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Chapter 14:
Material Requirements Planning (MRP) and Enterprise Resource Planning (ERP)

Learning Objectives:

- Develop a product structure
- Build a gross requirements plan
- Build a net requirements plan
- Determine lot sizes for lot-for-lot
- Describe MRP II
- Describe ERP

Materials Requirements Planning (MRP)

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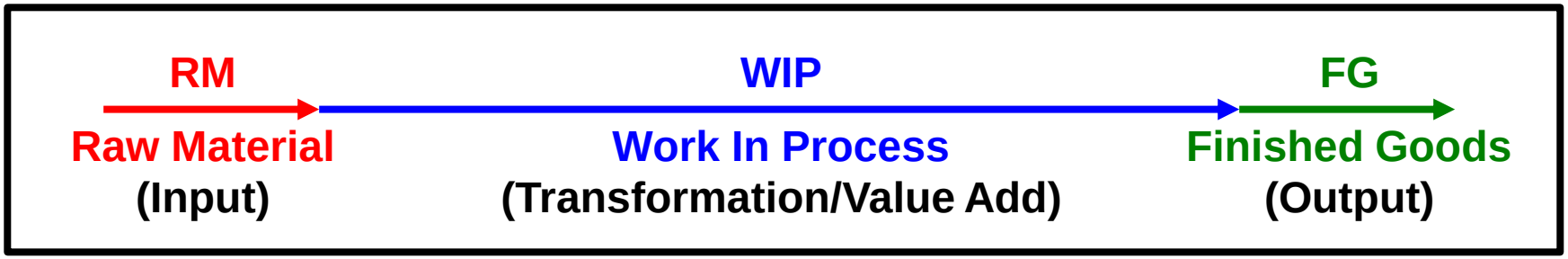
- Materials Requirements Planning (MRP): a dependent demand technique that uses a bill-of-material, inventory, expected receipts, and a master production schedule to determine material requirements

- Benefits of MRP
  - Better response to customer orders
  - Faster response to market changes
  - Improved utilization of facilities and labor
  - Reduced inventory levels

- Dependent demand: demand for one item related to the demand of another item

Types of Inventory



- Raw materials (RM): component parts, subassemblies, and supplies are inputs to manufacturing and service-delivery processes
- Work-in-process (WIP): partially finished products in various stages of completion that are awaiting further processing
- Finished goods (FG): completed products ready for distribution or sale to customers

Independent and Dependent Demands

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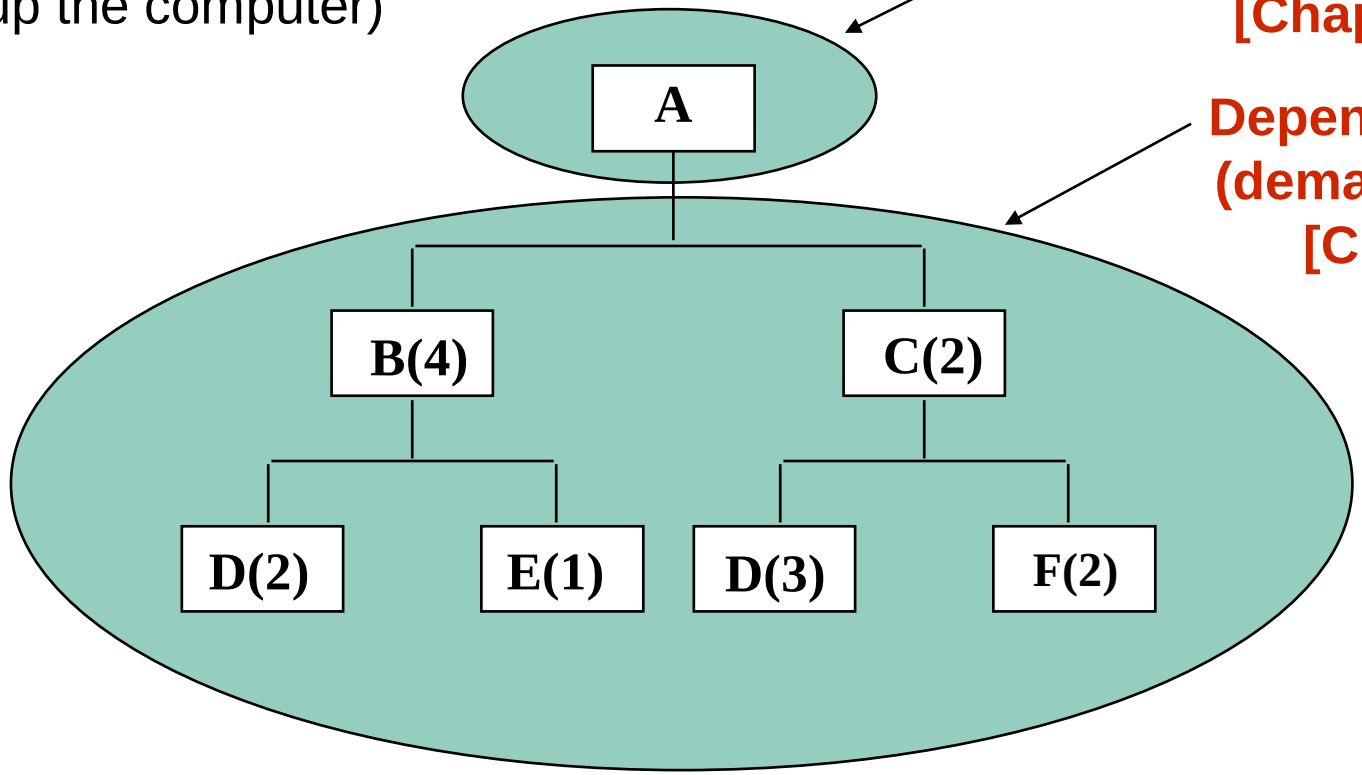
- Independent demand: finished goods, items that are ready to be sold (i.e., a computer)
- Dependent demand: components of finished products (i.e., parts that make up the computer)

Independent Demand (demand is *uncertain*) [Chapter 12]

Dependent Demand (demand is *certain*) [Chapter 14]



Independent vs Dependent Demand

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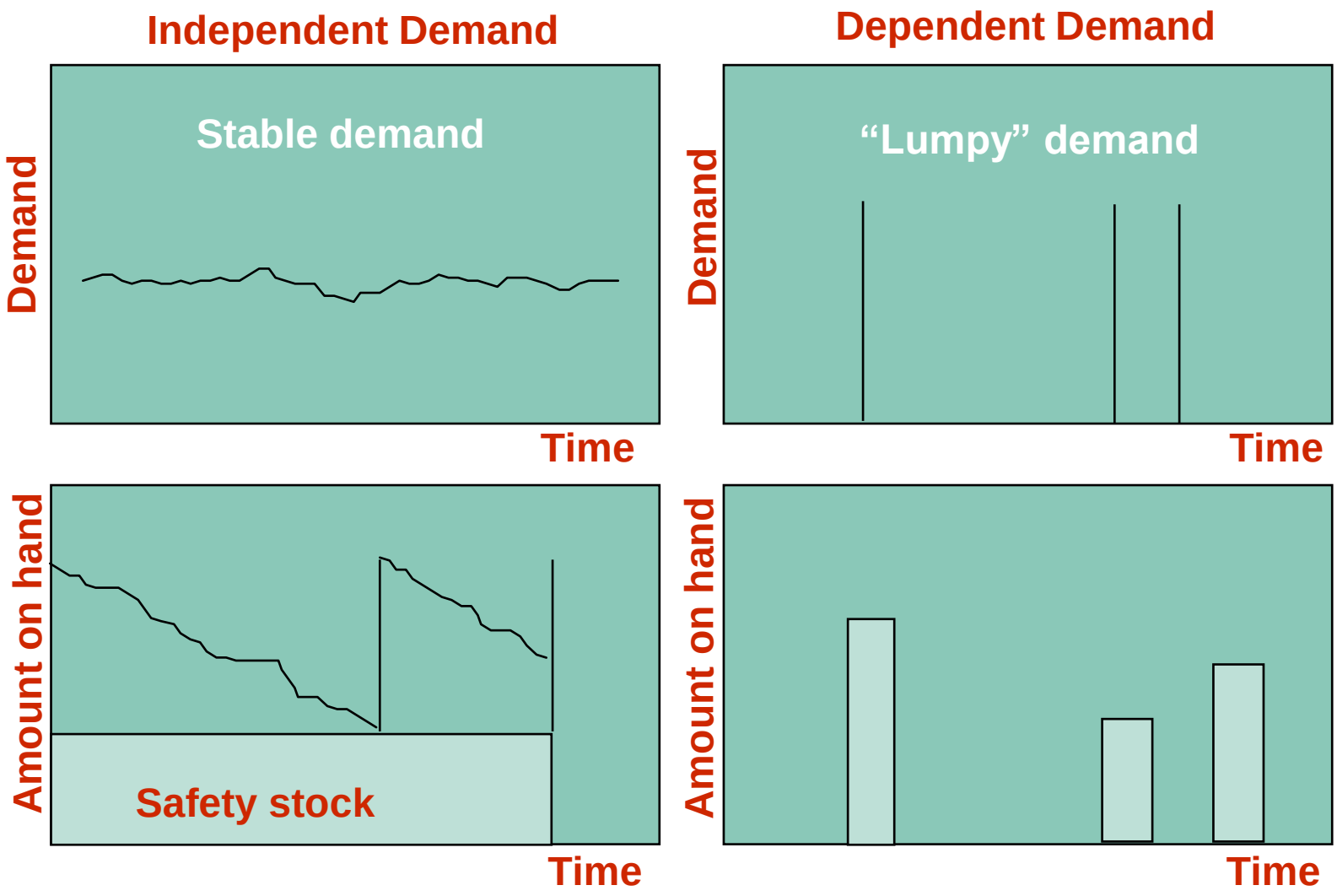
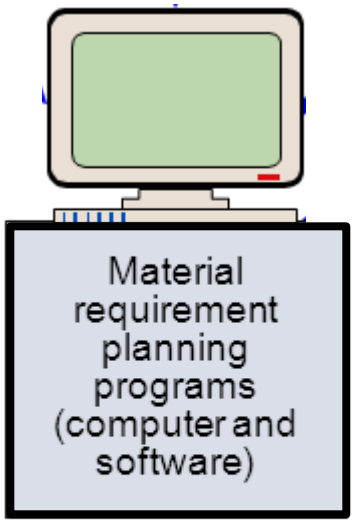
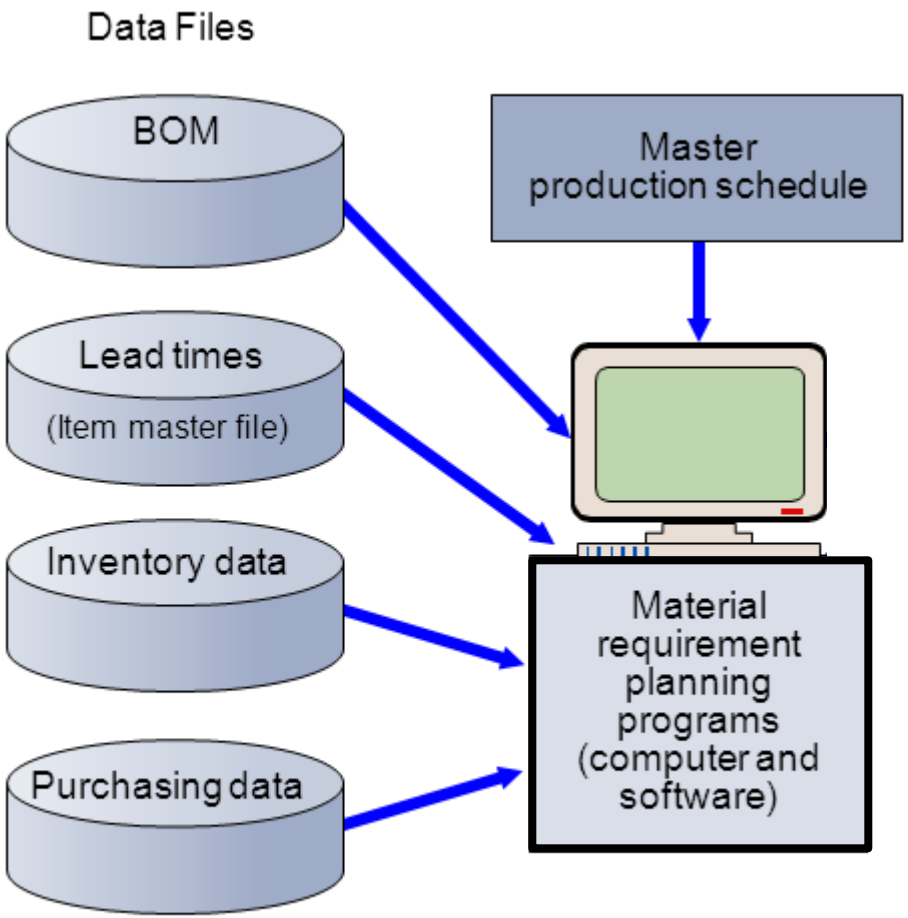


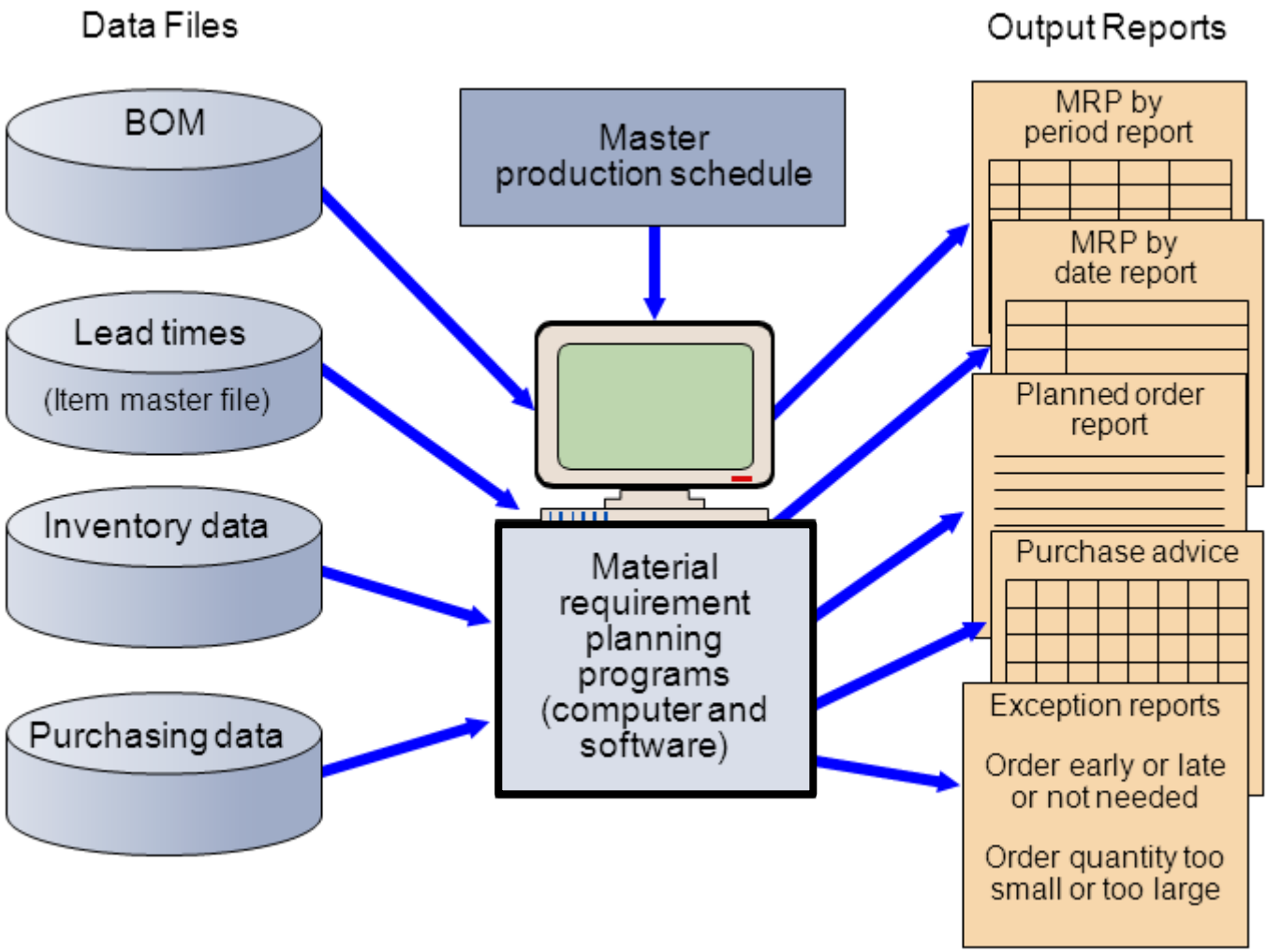
MRP Structure



MRP Structure



MRP Structure



MRP Inputs: Master Schedule

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- Master Production Schedule (MPS) (or, Master Schedule): One of primary inputs in MRP; states *what* is to be made (usually finished goods) and *when*

- Aggregate planning: development of a long-term output and resource plan in aggregate units of measure

- Disaggregation: the process of translating aggregate plans into short-term operations plans that provide the basis for weekly and daily schedules and details resource requirements

Aggregate Plan and Master Schedule

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- The Aggregate Plan is the basis for development of the Master Production Schedule

Months	January				February			
Aggregate Plan (Shows the total quantity of amplifiers)	1,500				1,200			
Weeks	1	2	3	4	5	6	7	8
Master Production Schedule (Shows the specific type and quantity of amplifier to be produced								
240-watt amplifier	100		100		100		100	
150-watt amplifier		500		500		450		450
75-watt amplifier			300				100	

Master Schdule:	240-watt amp	1	2	3	4	5	6	7	8	9	10	11
	Quantity	100		100		100		100				

MRP Inputs: Bill-of-Materials

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- Bill of Materials (BOM): One of the primary inputs of MRP; a listing of all of the components, their description and the quantity of each to make *one unit* of a product
- Product structure tree: Visual depiction of the requirements in a bill of materials, where all components are listed by levels

Hard Rock Cafe's Hickory BBQ Bacon Cheeseburger

DESCRIPTION	QTY
Bun	1
Hamburger patty	8 oz.
Cheddar cheese	2 slices
Bacon	2 strips
BBQ onions	1/2 cup
Hickory BBQ sauce	1 oz.
Burger set	
Lettuce	1 leaf
Tomato	1 slice
Red onion	4 rings
Pickle	1 slice
French fries	5 oz.
Seasoned salt	1 tsp.
11-inch plate	1
HRC flag	1

Chair Assembly:

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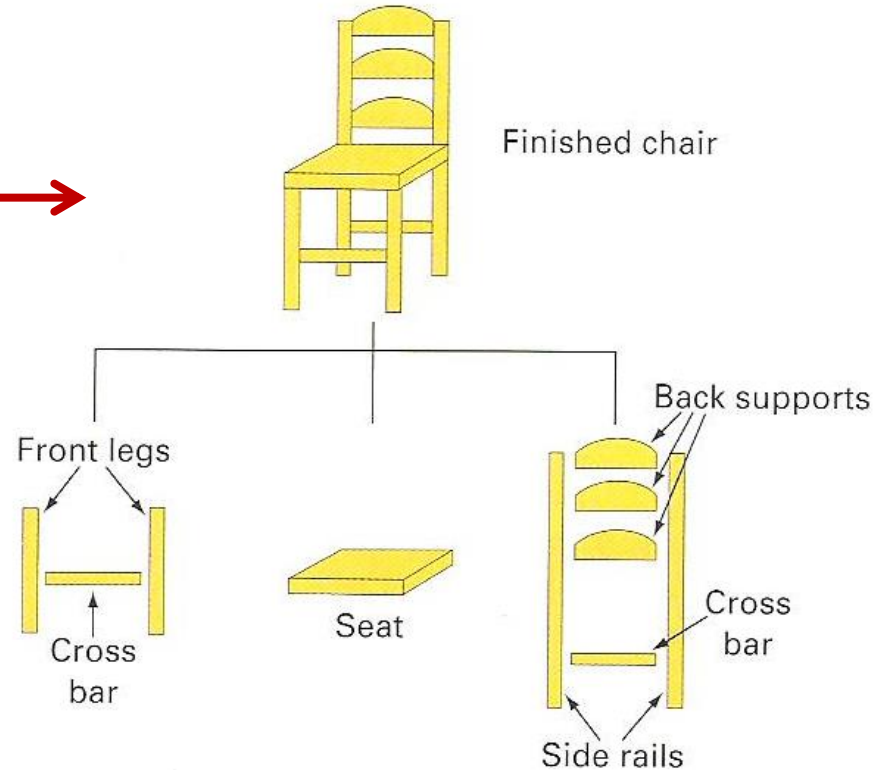
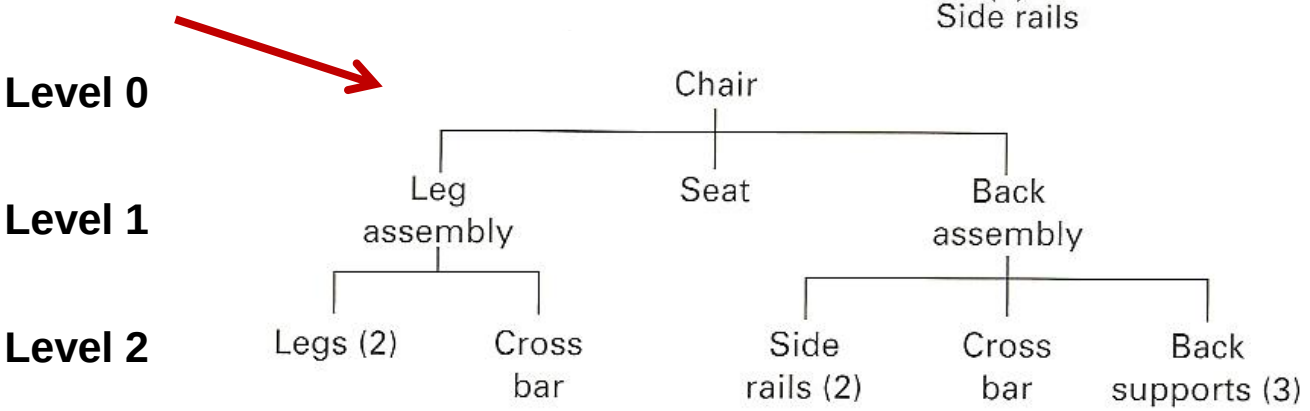
Assembly Diagram →



Product Structure Tree →



Brent's homework from 1998

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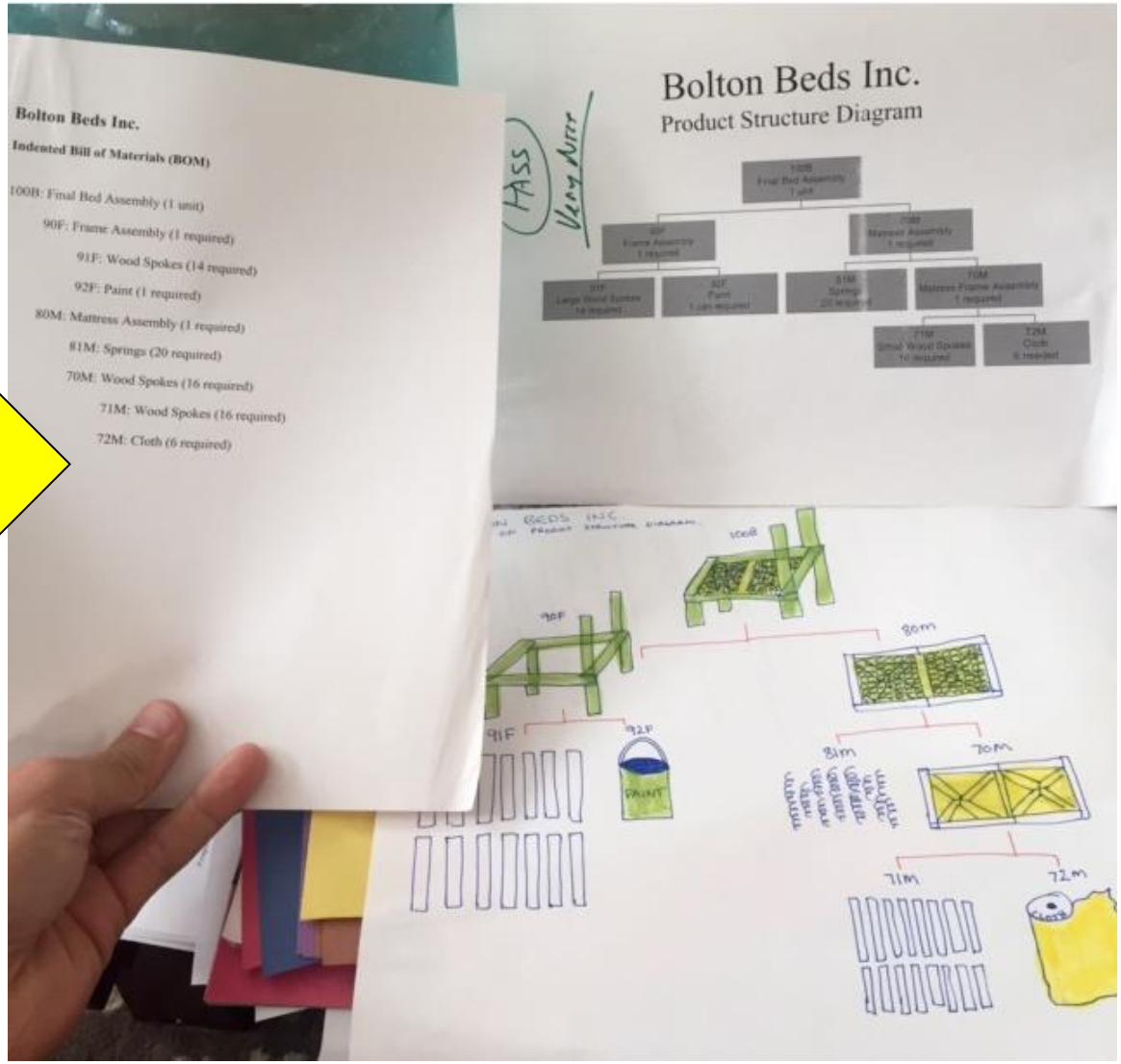

Bill of Materials (indented)

Product Structure Tree

Assembly Diagram

Product Structure Tree Example #1

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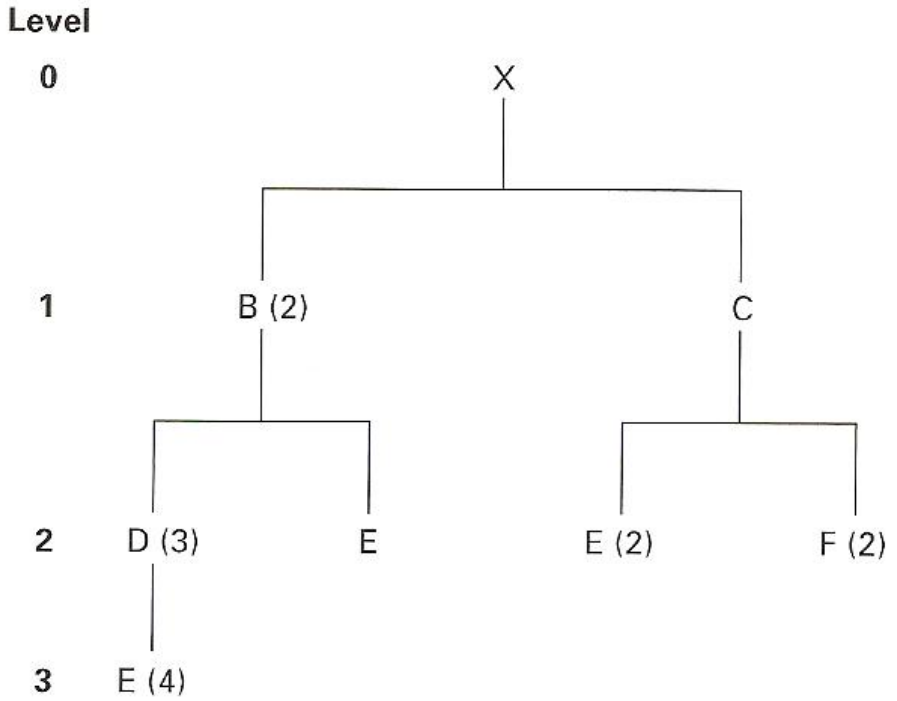
Use the information presented in the figure, determine the quantities of B, C, D, E and F needed to assemble one X



X = 1

B: (2 x X) = (2 x 1) = 2

C: (1 x X) = (1 x 1) = 1

D: (3 x B) = (3 x 2) = 6

F: (2 x C) = (2 x 1) = 2

E: (4 x D) + (1 x B) + (2 x C)
= (4 x 6) + (1 x 2) + (2 x 1)
= 24 + 2 + 2 =28

Product Structure Tree Example #2

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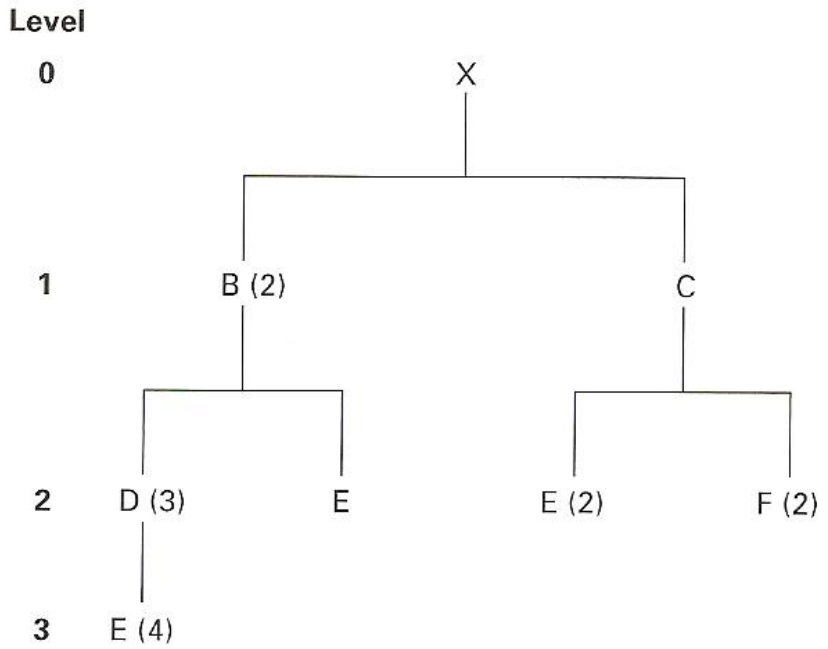
Use the information presented in the figure, determine the quantities of these components that will be required to assemble 10 Xs, taking into account the quantities on hand (inventory) of various components



X = 10

B: (2 x X) = (2 x 10) = 20 – 4 on hand = **16**

C: (1 x X) = (1 x 10) = 10 – 10 on hand = **0**

D: (3 x B) = (3 x 16) = 48 – 8 on hand = **40**

F: (2 x C) = (2 x 0) = 0

E: (4 x D) + (1 x B) + (2 x C)
= (4 x 40) + (1 x 16) + (2 x 0)
= 160 + 16 + 0 = 176 – 60 **= 116**

Component	On Hand
B	4
C	10
D	8
E	60

MRP Inputs: Inventory Records

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- One of the primary inputs in MRP

- Inventory records includes information on the status of each item by time period
  - Gross requirements
  - Scheduled receipts
  - Amount on hand
  - Lead times
  - Lot sizes

MRP Processing

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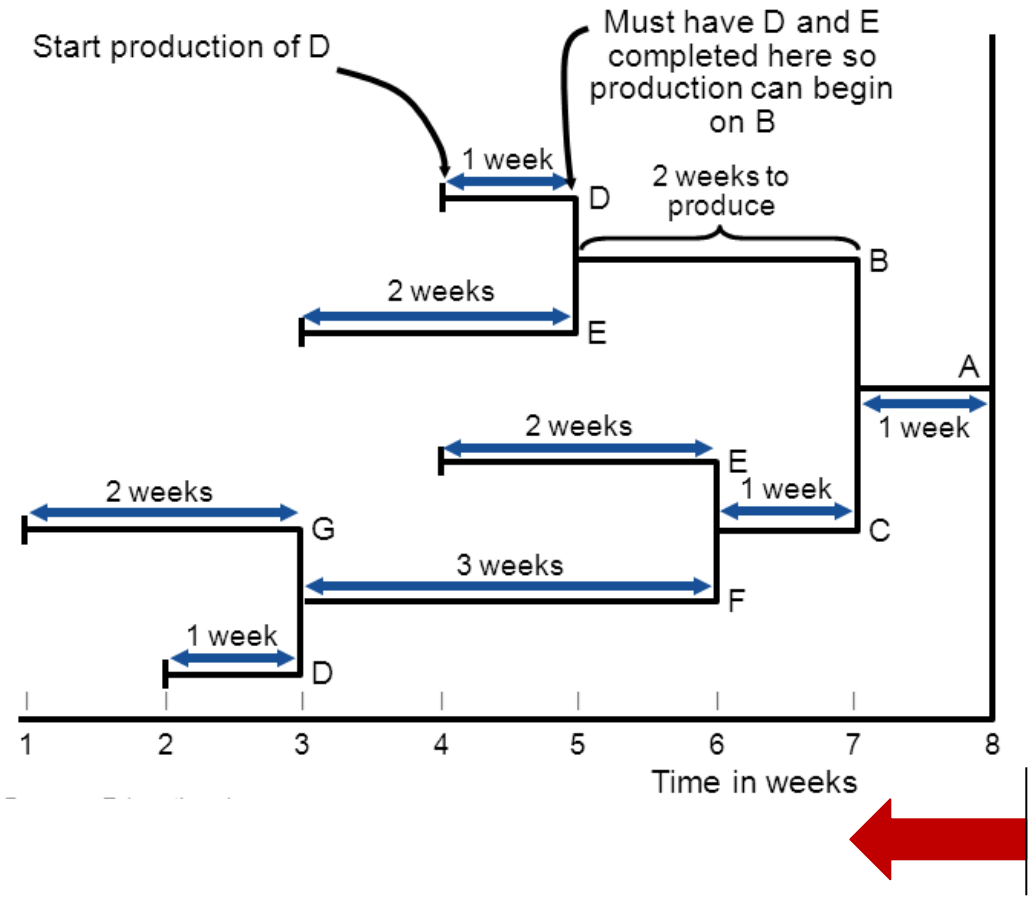
- MRP processing takes the end item requirements specified by the master schedule and “explodes” them into time-phased requirements for assemblies, parts and raw materials
  - Uses Bill of Materials offset by lead time



MRP Explosion

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- MRP explosion is the process of using the logic of dependent demand to calculate the quantity and timing of orders for all subassemblies and components that go into and support the production of finished goods

- Lot sizing is the process of determining the appropriate amount and timing of ordering to reduce costs
  - There are three common lot sizing methods for MRP:
    - Lot-for-lot (LFL): An ordering schedule that covers the gross requirements for each week
    - Fixed order quantity (FOQ): uses a fixed order size for every order or production run
    - Periodic order quantity (POQ): orders a quantity equal to the gross requirement quantity in one or more predetermined time periods minus the projected on-hand quantity of the previous time period

MRP Processing

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- The determination of the net requirements (netting) is the core of MRP processing
- **Net Requirements** = Gross Requirements – Available Inventory
  - Gross Requirements = Total expected demand
  - Available inventory = Projected on hand – ~~Safety Stock~~ – ~~Inventory allocated to other items~~
  - Projected on Hand = Projected On Hand inventory + Scheduled Receipts

Therefore….

Net requirements = Gross Requirements – Projected on Hand

MRP Processing

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Said another way……

- Gross Requirements (total demand for a product)
- Scheduled Receipts (on order, could be a make/manufactured or buy/purchased product)
- Projected on Hand (product already in inventory/on hand)
- Net Requirements (remaining total to make or buy)

EXAMPLE

- Gross Requirements = 200
- On order = 75
- On hand = 35
  - Net Requirements = 200 – 75 – 35 = 90

MRP Processing

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MRP Schedule Forms posted on www.OperationsUniversity.Org

Item	1	2	3	4	5	6	7	8	9	10	11
Quantity											

Item: LT = Lot Size:	Beg Inv	1	2	3	4	5	6	7	8	9	10	11
Gross Requirements												
Scheduled Receipts												
Projected on Hand												
Net Requirements												
Planned Order Receipts												
Planned Order Releases												

- Gross requirements: total expected demand
- Scheduled receipts: Open orders scheduled to arrive
- Projected on hand: Expected inventory on hand at the beginning of each time period
- Net requirements: Actual amount needed in each time period
- Planned-order receipts: Quantity expected to received at the beginning of the period
- Planned-order releases: Planned amount to be order in each time period; planned-order receipts offset by lead time

MRP Processing Example #1

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- A firm that produces wood shutters and bookcases has received two orders for shutters: one for 100 shutters and one for 150 shutters. The 100-unit order is due for delivery at the start of week 4 and the 150-unit order is due for delivery at the start of week 8. Each shutter consists of two frames and four slatted wood sections. The wood sections are made by the firm and fabrication takes one week. The frames are ordered, and lead time is two weeks. Assembly of the shutters requires one week. There is a scheduled receipt of 70 wood sections in (i.e., at the beginning) of week 1. Determine the size and timing of planned order releases necessary to meet delivery requirements under each of these conditions:

  a. Lot-for-lot ordering (i.e., order size equal to net requirements)

MRP Processing Example #1
Summary of information provided

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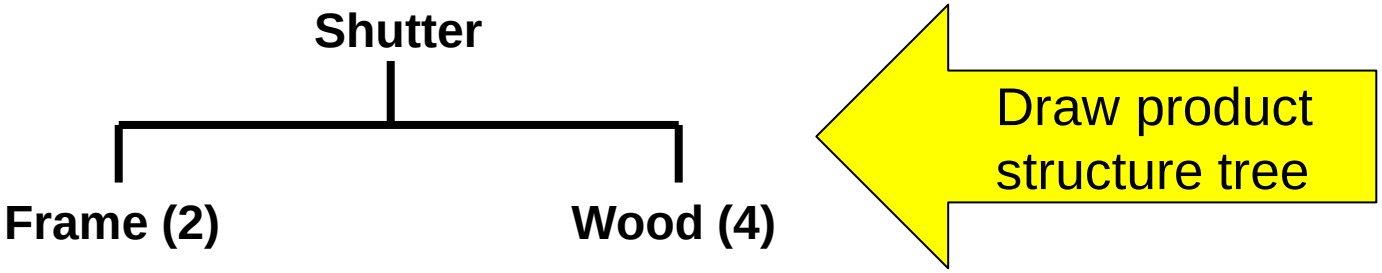
- Orders for shutters:
  - One for 100 shutters, due week 4
  - One for 150 shutters, due week 8
- Each shutter consists of two frames and four slatted wood sections



- Wood sections are made by the firm, fabrication takes one week
- Frames are ordered, and lead time is two weeks
- Assembly of the shutters requires one week
- There is a scheduled receipt of 70 wood sections in week 1
- Determine the size and timing of planned order releases necessary to meet these conditions:

a. Lot-for-lot ordering (i.e., order size equal to net requirements)

b. Lot size: Frames = 320 units, wood = 70 units

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MRP Example 1a (Lot-For-Lot)

STEPS:

1. **Start with Blank MRP form**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity								

Item: Shutters	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Frames (2)	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4)	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1a (Lot-For-Lot)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Frames (2)	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4)	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1a (Lot-For-Lot)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters LT = 1 wk Lot Size: LFL	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements									
Scheduled Receipts									
Projected on Hand									
Net Requirements									
Planned Order Receipts									
Planned Order Releases									

Item: Frames (2) LT = 2 wk Lot Size: LFL	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements									
Scheduled Receipts									
Projected on Hand									
Net Requirements									
Planned Order Receipts									
Planned Order Releases									

Item: Wood Section (4) LT = 1 wk Lot Size: LFL	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements									
Scheduled Receipts		70							
Projected on Hand									
Net Requirements									
Planned Order Receipts									
Planned Order Releases									

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MRP Example 1a (Lot-For-Lot)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				150
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements										
Scheduled Receipts			70							
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1a (Lot-For-Lot)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**
5. **Process shutter requirements for first order**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				
Scheduled Receipts						0				
Projected on Hand						0				
Net Requirements						100				
Planned Order Receipts						100				
Planned Order Releases					100					

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements										
Scheduled Receipts			70							
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1a (Lot-For-Lot)

STEPS:

1. Start with Blank MRP form
2. Fill in Master Schedule info
3. Fill in information given in problem
4. Flow down Master Schedule info
5. Process shutter requirements for first order
6. Flow down shutter requirements to Frames & Wood and process requirements

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				
Scheduled Receipts						0				
Projected on Hand						0				
Net Requirements						100				
Planned Order Receipts						100				
Planned Order Releases					100					

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements					200^{S}					
Scheduled Receipts					0					
Projected on Hand					0					
Net Requirements					200					
Planned Order Receipts					200					
Planned Order Releases			200							

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements					400^{S}					
Scheduled Receipts			70		0					
Projected on Hand			70	70	70					
Net Requirements					330					
Planned Order Receipts					330					
Planned Order Releases				330						

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MRP Example 1a (Lot-For-Lot)

STEPS:

1. Start with Blank MRP form
2. Fill in Master Schedule info
3. Fill in information given in problem
4. Flow down Master Schedule info
5. Process shutter requirements for first order
6. Flow down shutter requirements to Frames & Wood and process requirements
7. Process requirements for second order

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				150
Scheduled Receipts						0				0
Projected on Hand						0				0
Net Requirements						100				150
Planned Order Receipts						100				150
Planned Order Releases					100				150	

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements					200^{S}				300^{S}	
Scheduled Receipts					0				0	
Projected on Hand					0				0	
Net Requirements					200				300	
Planned Order Receipts					200				300	
Planned Order Releases			200				300			

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements					400^{S}				600^{S}	
Scheduled Receipts			70		0				0	
Projected on Hand			70	70	70				0	
Net Requirements					330				600	
Planned Order Receipts					330				600	
Planned Order Releases				330				600		

MRP Processing Example #1
Summary of information provided

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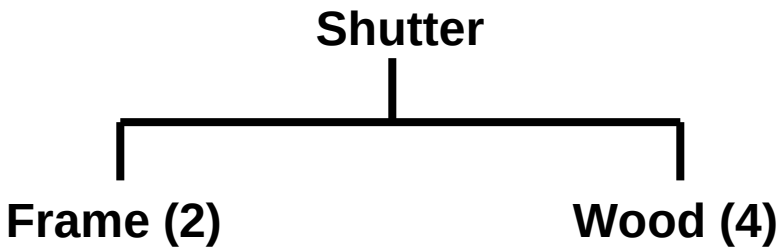
- Orders for shutters:
  - One for 100 shutters, due week 4
  - One for 150 shutters, due week 8
- Each shutter consists of two frames and four slatted wood sections



- Wood sections are made by the firm, fabrication takes one week
- Frames are ordered, and lead time is two weeks
- Assembly of the shutters requires one week
- There is a scheduled receipt of 70 wood sections in week 1
- Determine the size and timing of planned order releases necessary to meet these conditions:
  a. Lot-for-lot ordering (i.e., order size equal to net requirements)
  b. Lot size: Frames = 320 units, wood = 70 units

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MRP Example 1b (Lot Sizes)

STEPS:

1. **Start with Blank MRP form**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity								

Item: Shutters Lot Size:	LT	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Frames (2) Lot Size:	LT	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4) Lot Size:	LT	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1b (Lot Sizes)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Frames (2)	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4)	LT	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:										
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1b (Lot Sizes)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters LT = 1 wk Lot Size: LFL	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements									
Scheduled Receipts									
Projected on Hand									
Net Requirements									
Planned Order Receipts									
Planned Order Releases									

Item: Frames (2) LT = 2 wk Lot Size: 320	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements									
Scheduled Receipts									
Projected on Hand									
Net Requirements									
Planned Order Receipts									
Planned Order Releases									

Item: Wood Section (4) LT = 1 wk Lot Size: 70	Beg Inv	1	2	3	4	5	6	7	8
Gross Requirements									
Scheduled Receipts		70							
Projected on Hand									
Net Requirements									
Planned Order Receipts									
Planned Order Releases									

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MRP Example 1b (Lot Sizes)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				150
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	320									
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	70									
Gross Requirements										
Scheduled Receipts			70							
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1b (Lot Sizes)

STEPS:

1. Start with Blank MRP form
2. Fill in Master Schedule info
3. Fill in information given in problem
4. Flow down Master Schedule info
5. Process shutter requirements for first order

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				
Scheduled Receipts						0				
Projected on Hand						0				
Net Requirements						100				
Planned Order Receipts						100				
Planned Order Releases					100					

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	320									
Gross Requirements										
Scheduled Receipts										
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	70									
Gross Requirements										
Scheduled Receipts			70							
Projected on Hand										
Net Requirements										
Planned Order Receipts										
Planned Order Releases										

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MRP Example 1b (Lot Sizes)

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**
5. **Process shutter requirements for first order**
6. **Flow down shutter requirements to Frames & Wood and process requirements [Wood rqmt: 330/70 = 4.7, so order 5 lots: 5x70=350]**

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				
Scheduled Receipts						0				
Projected on Hand						0				
Net Requirements						100				
Planned Order Receipts						100				
Planned Order Releases					100					

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	320									
Gross Requirements					200^{S}					
Scheduled Receipts					0					
Projected on Hand					0	120				
Net Requirements					200					
Planned Order Receipts					320					
Planned Order Releases			320							

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	70									
Gross Requirements					400^{S}					
Scheduled Receipts			70		0					
Projected on Hand			70	70	70	20				
Net Requirements					330					
Planned Order Receipts					350					
Planned Order Releases				350						

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MRP Example 1b (Lot Sizes)

STEPS: 1. Start with Blank MRP form

2. **Fill in Master Schedule**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**
5. **Process shutter requirements for first order**
6. **Flow down shutter requirements to Frames & Wood and process requirements**
7. **Process requirements for second order**

[Wood rqmt: 580/70 = 8.3, so order 9 lots: 9x70=630]

Master Schedule:	Item: Shutters	1	2	3	4	5	6	7	8
	Quantity				100				150

Item: Shutters	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	LFL									
Gross Requirements						100				150
Scheduled Receipts						0				0
Projected on Hand						0				0
Net Requirements						100				150
Planned Order Receipts						100				150
Planned Order Releases					100				150	

Item: Frames (2)	LT = 2 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	320									
Gross Requirements					200^{S}				300^{S}	
Scheduled Receipts					0				0	
Projected on Hand					0	120	120	120	120	140
Net Requirements					200				180	
Planned Order Receipts					320				320	
Planned Order Releases			320				320			

Item: Wood Section (4)	LT = 1 wk	Beg Inv	1	2	3	4	5	6	7	8
Lot Size:	70									
Gross Requirements					400^{S}				600^{S}	
Scheduled Receipts			70		0				0	
Projected on Hand			70	70	70	20	20	20	20	50
Net Requirements					330				580	
Planned Order Receipts					350				630	
Planned Order Releases				350				630		

MRP Example #2

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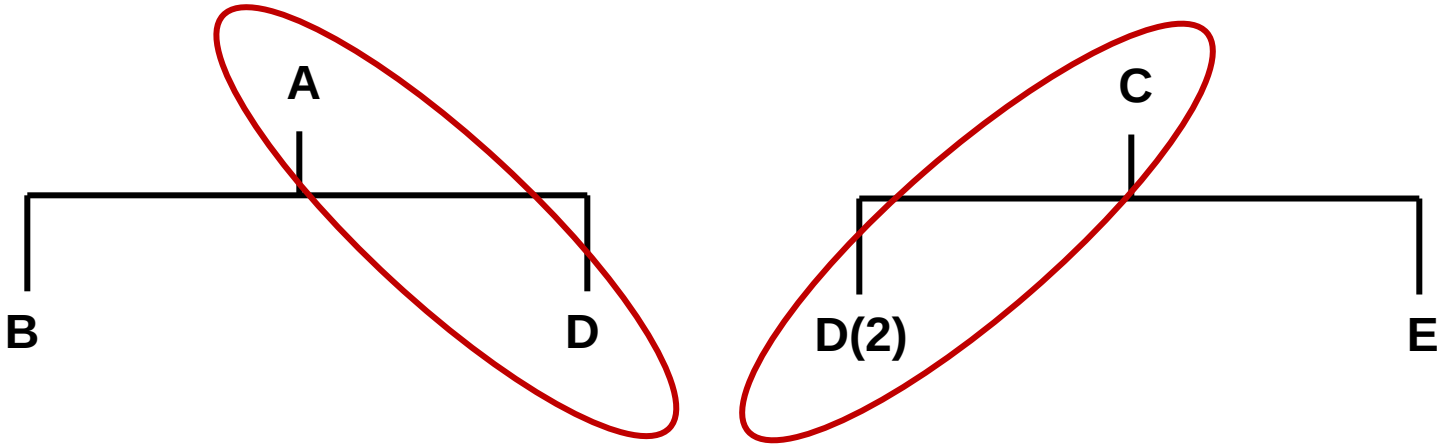
- Consider the two product structure trees shown, note that both products have D as a component. Suppose we want to develop a material requirements plan for D given this information: there is a beginning inventory of 110 units of D on hand, and all items have lead times of one week. The master schedule calls for 80 units of A in week 4 and 50 units of C in week 5.



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MRP Example 2

STEPS:

1. **Start with Blank MRP form**

Master Schedule:	Item	1	2	3	4	5	6

Item:	LT	Beg Inv	1	2	3	4	5	6
Lot Size:								
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item:	LT	Beg Inv	1	2	3	4	5	6
Lot Size:								
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item:	LT	Beg Inv	1	2	3	4	5	6
Lot Size:								
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

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MRP Example 2

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**

Master Schedule:	Item	1	2	3	4	5	6
	Quantity of A				80		
	Quantity of C					50	

Item:	LT	Beg Inv	1	2	3	4	5	6
Lot Size:								
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item:	LT	Beg Inv	1	2	3	4	5	6
Lot Size:								
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item:	LT	Beg Inv	1	2	3	4	5	6
Lot Size:								
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

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MRP Example 2

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**

Master Schedule:	Item	1	2	3	4	5	6
	Quantity of A				80		
	Quantity of C					50	

Item: A Lot Size:	LT = 1 LFL	Beg Inv	1	2	3	4	5	6
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item: C Lot Size:	LT = 1 LFL	Beg Inv	1	2	3	4	5	6
Gross Requirements								
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item: D (A:x1, C:x2) Lot Size:	LT = 1 LFL	Beg Inv	1	2	3	4	5	6
Gross Requirements								
Scheduled Receipts								
Projected on Hand		**110**						
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

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MRP Example 2

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**

Master Schedule:	Item	1	2	3	4	5	6
	Quantity of A				80		
	Quantity of C					50	

Item: A	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements						80		
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item: C	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements							50	
Scheduled Receipts								
Projected on Hand								
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

Item: D (A:x1, C:x2)	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements								
Scheduled Receipts								
Projected on Hand		**110**						
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

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MRP Example 2

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**
5. **Process requirements for both A and C**

Master Schedule:	Item	1	2	3	4	5	6
	Quantity of A				80		
	Quantity of C					50	

Item: A	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements						80		
Scheduled Receipts						0		
Projected on Hand						0		
Net Requirements						80		
Planned Order Receipts						80		
Planned Order Releases					80			

Item: C	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements							50	
Scheduled Receipts							0	
Projected on Hand							0	
Net Requirements							50	
Planned Order Receipts							50	
Planned Order Releases						50		

Item: D (A:x1, C:x2)	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements								
Scheduled Receipts								
Projected on Hand		110						
Net Requirements								
Planned Order Receipts								
Planned Order Releases								

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MRP Example 2

STEPS:

1. **Start with Blank MRP form**
2. **Fill in Master Schedule info**
3. **Fill in information given in problem**
4. **Flow down Master Schedule info**
5. **Process requirements for both A and C**
6. **Process requirements for D to support A**

	Quantity of A				80		
	Quantity of C					50	

Item: A	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements						80		
Scheduled Receipts						0		
Projected on Hand						0		
Net Requirements						80		
Planned Order Receipts						80		
Planned Order Releases					80			

Item: C	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements							50	
Scheduled Receipts							0	
Projected on Hand							0	
Net Requirements							50	
Planned Order Receipts							50	
Planned Order Releases						50		

Item: D (A:x1, C:x2)	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements					80[A]			
Scheduled Receipts					0			
Projected on Hand		110	110	110	110	30		
Net Requirements					-30			
Planned Order Receipts					0			
Planned Order Releases				0				

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MRP Example 2

STEPS:

1. Start with Blank MRP form
2. Fill in Master Schedule info
3. Fill in information given in problem
4. Flow down Master Schedule info
5. Process requirements for both A and C
6. Process requirements for D to support A
7. Process requirements for D to support C

Master Schedule:	Item	1	2	3	4	5	6
	Quantity of A				80		
	Quantity of C					50	

Item: A	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements						80		
Scheduled Receipts						0		
Projected on Hand						0		
Net Requirements						80		
Planned Order Receipts						80		
Planned Order Releases					80			

Item: C	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements							50	
Scheduled Receipts							0	
Projected on Hand							0	
Net Requirements							50	
Planned Order Receipts							50	
Planned Order Releases						50		

Item: D (A:x1, C:x2)	LT = 1	Beg Inv	1	2	3	4	5	6
Lot Size:	LFL							
Gross Requirements					80[A]	100[C]		
Scheduled Receipts					0	0		
Projected on Hand		110	110	110	110	30		
Net Requirements					-30	70		
Planned Order Receipts					0	70		
Planned Order Releases				0	70			

MRP Example #2: Calculated Algebraically w/out the MRP Matrix

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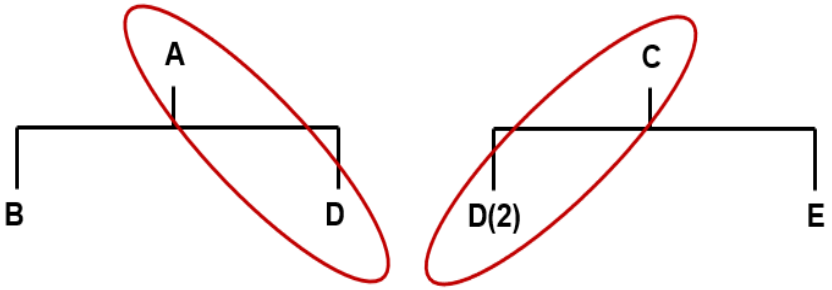
- Gross Requirements:
  - 80 units of A (1x D per Item A)
  - 50 units of C (2x D per Item C)



- Beginning inventory of 110 units of D on hand

THEREFORE

- 80 units of A (1x D per Item A) = 80
- 50 units of C (2x D per Item C) = 100
  - **Gross Requirements of D = 180**
- 110 units of D on hand = -110
  - **Net Requirements of D = 70**

MRP Processing: Updating the System

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- Regenerative system: approach that updates MRP records *periodically*
  - Best suited to fairly stable systems
  - Requires data accuracy 90% or better

- Net-change system: approach that updates MRP records *continuously*
  - Best suited to systems that have frequent changes
  - Requires data accuracy of 99% or better

MRP Outputs: Reports

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- Primary Reports:
  - Planned orders: schedule indicating the amount and timing of future orders
  - Order releases: authorization for the execution of planned orders
  - Changes: revisions of due dates or order quantities, or cancellations of orders

- Secondary Reports:
  - Performance-control reports: evaluation of system operation, including deviations from plans and cost information
  - Planning reports: data useful for assessing future material requirements
  - Exception reports: date on any major discrepancies encountered

MRP in Services

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- Food catering service
  - End item → catered food
  - Dependent demand → ingredients for each recipe, i.e. bill of materials

- Hotel renovation
  - Activities and materials “exploded” into component parts for cost estimation and scheduling

Benefits and Requirements of MRP

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- Benefits of MRP
  - Low levels of in-process inventories
  - Ability to track material requirements
  - Ability to evaluate capacity requirements
  - Means of allocating production time
  - Ability to easily determine inventory usage by back-flushing

- Requirements of MRP
  - Computer and necessary software
  - Accurate and up-to-date Master schedules, Bills of materials, Inventory records
  - Integrity of data

Evolution of MRP

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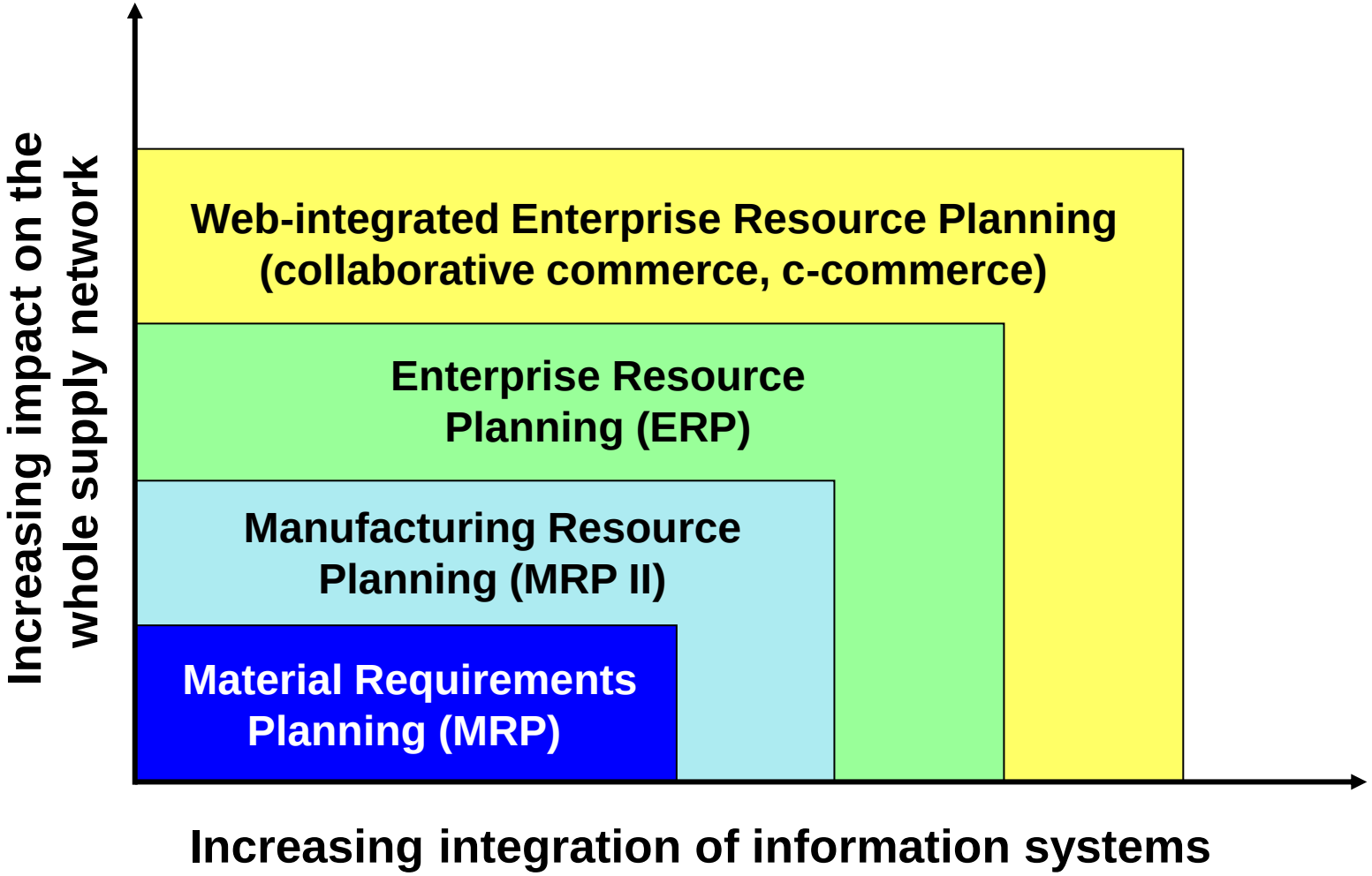

Capacity Planning

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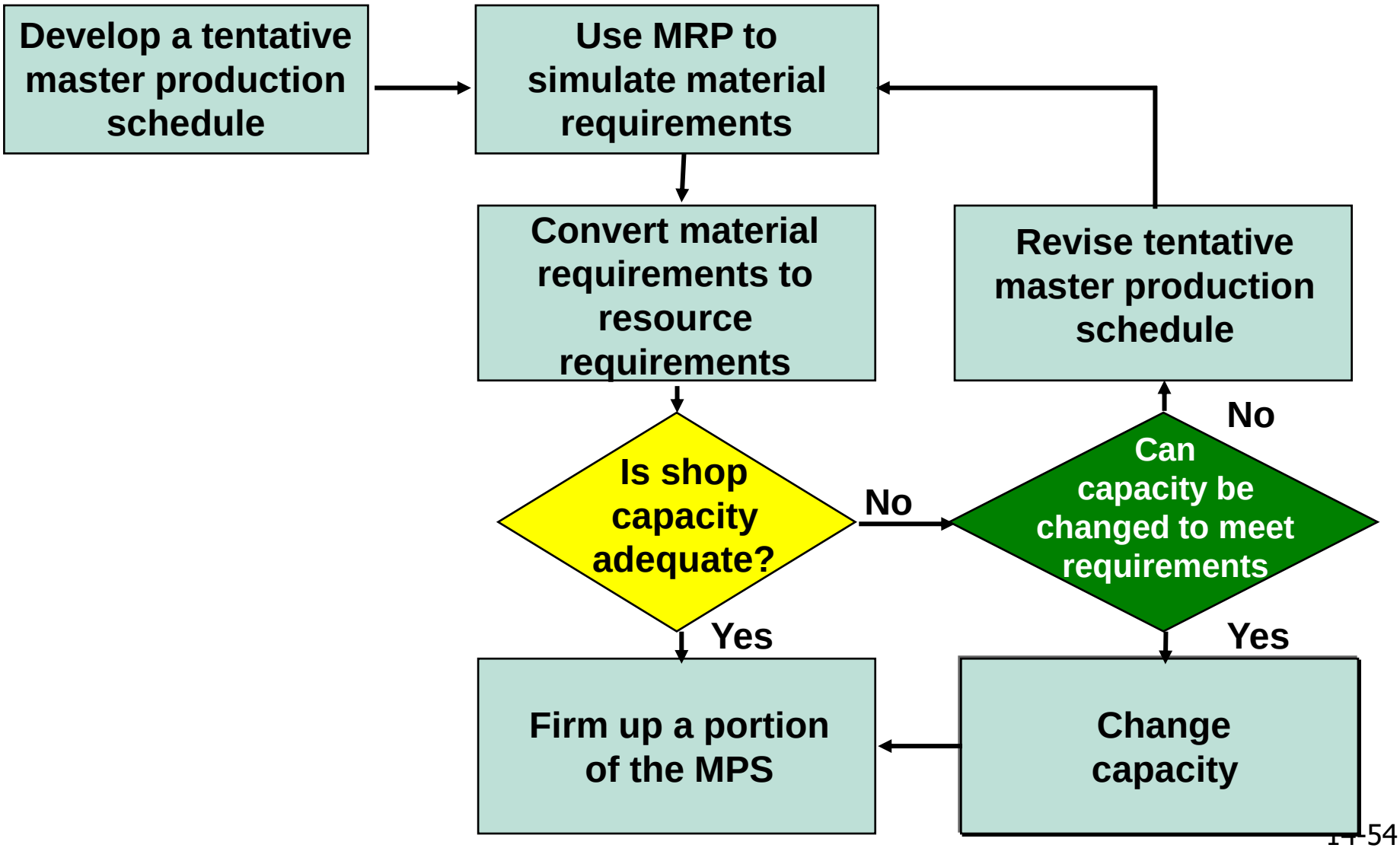
- Basic MRP **does not** consider capacity limitations so Capacity Requirements Planning (MRP II) addresses this issue

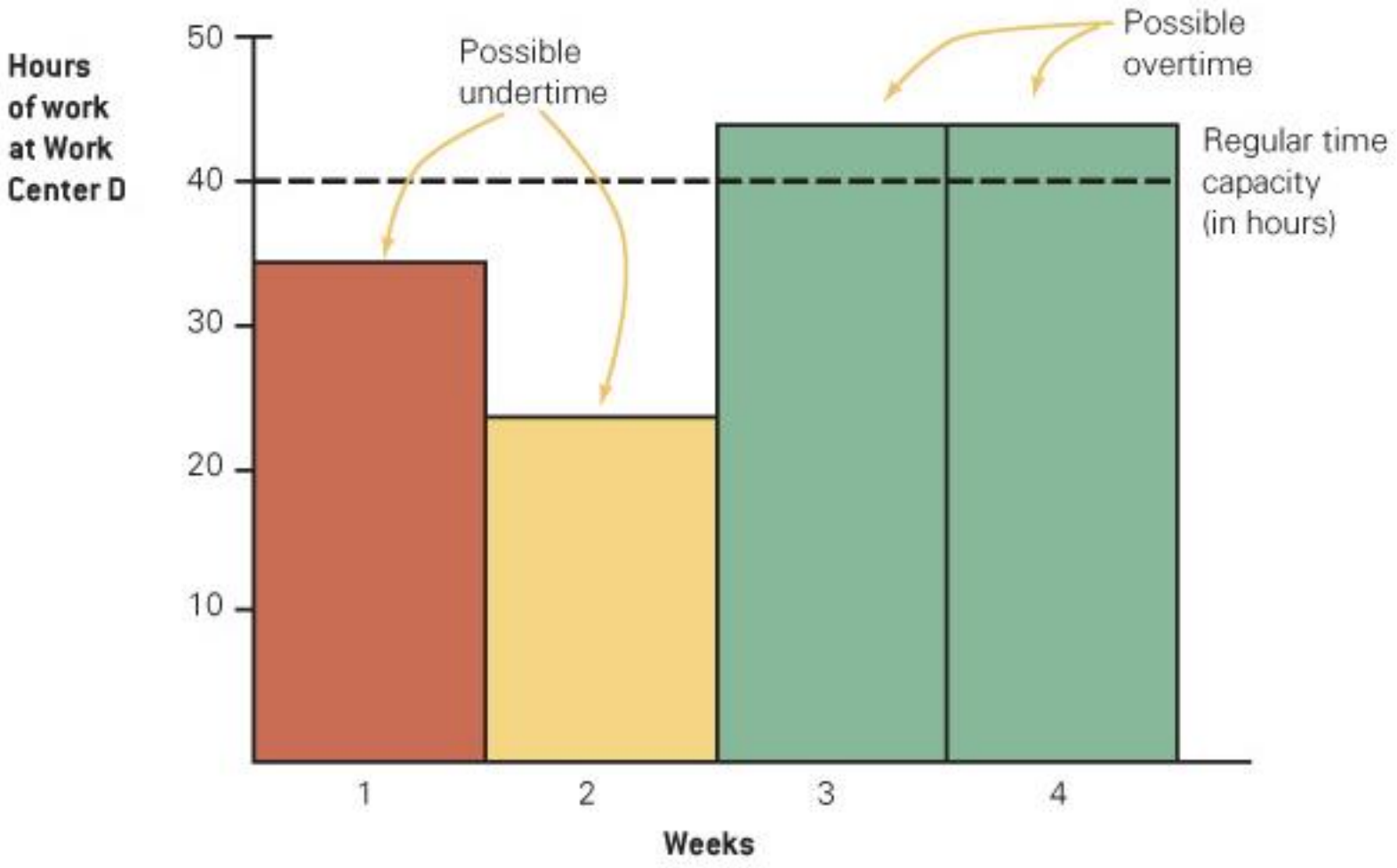
- Capacity Requirements Planning (CRP): is the process of determining the amount of *labor* and *machine* resources required to accomplish the tasks of production on a more detailed level, taking into account all component parts and end items in the materials plan

  - Load reports: department or work center reports that compare known and expected future capacity requirements with projected capacity availability

Capacity Planning



Example Load Report



Enterprise Resource Planning (ERP)

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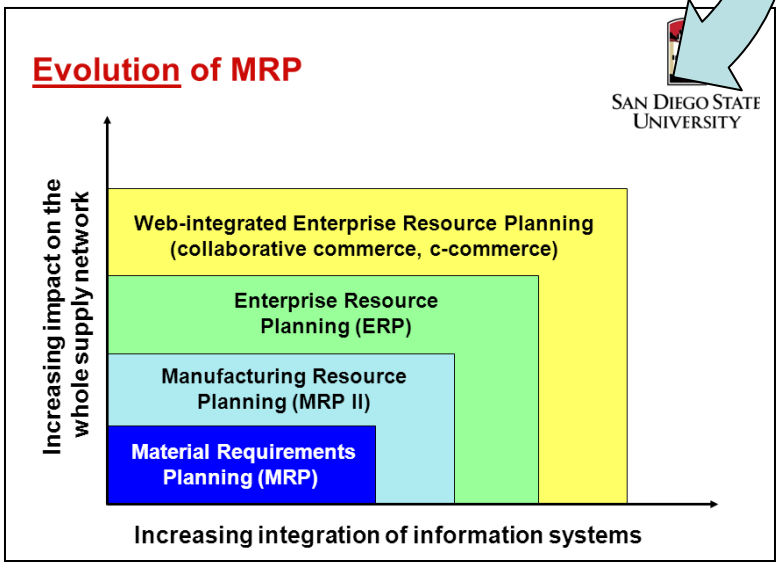
- Enterprise Resource Planning (ERP): integration of financial, manufacturing, and human resources on a single computer system
  - Next step in an evolution that began with MRP
- ERP software provides a system to capture and make data available in real time to decision makers and other users in the organization
- Provides tools for planning and monitoring various business processes
- ERP strategy considerations
  - High initial cost
  - High cost to maintain
  - Future upgrades
  - Training



MRP and ERP

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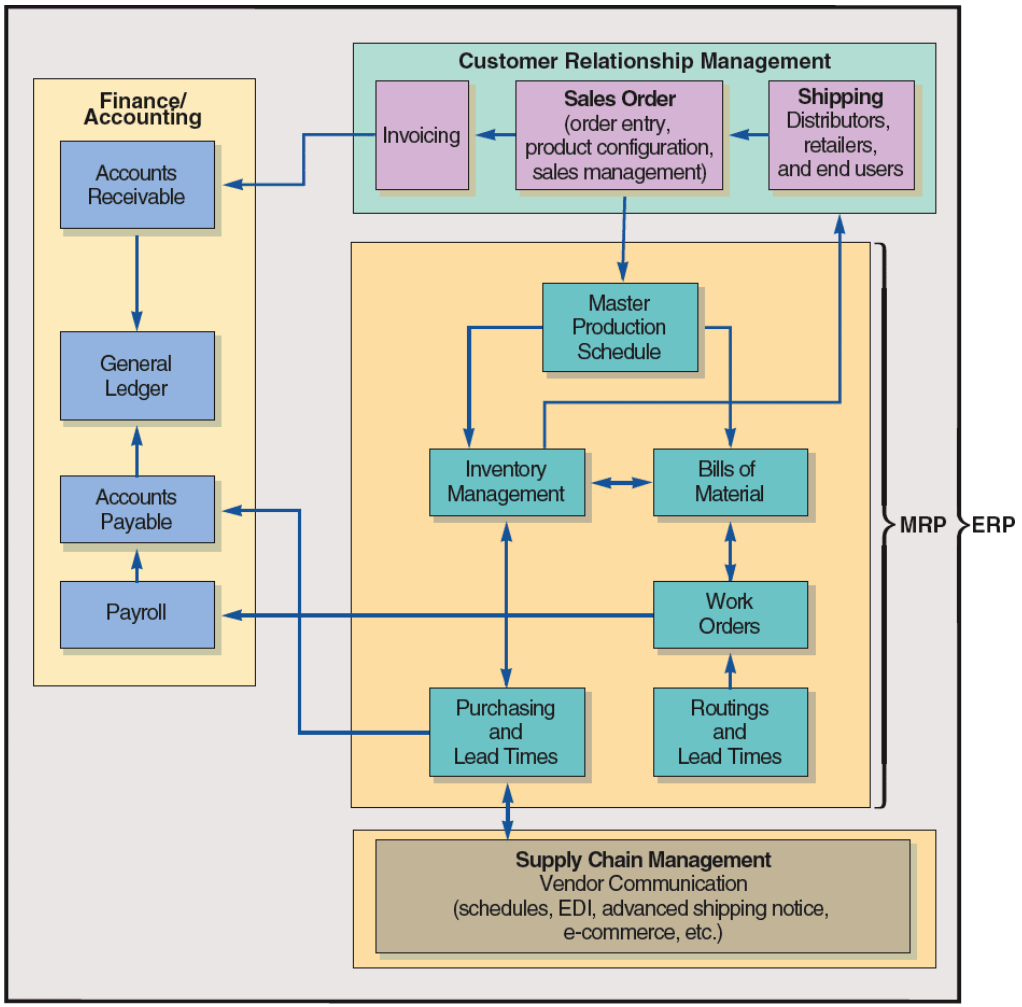
- ERP modules include
  - Basic MRP
  - Finance
  - Human resources
  - Supply Chain Management (SCM)
  - Customer Relationship Management (CRM)



Advantages and Disadvantages of ERP Systems

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Advantages of ERP Systems:

- Provides integration of the supply chain, production, and administration
- Creates commonality of databases
- Can incorporate improved best processes
- Increases communication and collaboration between business units and sites
- Has an off-the-shelf software database
- May provide a strategic advantage

Disadvantages of ERP Systems:

- Is very expensive to purchase and even more so to customize
- Implementation may require major changes in the company and its processes
- Is so complex that many companies cannot adjust to it
- Involves an ongoing, possibly never completed, process for implementation
- Expertise is limited with ongoing staffing problems

Top ERP Providers

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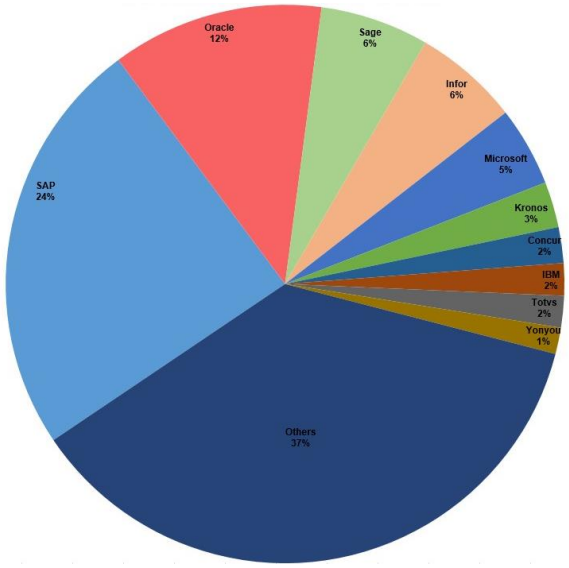
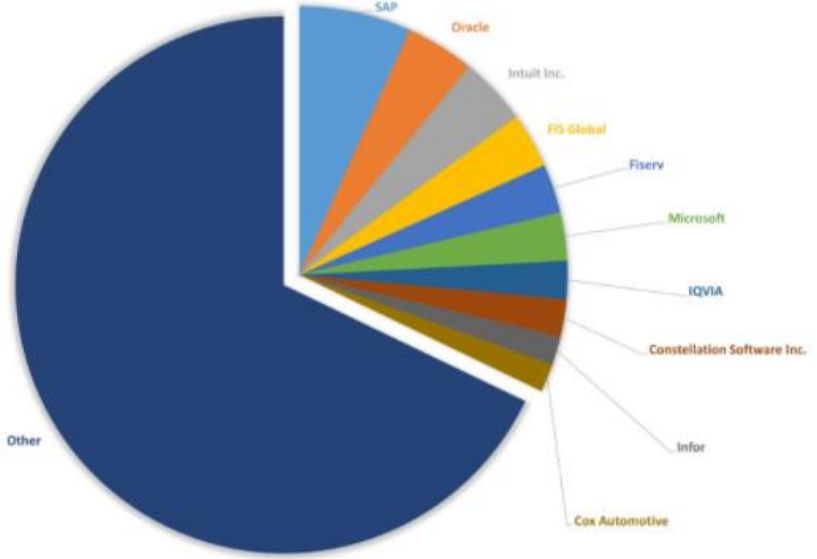
Worldwide ERP Software Market Share

Market Size: 2019 = $94B versus 2013 = $25B





2013

SAP = 24%
Oracle = 12%
Sage = 6%
Infor = 6%
Microsoft = 5%
Others = 47%

2019

SAP = 6.8%
Oracle = 4%
Intuit = 3%
FIS = 3%
Global = 2%
Microsoft = 2%
Others = 68%