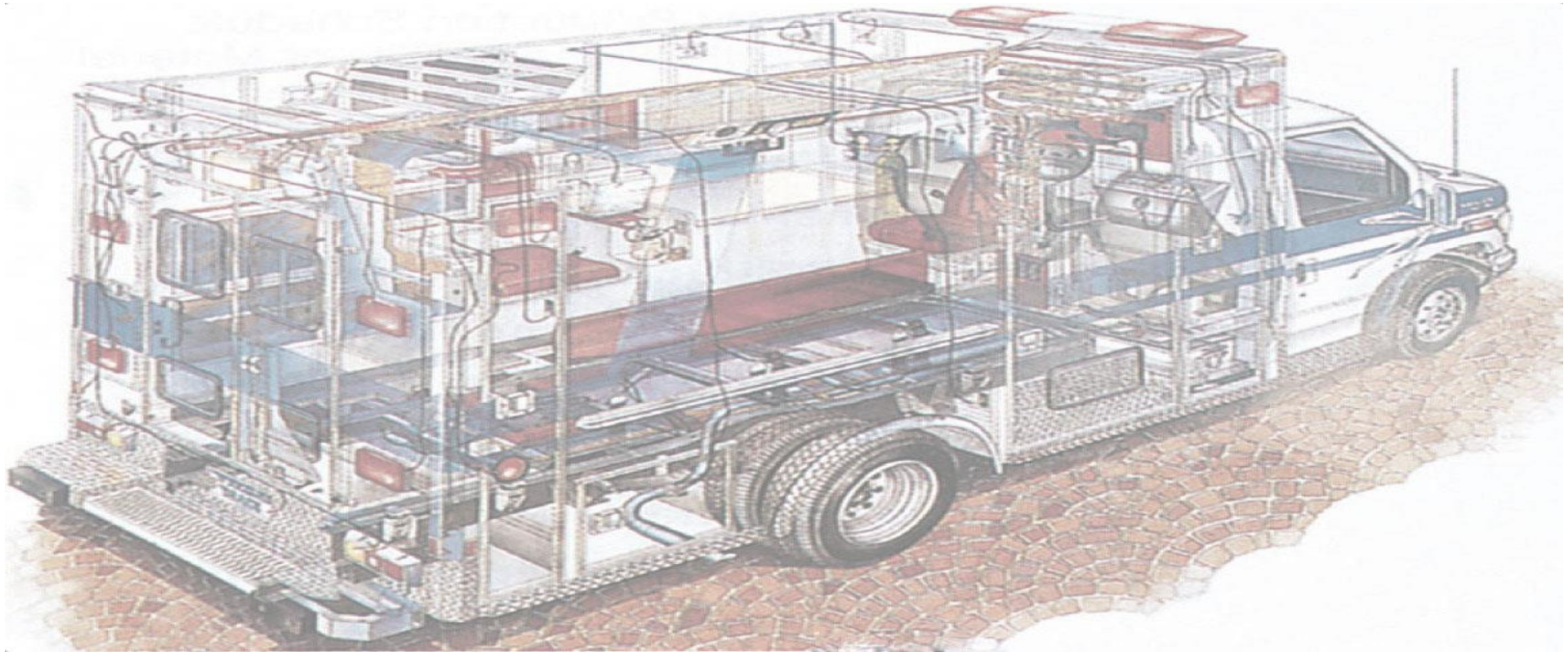
Chapter 4

Material and Capacity Requirements Planning

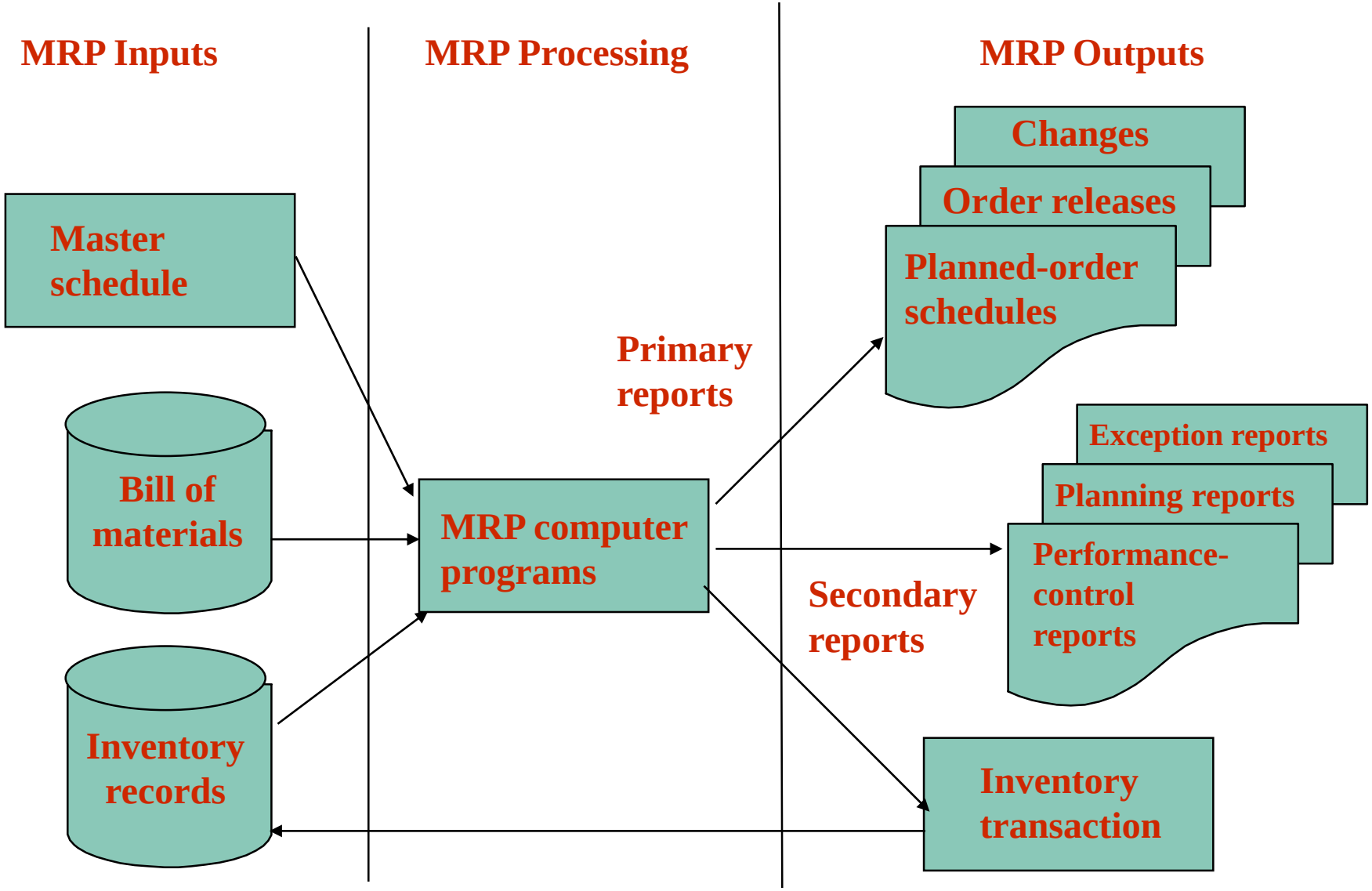


Introduction

- Material requirements planning (MRP) is a computer-based information system that translates master schedule requirements for end items into time-phased requirements for subassemblies, components, and raw materials.
- The MRP is designed to answer three questions:

1. What is needed? → Type
2. How much is needed? → quantity
3. When is it needed? → time

Overview of MRP



Overview of MRP cont…

- **MRP Inputs**
  - Master schedule
  - Bill of Materials
  - Inventory Records

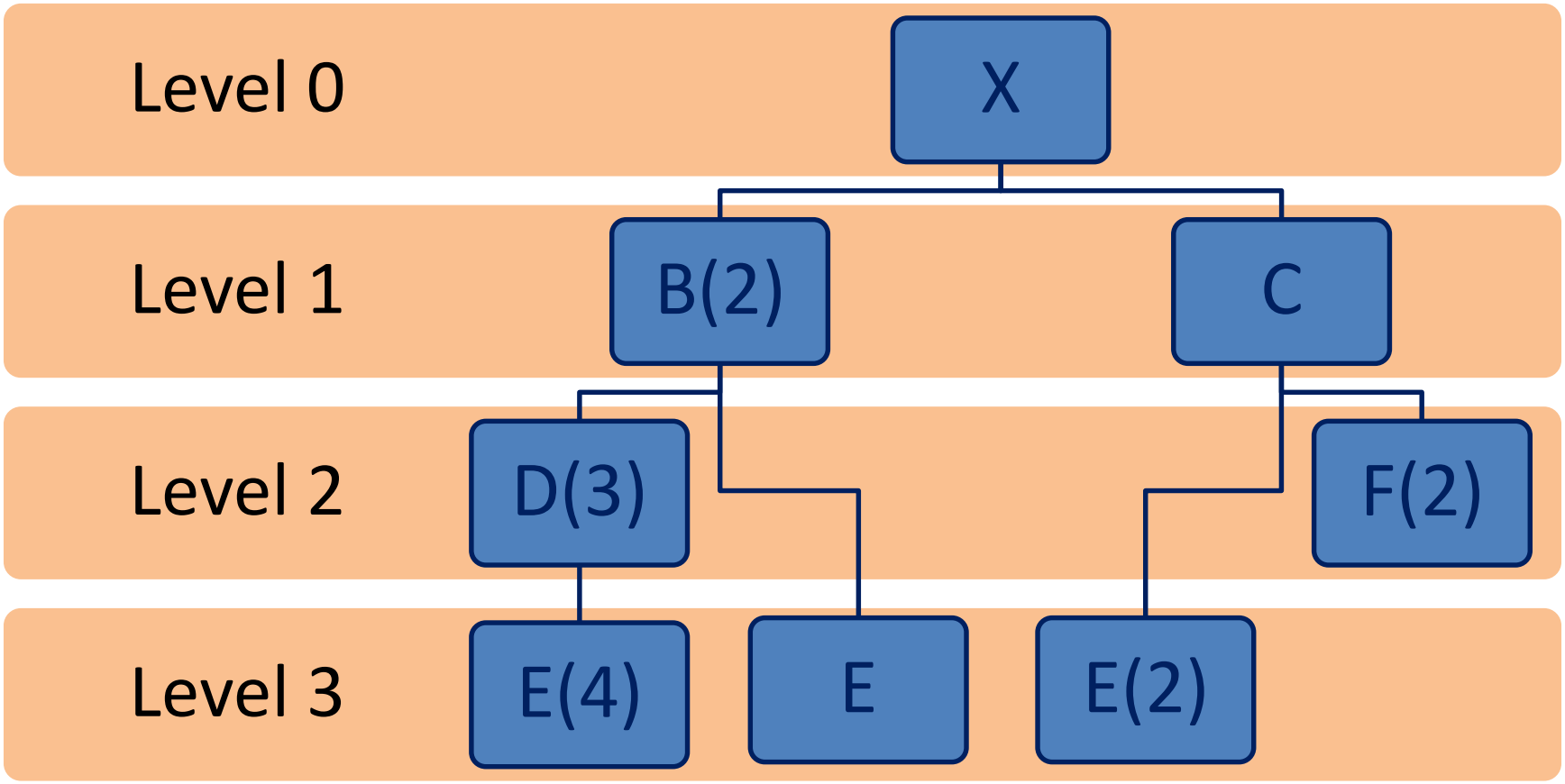
Overview of MRP cont…

- *Master schedule*:
  - States which end items are to be produced, when these are needed, and in what quantities.
- Bill-of-Materials:
  - a listing of all of the raw materials, parts, subassemblies, and assemblies needed to produce one unit of a product.
  - **Product structure tree**
    - A visual depiction of the requirements in a bill of materials, where all components are listed by levels.

Overview of MRP cont…

- Provides product structure
  - Items above given level are called parents
  - Items below given level are called components or children.
- **Low-level coding:**
  - Restructuring the bill of material so that multiple occurrences of a component all coincide with the lowest level at which the component occurs.

Overview of MRP cont…



Overview of MRP cont…

- Example:
- An end item X is composed of two Bs and one C. moreover, each Bs requires three Ds and one E, and each D requires four Es. Similarly, each C is made up of two Es and two Fs. The items at each level are components of the next level up and, as in a family tree, are parents of their respective components. The available inventory on hand of each items B, C, D, and E are 4, 10, 8, and 60 respectively. Note that the quantities of each item in the product structure tree refer only to the amounts needed to complete the assembly at the next higher level. Use this information to do the following:

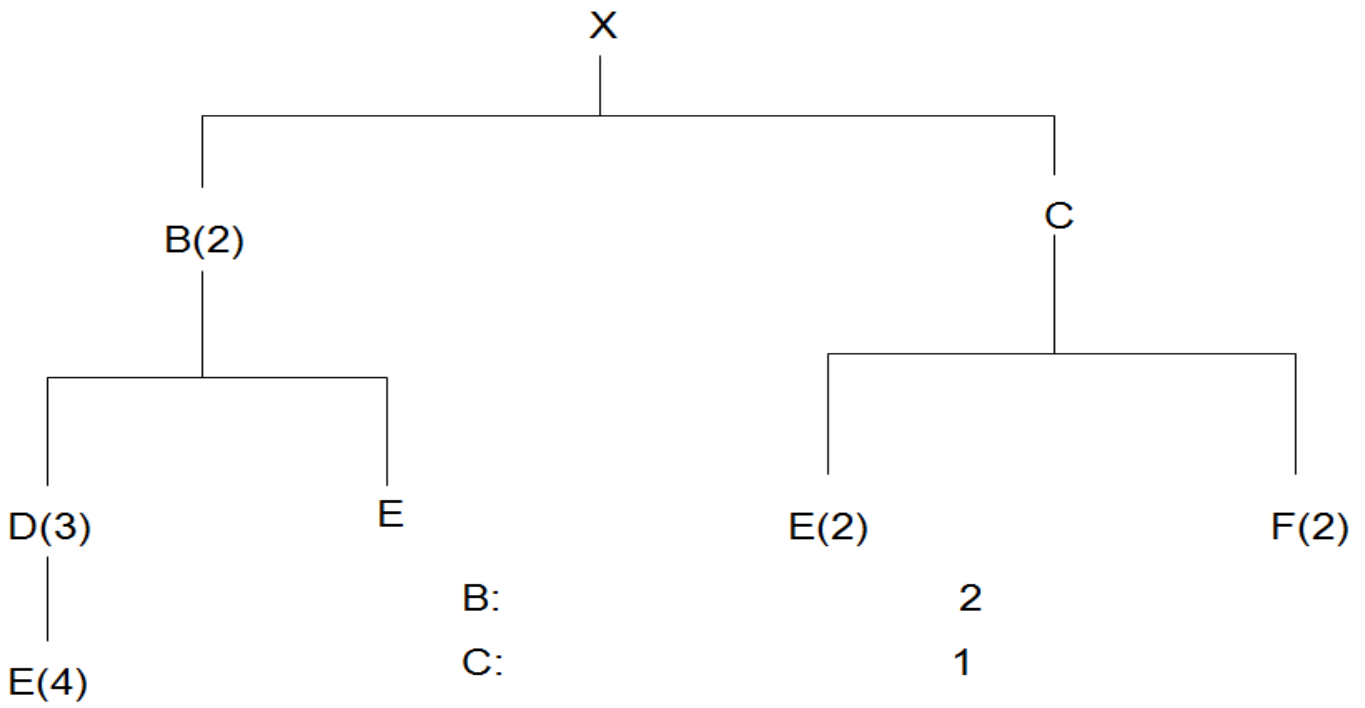
a. Draw the product tree diagram

b. Determine the quantities of B, C, D, E, and F needed to assemble one unit of X

c. Determine the quantities of these components that will required to assemble 10 Xs, taking into account the quantities on hand of various components

Overview of MRP cont…

Solution: tree diagram



B: 2

C: 1

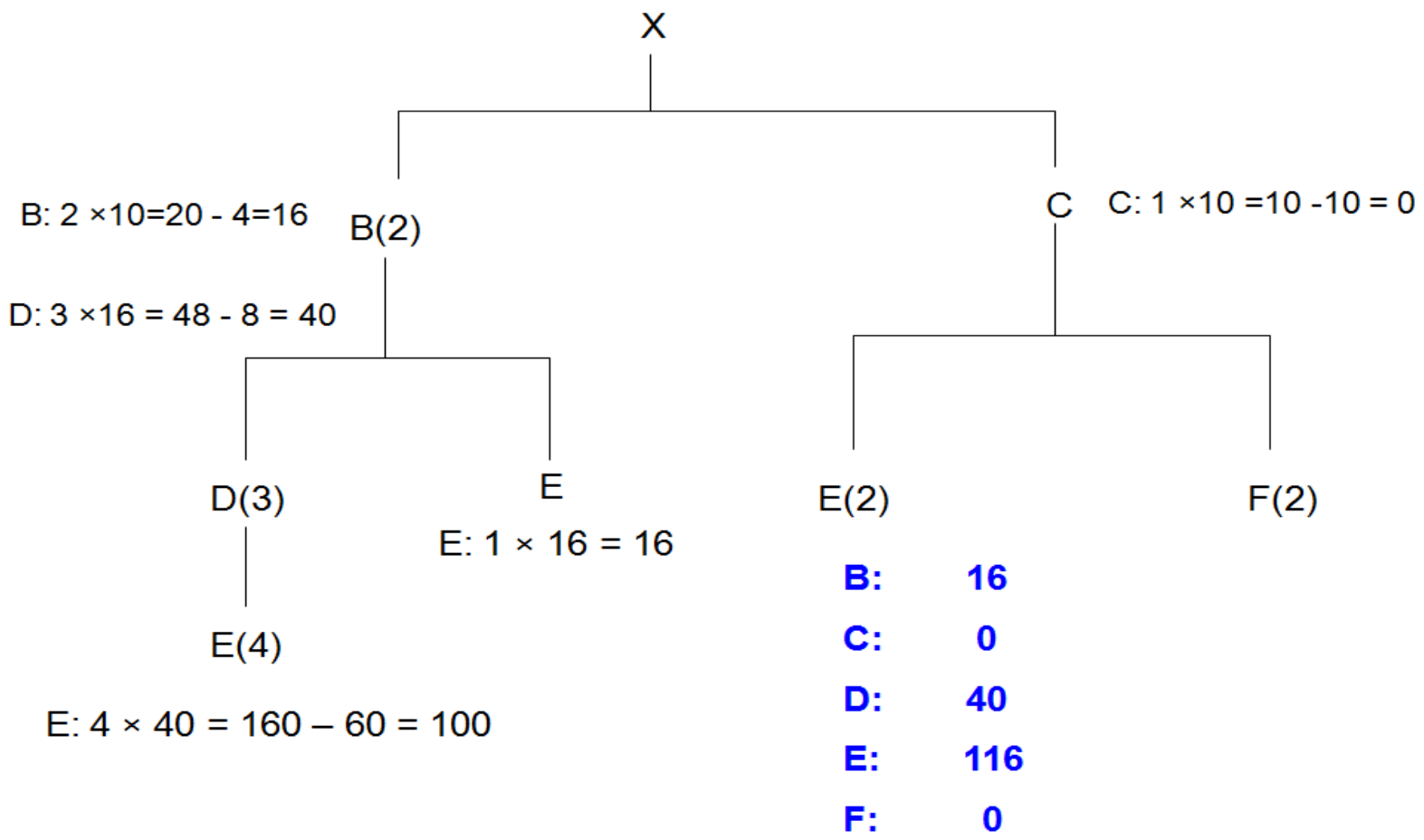
D: 2 ×3 = 6

E: 4 ×3 ×2 + 1 ×2 +2 ×1 = 28

F: 2

Overview of MRP cont…

Solution: tree diagram



Overview of MRP cont…

- Inventory records
  - Includes information on the status of each item by time period, called *time buckets.*
    - Information about
      - Gross requirements
      - Scheduled receipts
      - Expected amount on hand
    - Other details for each item such as
      - Supplier
      - Lead time
      - Lot size policy
      - Changes due to stock receipts and withdrawals
      - Canceled orders and similar events.

Overview of MRP cont…

Inventory Requirements

- Net requirements:

  Net Requirements = Gross Requirements
  – Available Inventory

- Available Inventory:

  Available Inventory = Projected on hand
  – Safety stock
  – Inventory allocated to other items

Overview of MRP cont…

- MRP Processing:
  - 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 using the bill of materials offset by lead times.
  - The quantities that are generated by exploding the bill of materials are *gross requirements*; they don't take into consideration any inventory that is currently on hand or due to be received.
  - The materials that a firm must actually acquire to meet the demand generated by the master schedule are the net material requirements which is calculated as the gross requirements minus the projected inventory plus a safety stock.

Overview of MRP cont…

MRP Record

Week Number	1	2	3	4	5	6
Gross Requirements						
Scheduled Receipts						
Projected on hand						
Net requirements						
Planned-order-receipt						
Planned-order release						

Gross requirements
- Total expected demand

Scheduled receipts
- Open orders scheduled to arrive

Projected on hand inventory
- Expected inventory on hand at the beginning of each time period

Overview of MRP cont…

- **Net requirements**
  - ➢Actual amount needed in each time period
- **Planned-order receipts**
  - ➢Quantity expected to be received at the beginning of the period offset by lead time
- **Planned-order releases**
  - ➢Planned amount to order in each time period

Overview of MRP cont…

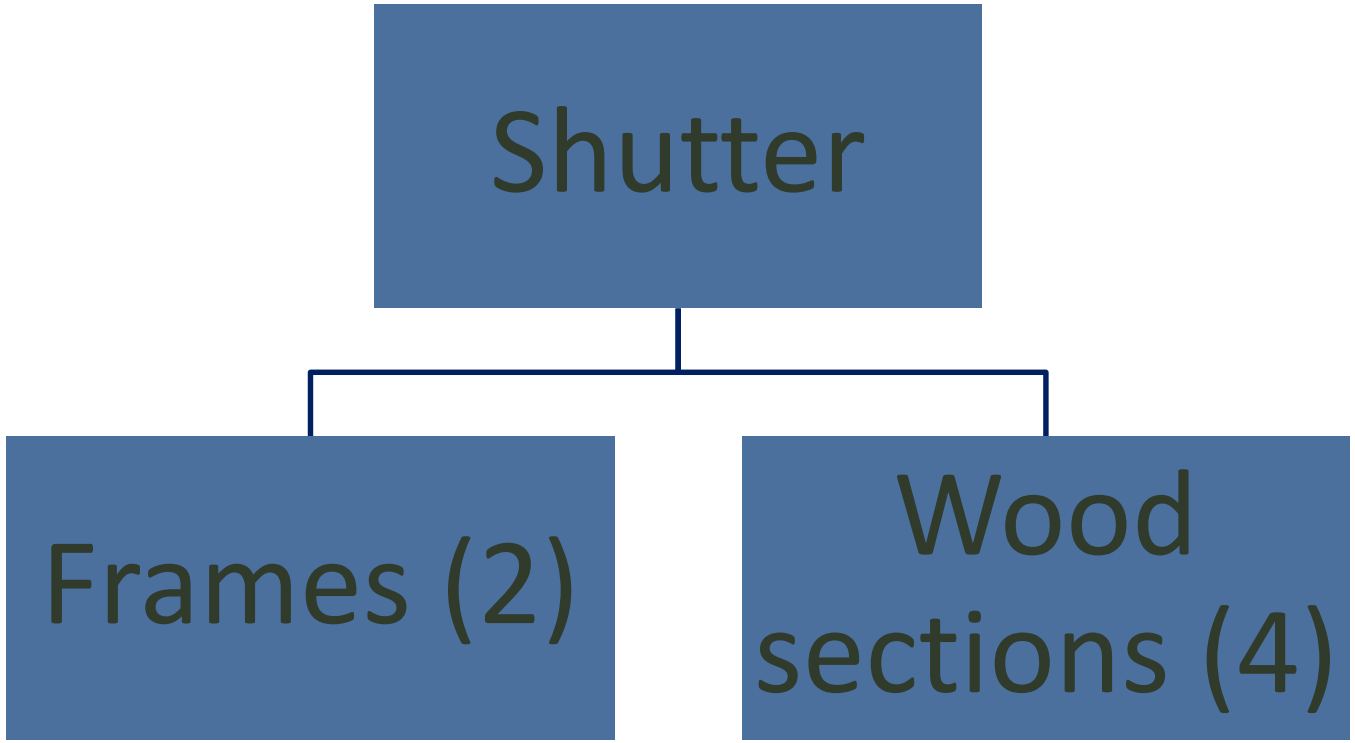
- **Examples:** A firm that produces wood shutters and bookcases has received two orders for shutters: one for 100 shutters and one for 150 shutters. The 100-unit order is due for delivery at the start of week 4 of the current schedule, and the 150-unit order is due for delivery at the start of week 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) week1. determine the size and timing of planned-order releases necessary to meet delivery requirements under each of these conditions:

Overview of MRP cont…

1. lot-for-lot ordering (i.e., order size equal to net requirements).
2. Lot-size ordering with a lot size of 320 units for frames and 70 units for wood sections.

Overview of MRP cont…

- **Solution:**

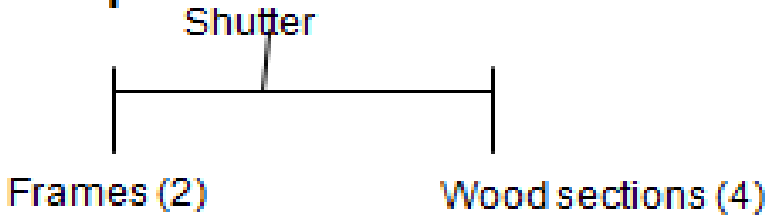


Overview of MRP cont…

a. Develop a master schedule:

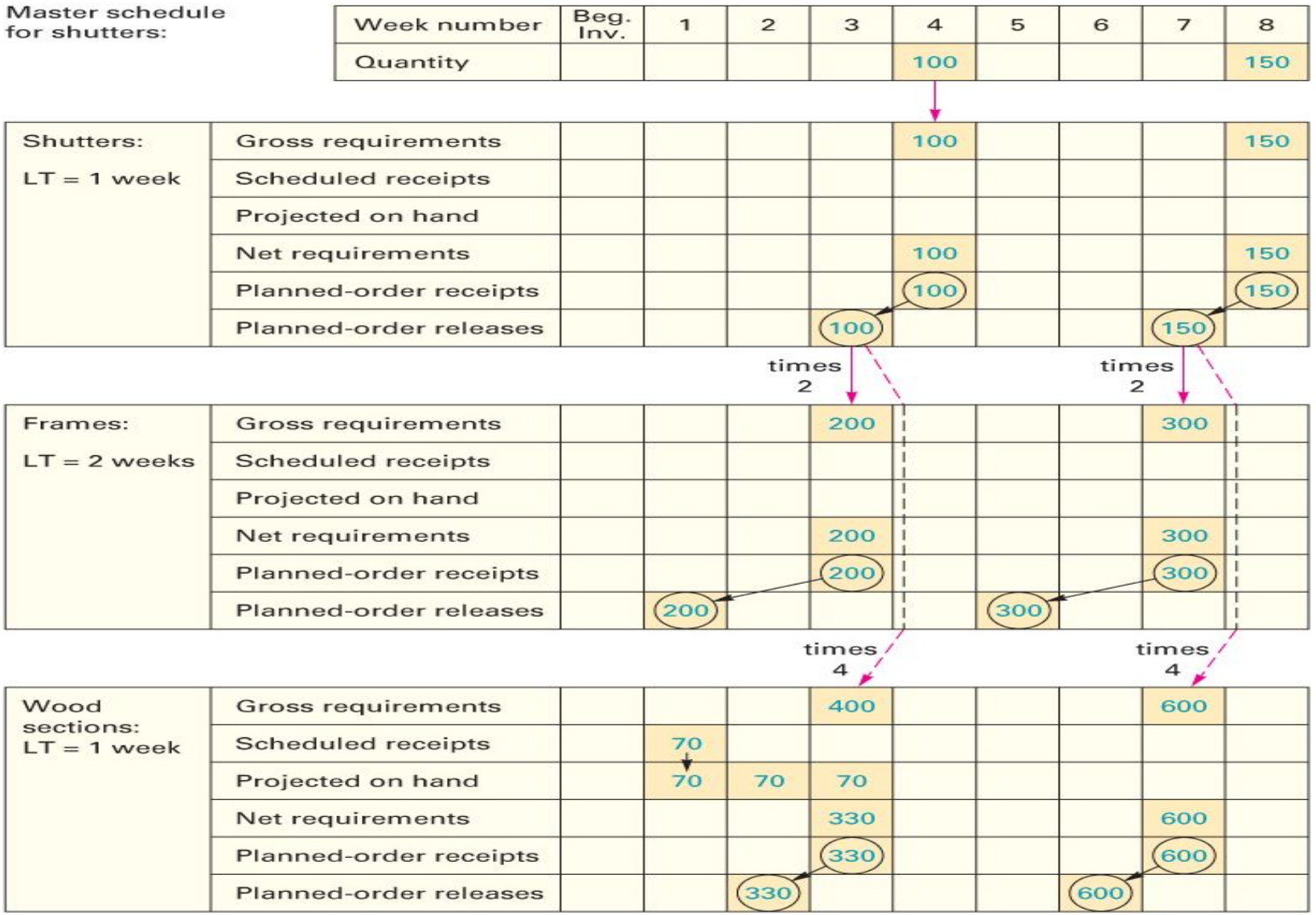
Week number	1	2	3	4	5	6	7	8
Quantity				100				
150								

b. Develop a product structure tree

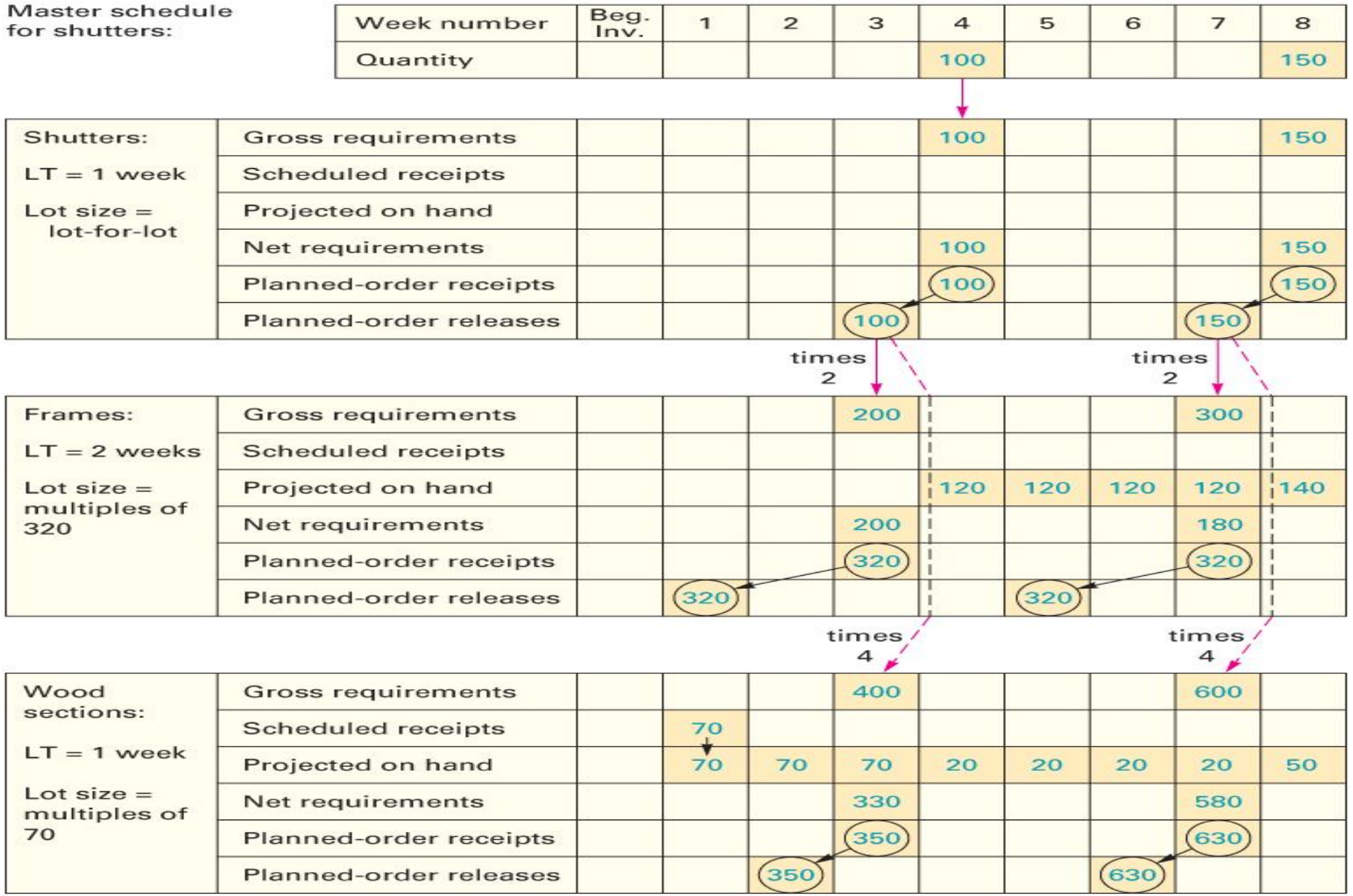


c. Using the master schedule, determine gross requirements for shutters. Next compute net requirements

Overview of MRP cont…



Overview of MRP cont…



Overview of MRP cont…

- **Example: 2**

TABLE Gross Material Requirements Plan for 50 Awesome Speaker Kits (As) with Order Release Dates Also Shown

	WEEK								LEAD TIME
	1	2	3	4	5	6	7	8	
A. Required date								50	
Order release date							50		1 week
B. Required date							100		
Order release date					100				2 weeks
C. Required date							150		
Order release date						150			1 week
E. Required date					200	300			
Order release date			200	300					2 weeks
F. Required date						300			
Order release date			300						3 weeks
D. Required date			600		200				
Order release date		600		200					1 week
G. Required date			300						
Order release date	300								2 weeks

Overview of MRP cont…

Solution: Net Requirements Plan:

ITEM	ON HAND	ITEM	ON HAND
A	10	E	10
B	15	F	5
C	20	G	0
D	10		

Lot Size	Lead Time (weeks)	On Hand	Safety Stock	Allo-cated	Low-Level Code	Item Identi-fication		Week 1	2	3	4	5	6	7	8
Lot-for-Lot	1	10	—	—	0	A	Gross Requirements								50
							Scheduled Receipts								
							Projected On Hand 10	10	10	10	10	10	10	10	10
							Net Requirements								40
							Planned Order Receipts								40
							Planned Order Releases							40	
Lot-for-Lot	2	15	—	—	1	B	Gross Requirements							80[A]	
							Scheduled Receipts								
							Projected On Hand 15	15	15	15	15	15	15	15	
							Net Requirements							65	
							Planned Order Receipts							65	
							Planned Order Releases					65			
Lot-for-Lot	1	20	—	—	1	C	Gross Requirements							120[A]	
							Scheduled Receipts								
							Projected On Hand 20	20	20	20	20	20	20	20	
							Net Requirements							100	
							Planned Order Receipts							100	
							Planned Order Releases						100		

Overview of MRP cont…

Lot-for-Lot	2	10	—	—	2	E	Gross Requirements						130[B]	200[C]		
							Scheduled Receipts									
							Projected On Hand	10	10	10	10	10	10			
							Net Requirements						120	200		
							Planned Order Receipts						120	200		
							Planned Order Releases			120	200					
Lot-for-Lot	3	5	—	—	2	F	Gross Requirements							200[C]		
							Scheduled Receipts									
							Projected On Hand	5	5	5	5	5	5	5		
							Net Requirements							195		
							Planned Order Receipts							195		
							Planned Order Releases			195						
Lot-for-Lot	1	10	—	—	3	D	Gross Requirements			390[F]		130[B]				
							Scheduled Receipts									
							Projected On Hand	10	10	10	10					
							Net Requirements			380		130				
							Planned Order Receipts			380		130				
							Planned Order Releases		380		130					
Lot-for-Lot	2	0	—	—	3	G	Gross Requirements			195[F]						
							Scheduled Receipts									
							Projected On Hand			0						
							Net Requirements			195						
							Planned Order Receipts			195						
							Planned Order Releases	195								

Overview of MRP cont…

- Updating the System:
  - An MRP is not a static document
    - As time passes
      - Some orders get completed
      - Other orders are nearing completion
      - New orders will have been entered
      - Existing orders will have been altered
        - Quantity changes
        - Delays
        - Missed deliveries

Overview of MRP cont…

- MRP Outputs:
  - Primary Outputs
    - **Planned orders**
      - A schedule indicating the amount and timing of future orders.
    - **Order releases**
      - Authorizing the execution of planned orders.
    - **Changes**
      - Revisions of the dates or quantities, or the cancellation of orders.

Overview of MRP cont…

- **Secondary Outputs**
  - ➢ Performance-control reports
    - ✓ Evaluation of system operation, including deviations from plans and cost information.

      E.g., missed deliveries and stock outs
  - ➢ Planning reports
    - ➢ Data useful for assessing future material requirements.

      E.g., purchase commitments
  - ➢ Exception reports
    - ➢ Data on any major discrepancy encountered.

      E.g., late and overdue orders, excessive scrap rates.

Lot Sizing Rules

- Lot-for-Lot (L4L) ordering
  - The order or run size is set equal to the demand for that period
  - Minimizes investment in inventory
  - It results in variable order quantities
  - A new setup is required for each run
- Economic Order Quantity (EOQ)
  - Can lead to minimum costs if usage of item is fairly uniform
    - This may be the case for some lower-level items that are common to different ‘parents’
    - Less appropriate for ‘lumpy demand’ items because inventory remnants often result
- Fixed Period Ordering
  - Provides coverage for some predetermined number of periods.

Lot size techniques cont…

- Safety Stock
  - ➢ Theoretically, MRP systems should not require safety stock
  - ➢ Variability may necessitate the strategic use of safety stock
    - ➢ A bottleneck process or one with varying scrap rates may cause shortages in downstream operations.
    - ➢ Shortages may occur if orders are late or fabrication or assembly times are longer than expected.

MRP Benefits

- Enables managers to easily
  - ➢ determine the quantities of each component for a given order size
  - ➢ To know when to release orders for each component
  - ➢ To be alerted when items need attention
- Additional benefits
  - ➢ Low levels of in-process inventories
  - ➢ The ability to track material requirements
  - ➢ The ability to evaluate capacity requirements
  - ➢ A means of allocating production time
  - ➢ The ability to easily determine inventory usage via ***back flushing.***
    - ➢ Exploding an end item's BOM to determine the quantities of the components that were used to make the item.

Capacity Planning

- Feedback from the MRP system
- **Load reports** show resource requirements for work centers
- Work can be moved between work centers to smooth the load or bring it within capacity

Capacity Planning cont…

- Smoothing Tactics:

1. Overlapping
   - Sends part of the work to following operations before the entire lot is complete
   - Reduces lead time
2. Operations splitting
   - Sends the lot to two different machines for the same operation
   - Shorter throughput time but increased setup costs
3. Order or lot splitting
   - Breaking up the order into smaller lots and running part earlier (or later) in the schedule

Capacity Planning cont…

- **Order Splitting:**
  - Develop a capacity plan for a work cell at Wiz Products
  - There are 12 hours available each day
  - Each order requires 1 hour

Day	1	2	3	4	5
Orders	10	14	13	10	14

Capacity Planning cont…

Order Splitting

DAY	UNITS ORDERED	CAPACITY REQUIRED (HOURS)	CAPACITY AVAILABLE (HOURS)	UTILIZATION: OVER/ (UNDER) (HOURS)	PRODUCTION PLANNER'S ACTION	NEW PRODUCTION SCHEDULE
1	10	10	12	(2)		12
2	14	14	12	2	Split order: move 2 units to day 1	12
3	13	13	12	1	Split order: move one unit to day 6 or request overtime	13
4	10	10	12	(2)		12
5	14	14	12	2	Split order: move 2 units to day 4	12
	61					

Capacity Planning cont…