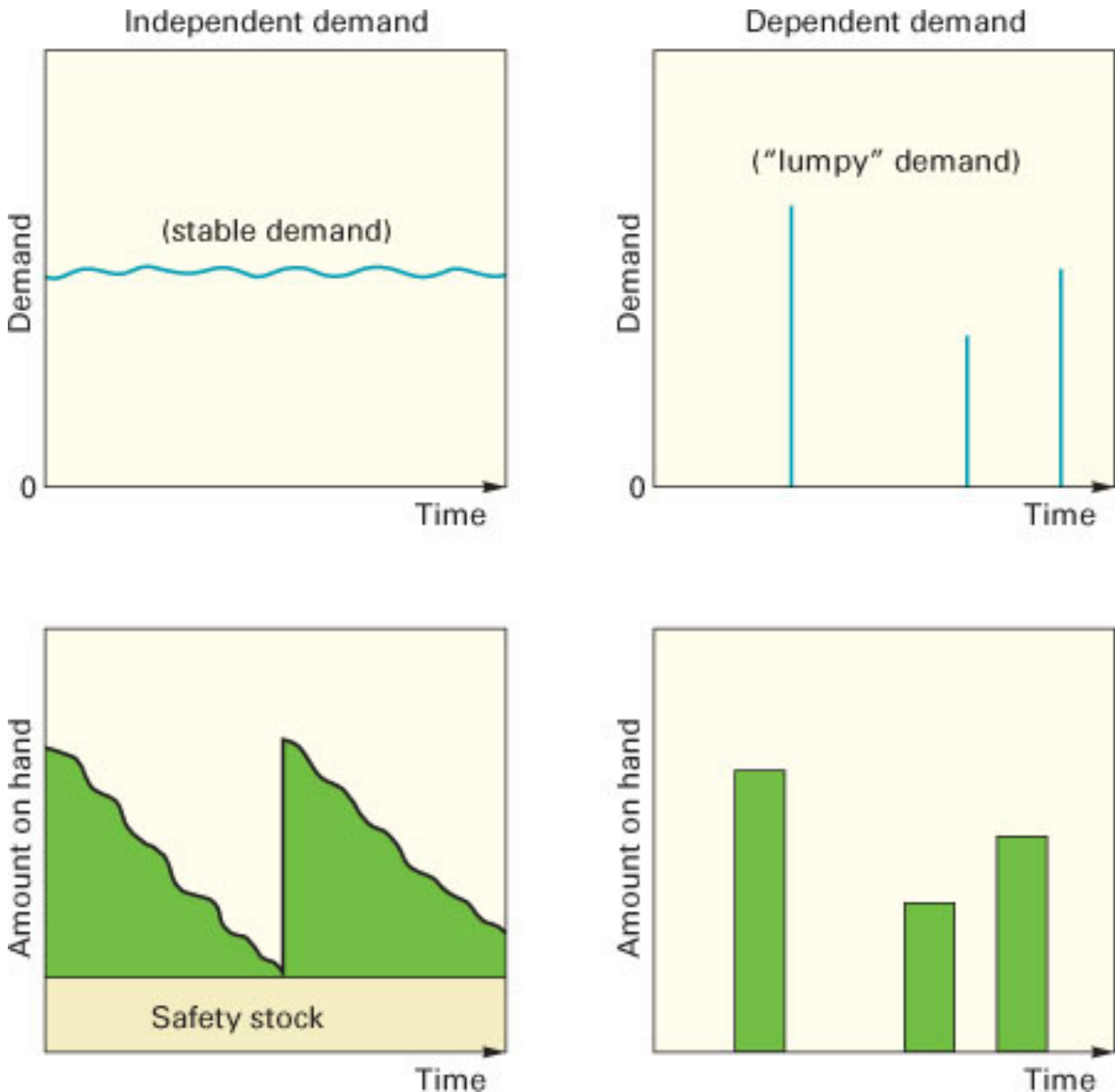
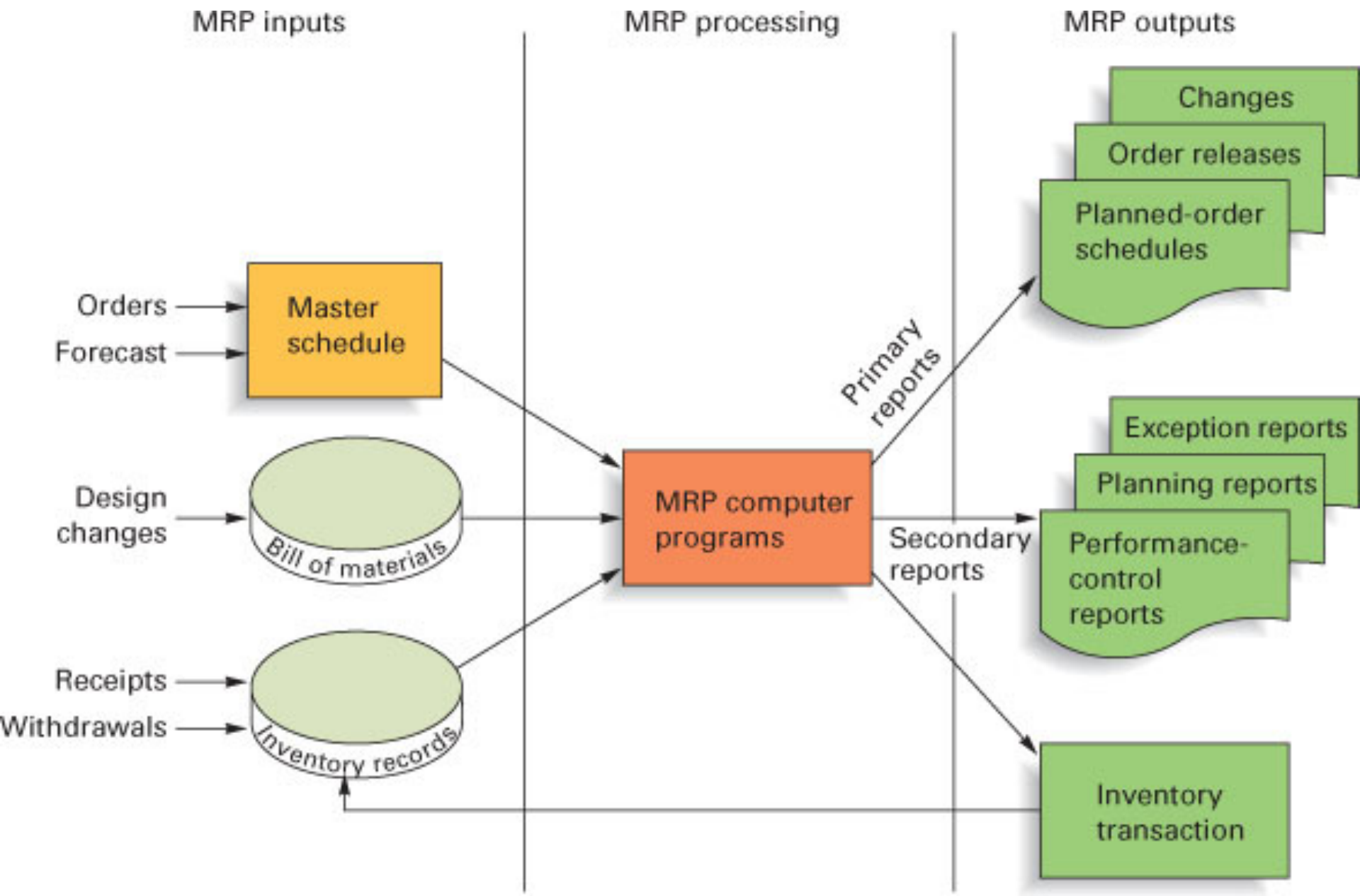
# MRP and ERP

Chapter 14

Comparison of independent and dependent demand



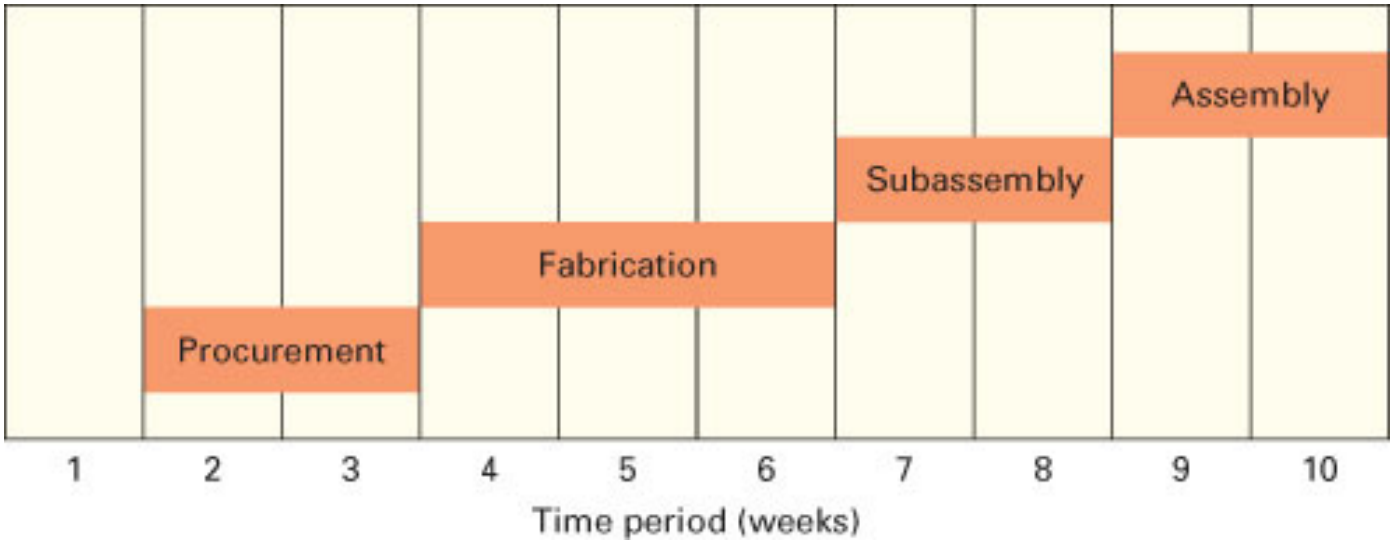

MRP inputs
MRP processing
MRP outputs
Orders
Forecast
Master schedule
Design changes
Bill of materials
Receipts
Withdrawals
Inventory records
MRP computer programs
Primary reports
Secondary reports
Changes
Order releases
Planned-order schedules
Exception reports
Planning reports
Performance-control reports
Inventory transaction

# MRP Inputs

## The Master Schedule

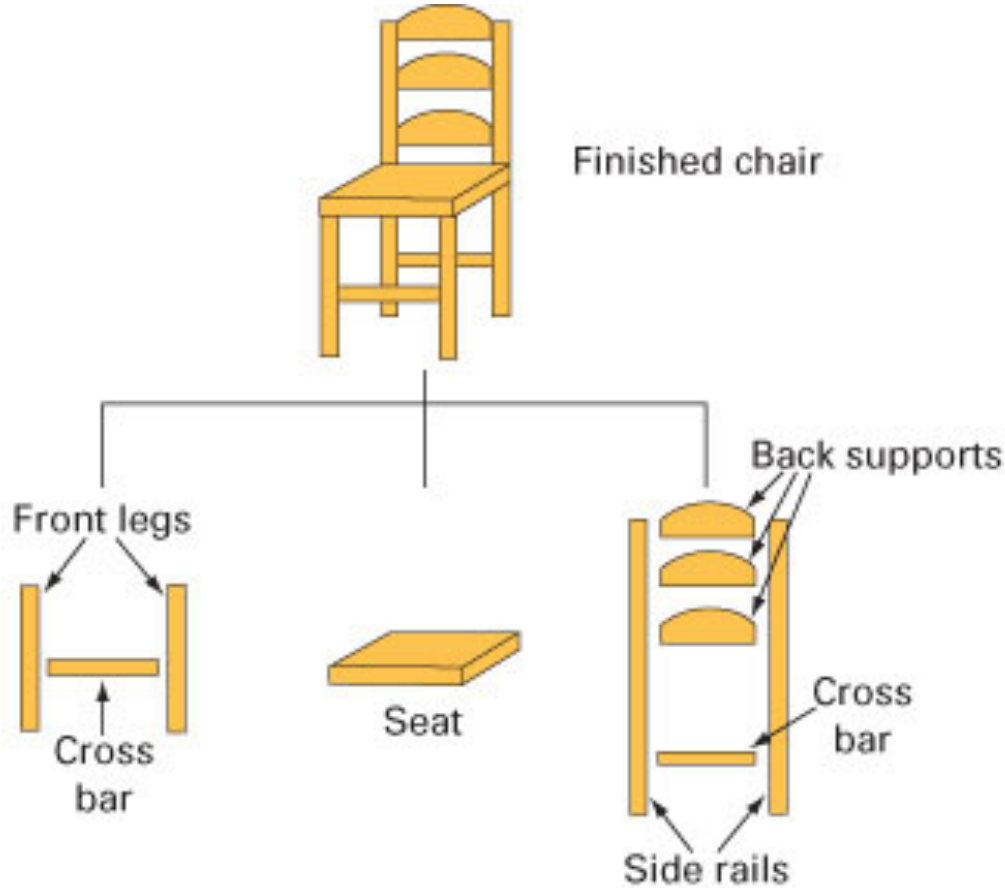
**Week number**

| Item: X | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Quantity | | | | 100 | | | | 150 |

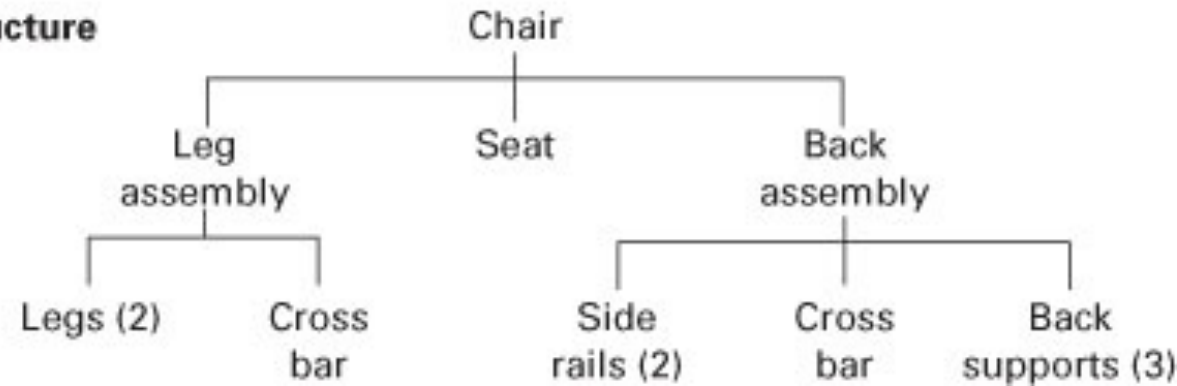


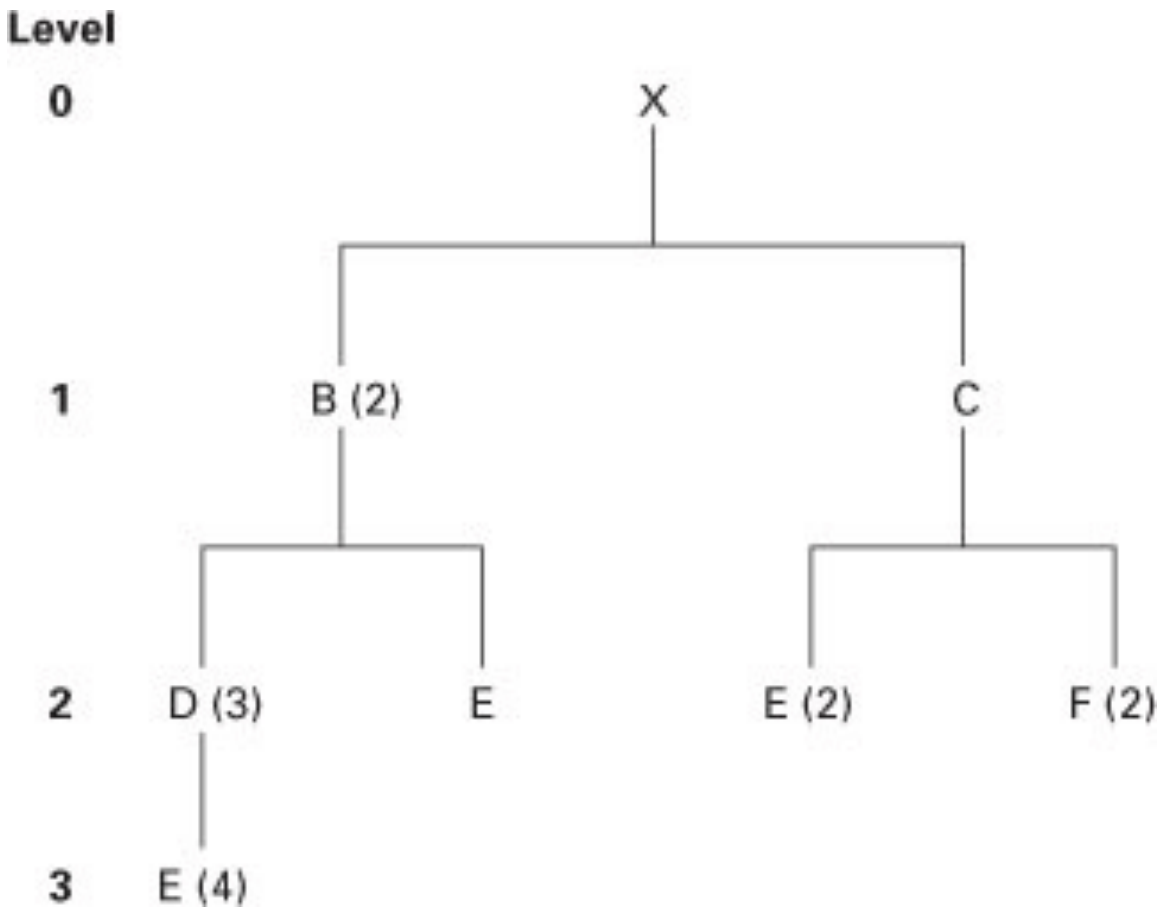
# The Bill of Materials

**Assembly diagram**




**Product structure tree**



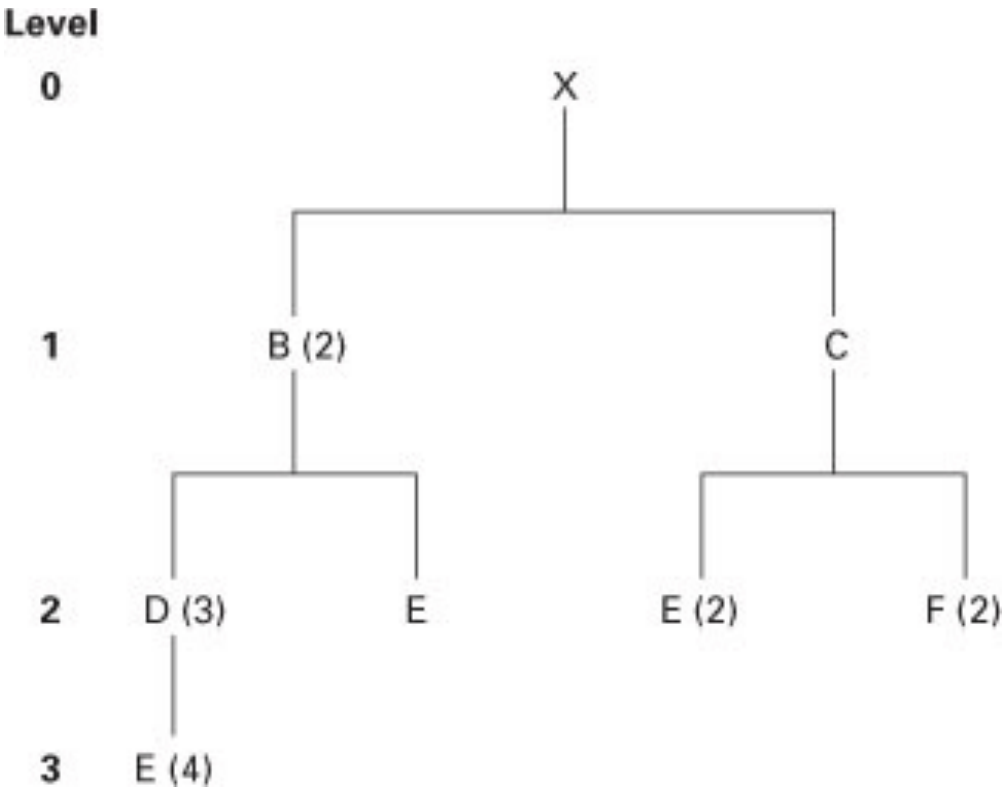

Level
0
X
1
B (2)
C
2
D (3)
E
E (2)
F (2)
3
E (4)

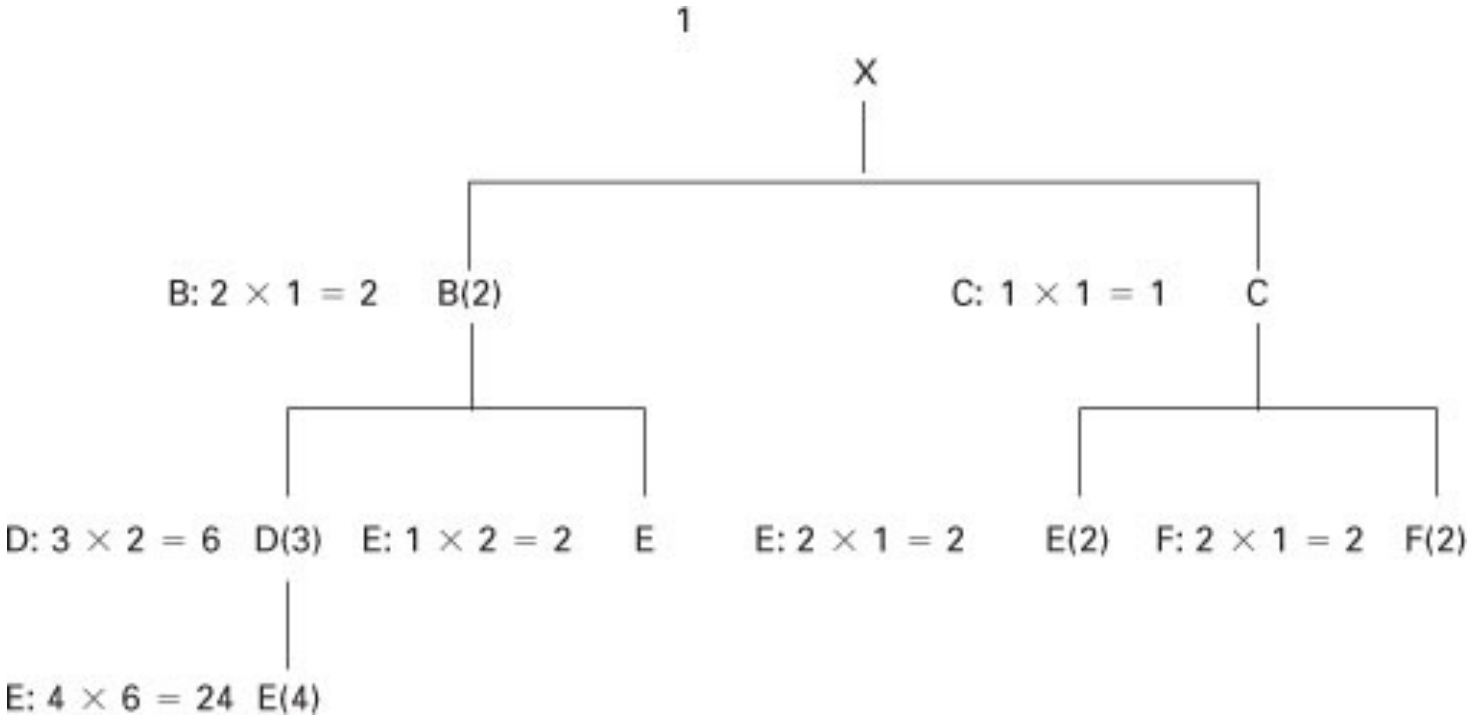
# Example

Use the information presented in figure to do the following:

1. Determine the quantities of B, C, D, E, and F needed to assemble one X.
2. Determine the quantities of these components that will be required to assemble 10 Xs, taking into account the quantities on hand (i.e., in inventory) of various components:

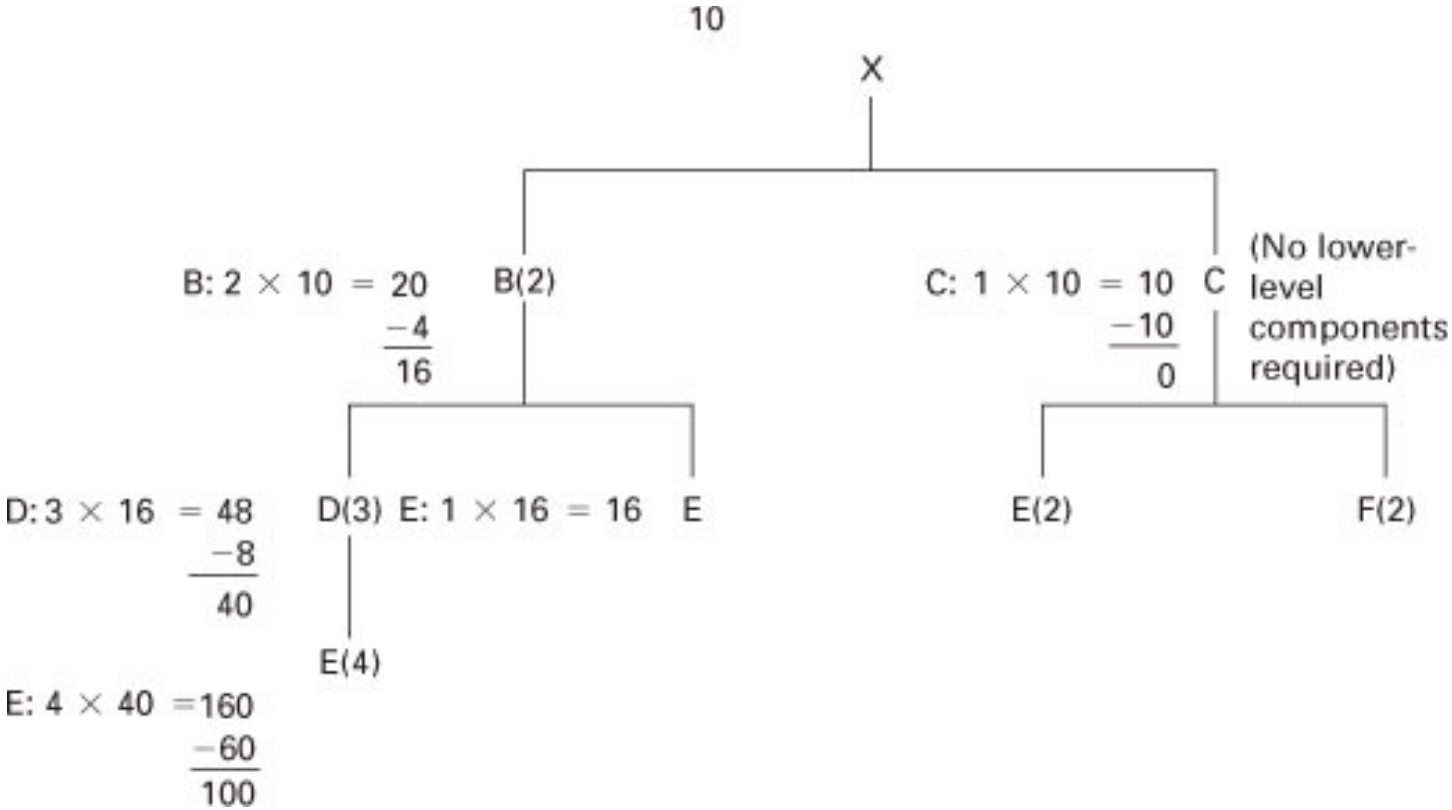
| Component | On Hand |
|---|---|
| B | 4 |
| C | 10 |
| D | 8 |
| E | 60 |






| | |
|---|---|
| B: | 2 |
| C: | 1 |
| D: | 6 |
| E: | 28 (Note that E occurs in three places, with requirements of 24 + 2 + 2 = 28) |
| F: | 2 |

| | |
|---|---|
| B: | 2 |
| C: | 1 |
| D: | 6 |
| E: | 28 (Note that E occurs in three places, with requirements of 24 + 2 + 2 = 28) |
| F: | 2 |

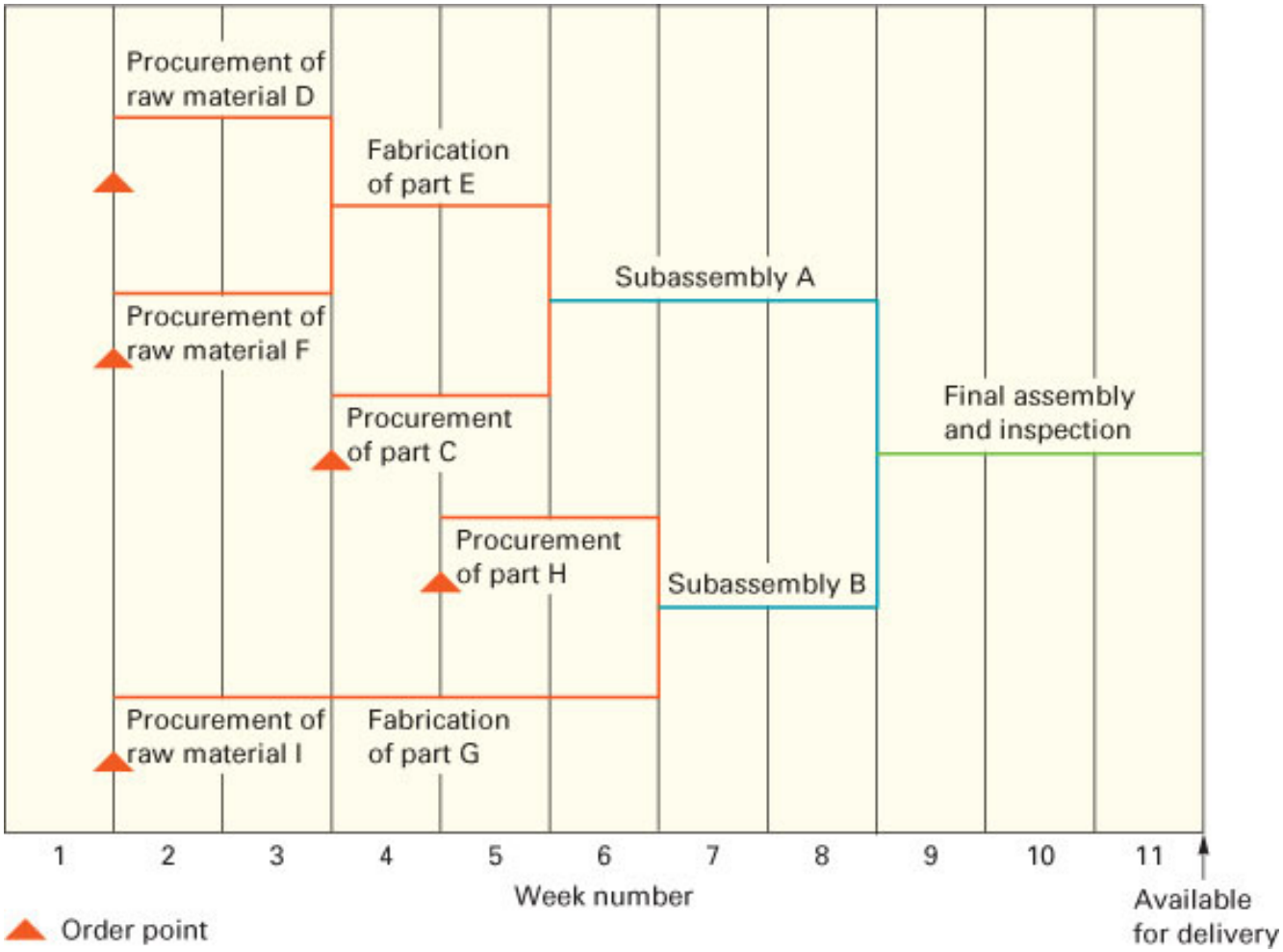



| | |
|---|---|
| B: | 16 |
| C: | 0 |
| D: | 40 |
| E: | 116 |
| F: | 0 |

# The Inventory Records

# MRP Processing

Assembly time chart showing material order points needed to meet scheduled availability of the end item



$$\text{Net requirements} = \text{Gross requirements} - \text{Available inventory}$$

$$\text{Available inventory} = \text{Projected on hand} - \text{Safety stock} - \text{Inventory allocated to other items}$$

$$\text{Net requirements} = \text{Gross requirements} - \text{Projected on-hand inventory}$$

**Gross requirements:** The total expected demand for an item or raw material *during* each time period without regard to the amount on hand. For end items, these quantities are shown in the master schedule; for components, these quantities are derived from the planned-order releases of their immediate "parents."

**Scheduled receipts:** Open orders (orders that have been placed and are) scheduled to arrive from vendors or elsewhere in the pipeline by the *beginning* of a period.

**Projected on hand:** The expected amount of inventory that will be on hand at the *beginning* of each time period: scheduled receipts plus available inventory from last period.

**Net requirements:** The actual amount needed in each time period.

**Planned-order receipts:** The quantity expected to be received by the *beginning* of the period in which it is shown. Under lot-for-lot ordering, this quantity will equal net requirements. Under lot-size ordering, this quantity may exceed net requirements. Any excess is added to available inventory in the *next* time period for simplicity, although in reality, it would be available in that period.

**Planned-order releases:** Indicates a *planned* amount to order in each time period; equals planned-order receipts offset by lead time. This amount generates gross requirements at the next level in the assembly or production chain. When an order is executed, it is removed from "planned-order releases" and entered under "scheduled receipts."

| Week Number | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Item: | | | | | | | | | |
| Gross requirements | | | | | | | | | |
| Scheduled receipts | | | | | | | | | |
| Projected on hand | | | | | | | | | |
| Net requirements | | | | | | | | | |
| Planned-order receipts | | | | | | | | | |
| Planned-order releases | | | | | | | | | |
| | | | | | | | | | |

# Example

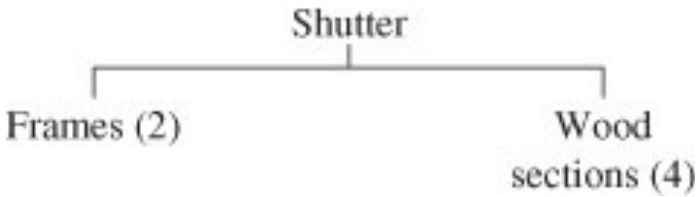
A firm that produces wood shutters and bookcases has received two orders for shutters: one for 100 shutters and one for 150 shutters. The 100-unit order is due for delivery at the start of week 4 of the current schedule, and the 150-unit order is due for delivery at the start of week 8. Each shutter 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) week 1. Determine the size and timing of planned-order releases necessary to meet delivery requirements under each of these conditions:

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.

Develop a master schedule:

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

Develop a product structure tree:




Using the master schedule, determine gross requirements for shutters. Next, compute net requirements. Using *lot-for-lot ordering*, determine planned-order receipt quantities and the planned-order release timing to satisfy the master schedule

Master schedule for shutters:

| Week number | Beg. Inv. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Quantity | | | | | 100 | | | | 150 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Shutters: LT = 1 week | Gross requirements | | | | | 100 | | | | 150 |
| | Scheduled receipts | | | | | | | | | |
| | Projected on hand | | | | | | | | | |
| | Net requirements | | | | | 100 | | | | 150 |
| | Planned-order receipts | | | | | 100 | | | | 150 |
| | Planned-order releases | | | | 100 | | | | 150 | |

times 2 times 2

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Frames: LT = 2 weeks | Gross requirements | | | | 200 | | | | 300 | |
| | Scheduled receipts | | | | | | | | | |
| | Projected on hand | | | | | | | | | |
| | Net requirements | | | | 200 | | | | 300 | |
| | Planned-order receipts | | | | 200 | | | | 300 | |
| | Planned-order releases | | 200 | | | | 300 | | | |

times 4 times 4

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Wood sections: LT = 1 week | Gross requirements | | | | 400 | | | | 600 | |
| | Scheduled receipts | | 70 | | | | | | | |
| | Projected on hand | | 70 | 70 | 70 | | | | | |
| | Net requirements | | | | 330 | | | | 600 | |
| | Planned-order receipts | | | | 330 | | | | 600 | |
| | Planned-order releases | | | 330 | | | | 600 | | |

Master schedule for shutters:

| Week number | Beg. Inv. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Quantity | | | | | 100 | | | | 150 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Shutters: | Gross requirements | | | | | 100 | | | | 150 |
| LT = 1 week | Scheduled receipts | | | | | | | | | |
| Lot size = lot-for-lot | Projected on hand | | | | | | | | | |
| | Net requirements | | | | | 100 | | | | 150 |
| | Planned-order receipts | | | | | 100 | | | | 150 |
| | Planned-order releases | | | | 100 | | | | 150 | |

times 2 times 2

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Frames: | Gross requirements | | | | 200 | | | | 300 | |
| LT = 2 weeks | Scheduled receipts | | | | | | | | | |
| Lot size = multiples of 320 | Projected on hand | | | | | 120 | 120 | 120 | 120 | 140 |
| | Net requirements | | | | 200 | | | | 180 | |
| | Planned-order receipts | | | | 320 | | | | 320 | |
| | Planned-order releases | | 320 | | | | 320 | | | |

times 4 times 4

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Wood sections: | Gross requirements | | | | 400 | | | | 600 | |
| | Scheduled receipts | | 70 | | | | | | | |
| LT = 1 week | Projected on hand | | 70 | 70 | 70 | 20 | 20 | 20 | 20 | 50 |
| Lot size = multiples of 70 | Net requirements | | | | 330 | | | | 580 | |
| | Planned-order receipts | | | | 350 | | | | 630 | |
| | Planned-order releases | | | 350 | | | | 630 | | |

Master schedule for shutters:

| Week number | Beg. Inv. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Quantity | | | | | | | | | |

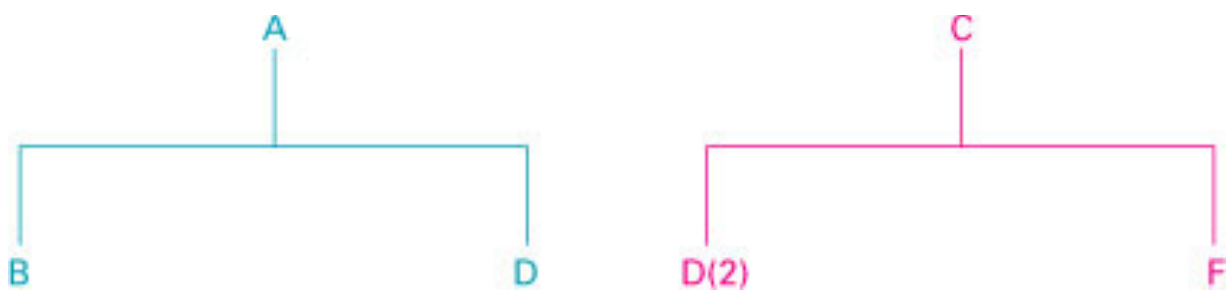
| Item: Shutters | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gross requirements | | | | | | | | | |
| Scheduled receipts | | | | | | | | | |
| Projected on hand | | | | | | | | | |
| Net requirements | | | | | | | | | |
| Planned-order receipts | | | | | | | | | |
| Planned-order releases | | | | | | | | | |

| Item: Frames | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gross requirements | | | | | | | | |
| Scheduled receipts | | | | | | | | |
| Projected on hand | | | | | | | | |
| Net requirements | | | | | | | | |
| Planned-order receipts | | | | | | | | |
| Planned-order releases | | | | | | | | |

| Item: Wood sections | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gross requirements | | | | | | | | |
| Scheduled receipts | | | | | | | | |
| Projected on hand | | | | | | | | |
| Net requirements | | | | | | | | |
| Planned-order receipts | | | | | | | | |
| Planned-order releases | | | | | | | | |

# Example

Consider the two product structure trees shown in figure. Note that both products have D as a component. Suppose we want to develop a material requirements plan for D given this additional 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. The plan is shown in figure 2. Note that requirements for B and F are not shown because they are not related to (i.e., neither a "parent" nor a "child" of) D.



# Material requirements plan for component D

Master schedule

| Week number | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Quantity of A | | | | | 80 | | |
| Quantity of C | | | | | | 50 | |

| A LT = 1 | Beg. Inv. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Gross requirements | | | | | 80 | | |
| Scheduled receipts | | | | | | | |
| Projected on hand | | | | | | | |
| Net requirements | | | | | 80 | | |
| Planned-order receipts | | | | | 80 | | |
| Planned-order releases | | | | 80 | | | |

| C LT = 1 | Beg. Inv. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Gross requirements | | | | | | 50 | |
| Scheduled receipts | | | | | | | |
| Projected on hand | | | | | | | |
| Net requirements | | | | | | 50 | |
| Planned-order receipts | | | | | | 50 | |
| Planned-order releases | | | | | 50 | | |

times 2

| D LT = 1 | Beg. Inv. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Gross requirements | | | | 80 | 100 | | |
| Scheduled receipts | | | | | | | |
| Projected on hand | 110 | 110 | 110 | 110 | 30 | | |
| Net requirements | | | | | 70 | | |
| Planned-order receipts | | | | | 70 | | |
| Planned-order releases | | | | 70 | | | |

# Updating the System

# MRP Outputs

**Primary Reports:** Production and inventory planning and control are part of primary reports. These reports normally include the following:

- *Planned orders,* a schedule indicating the amount and timing of future orders.
- *Order releases,* authorizing the execution of planned orders.
- *Changes,* to planned orders, including revisions of due dates or order quantities and cancellations of orders.

**Secondary Reports:** Performance control, planning, and exceptions belong to secondary reports.

- *Performance-control reports,* evaluate system operation. They aid managers by measuring deviations from plans, including missed deliveries and stockouts, and by providing information that can be used to assess cost performance.
- *Planning reports,* are useful in forecasting future inventory requirements. They include purchase commitments and other data that can be used to assess future material requirements.
- *Exception reports,* call attention to major discrepancies such as late and overdue orders, excessive scrap rates, reporting errors, and requirements for nonexistent parts.

# Other Considerations

**Safety Stock**

**Lot Sizing**

- **Lot-for-Lot Ordering.** Perhaps the simplest of all the methods is lot-for-lot ordering.
- **Economic Order Quantity Model.**
- **Fixed-Period Ordering.**

# MRP in Services

# Benefits and Requirements of MRP

**Benefits**

Low levels of in-process inventories.

The ability to keep track of material requirements.

The ability to evaluate capacity requirements generated by a given master schedule.

A means of allocating production time.

The ability to easily determine inventory usage by *backflushing*.

**Requirements**

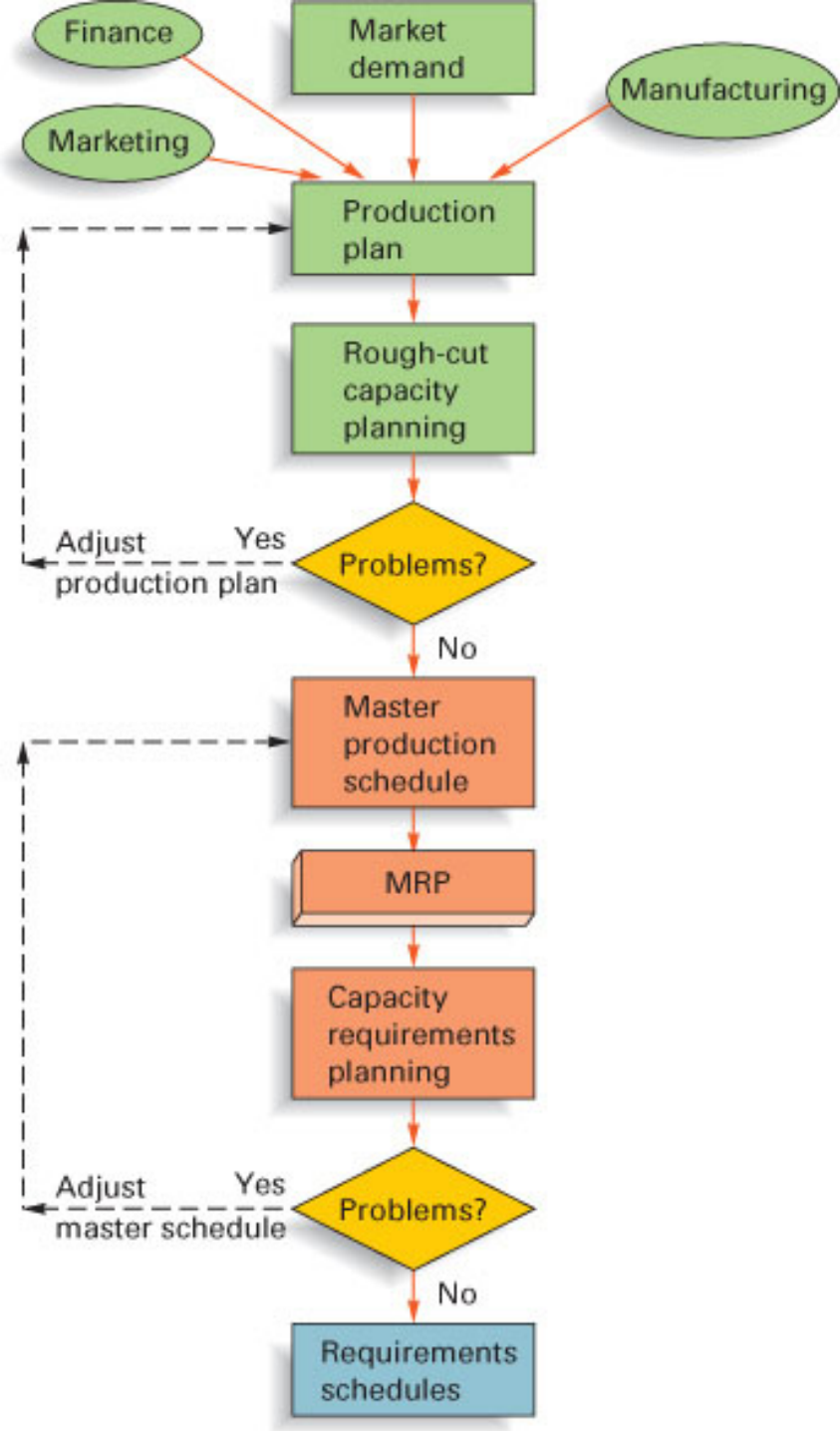
A computer and the necessary software programs to handle computations and maintain records.

Accurate and up-to-date

- Master schedules.
- Bills of materials.
- Inventory records.

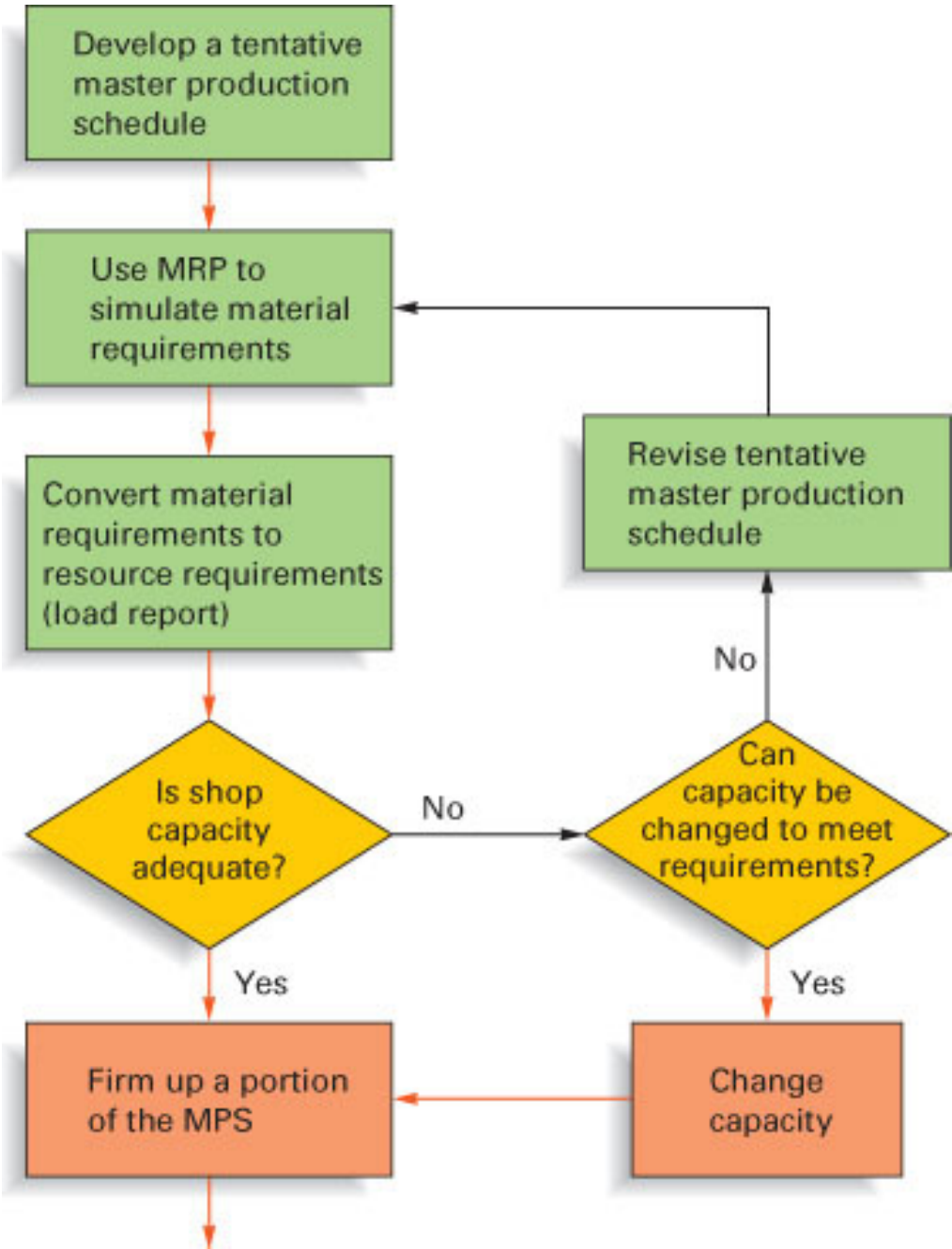
Integrity of *file data*.

# MRP II

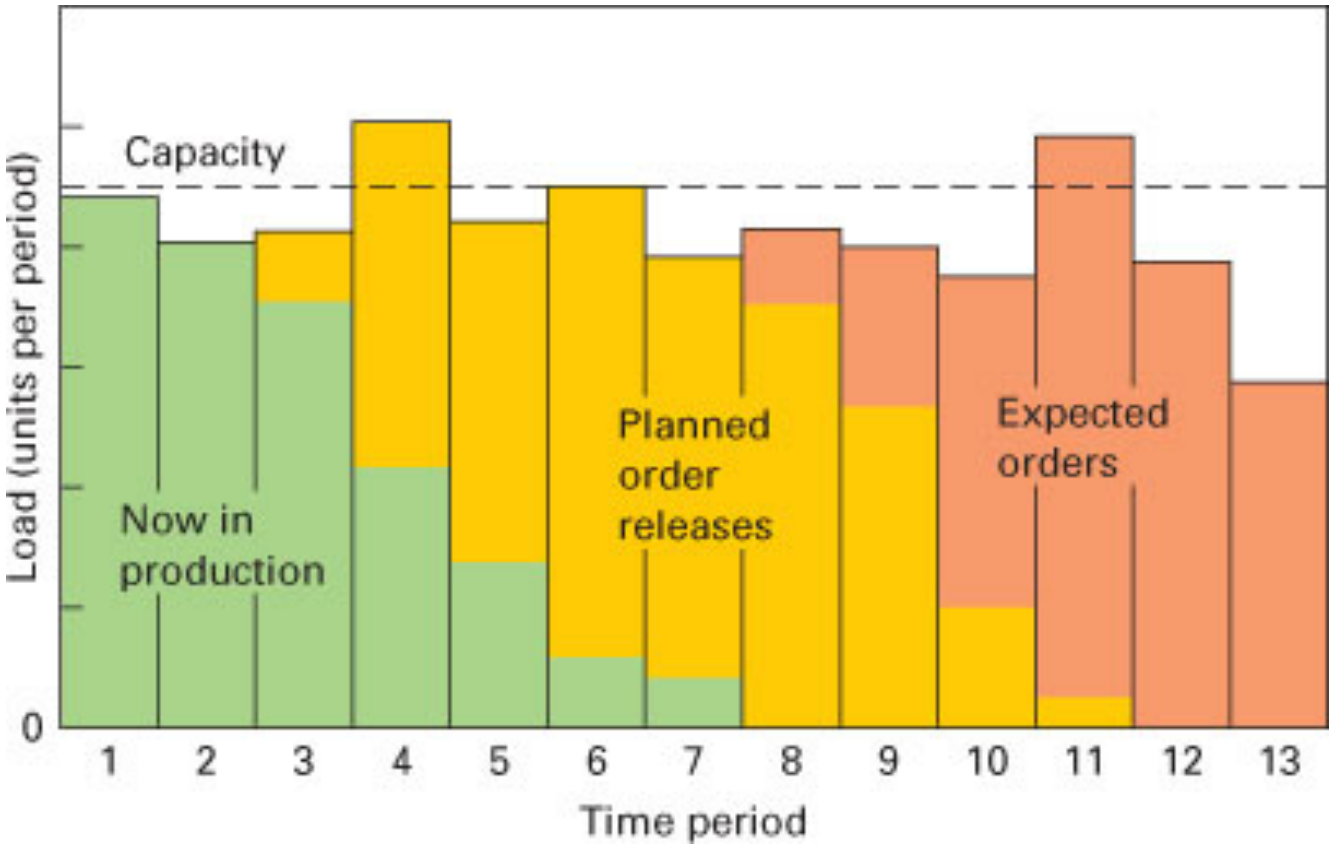

Finance
Market demand
Manufacturing
Marketing
Production plan
Rough-cut capacity planning
Adjust production plan
Yes
Problems?
No
Master production schedule
MRP
Capacity requirements planning
Adjust master schedule
Yes
Problems?
No
Requirements schedules

# Closed-Loop MRP

# Capacity Requirements Planning



A hypothetical department load profile



# ERP