased requirements for assemblies, parts, and raw materials using the bill of materials offset by the lead times

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Developing MRP

Master Production Schedule for the next six periods							

		1	2	3	4	5	6
Product A		100	150	200	100	0	200
Component C			50	60			70

A
B 3   C 1
E 2   D 1 D 1   F 1
G 1

Product Structure
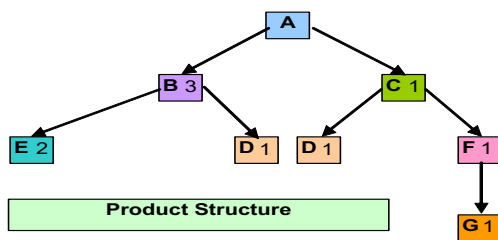
Component	On hand	Lead time	Lot size
A	150	1	LFL
B	1000	2	LFL
C	300	1	LFL
D	750	2	3 periods
E	1700	6	3 periods
F	200	1	400
G	500	3	500

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Product A

		Lot size	LFL
		Lead Time	1

	0	1	2	3	4	5	6
Gross Requirement		100	150	200	100		200
On hand Inventory	150	50	0	0	0	0	0
Net Requirement		0	100	200	100	0	200
Planned Receipts		0	100	200	100	0	200
Planned Order Releases		100	200	100	0	200	0

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Component B
BOM Qty 3 | | | | | | **Lot size** LFL / **Lead Time** 2

	0	1	2	3	4	5	6
Gross Requirement		300	600	300	0	600	0
On hand Inventory	1000	700	100	0	0	0	0
Net Requirement		0	0	200	0	600	0
Planned Receipts		0	0	200	0	600	0
Planned Order Releases		200	0	600	0	0	0

Component C
BOM Qty 1 | | | | | | **Lot size** LFL / **Lead Time** 1

	0	1	2	3	4	5	6
Gross Requirement		100	250	160	0	200	70
On hand Inventory	300	200	0	0	0	0	0
Net Requirement		0	50	160	0	200	70
Planned Receipts		0	50	160	0	200	70
Planned Order Releases		50	160	0	200	70	0

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Component D
BOM Qty 1 for B / 1 for C | | | | | | **Lot size** POQ-3 / **Lead Time** 2

	0	1	2	3	4	5	6
Gross Requirement		250	160	600	200	70	0
On hand Inventory	750	500	340	0	0	0	0
Net Requirement		0	0	260	200	70	0
Planned Receipts				530			
Planned Order Releases		530		0	0	0	0

Component E
BOM Qty 2 for B | | | | | | **Lot size** POQ-3 / **Lead Time** 6

	0	1	2	3	4	5	6
Gross Requirement		400	0	1200	0	0	0
On hand Inventory	1700	1300	1300	100	100	100	100
Net Requirement		0	0	0	0	0	0
Planned Receipts		0	0	0	0	0	0
Planned Order Releases		0	0	0	0	0	0

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MRP Core logic

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Capacity Requirements planning

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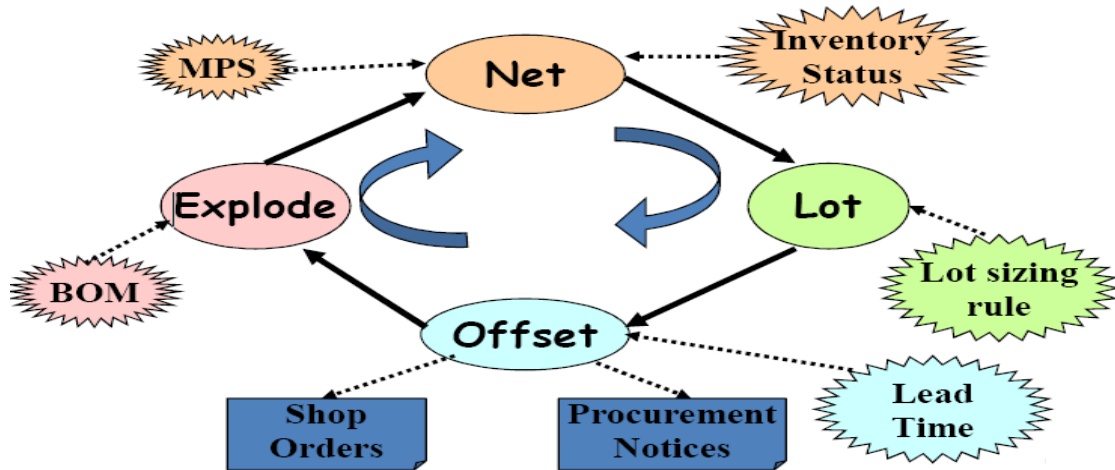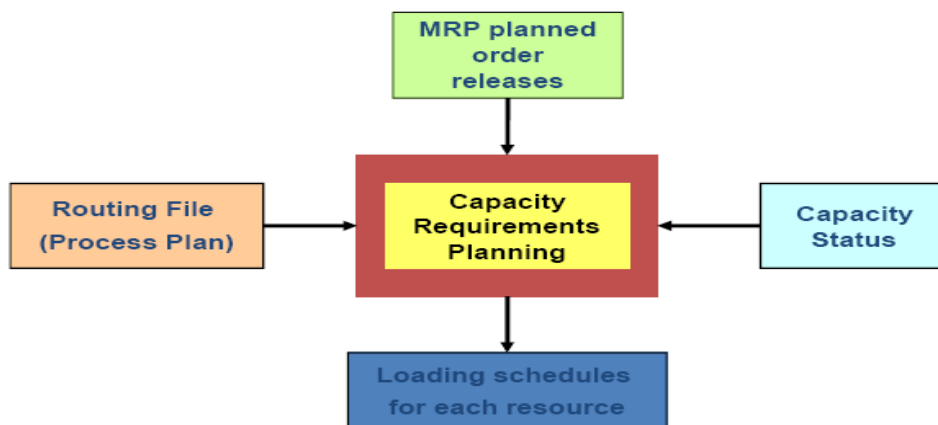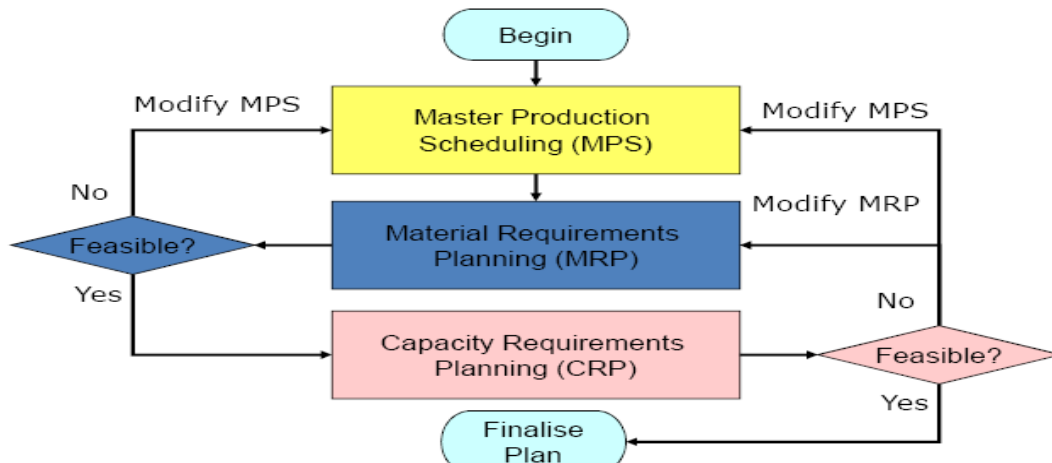
Comparison between MRP and CRP

Criteria for comparison	Material Requirements Planning (MRP)	Capacity Requirements Planning (CRP)
Input	Bill of Material (Product Structure)	Routing Information (Process Plan)
	MPS	MRP Schedules
	Lead time Data	Lead time Data
	Inventory Status	Capacity Status
	Lot Sizing Rules	
Output	Purchase Orders	Capacity loading schedules
	Work Orders	Capacity usage profiles

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MPS – MRP – CRP

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Manufacturing Requirements Planning (MRP II)

- Extension of MRP
- Plans all resources needed for running a business
- Variations include
  - Service Requirements Planning (SRP)
  - Business Requirements Planning (BRP)
  - Distribution Requirements Planning (DRP)

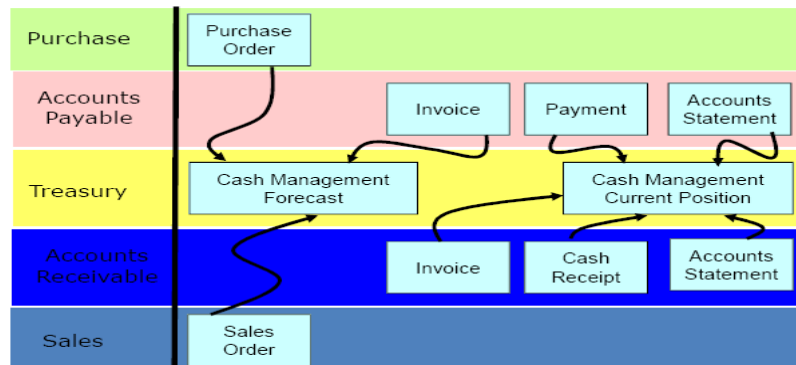2/13/19   208   **Institute of Management Technology** Hyderabad ...Harnessing Knowledge for Businesses

MRP II Modules

- Forecasting
- Customer order entry
- Production planning / Master Production Scheduling
- Product structure / Bill-of-Material processor
- Inventory control
- Material Requirements Planning
- Capacity planning
- Shop floor control
- Purchasing
- Accounting
- Financial analysis

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Enterprise Resource Planning (ERP)

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Typical modules of an ERP software

- Sales and distribution
- Production planning
- Accounts payable/receivable, treasury
- Operational (shop floor) control
- Purchasing
- Finance and cost control
- Human resources

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