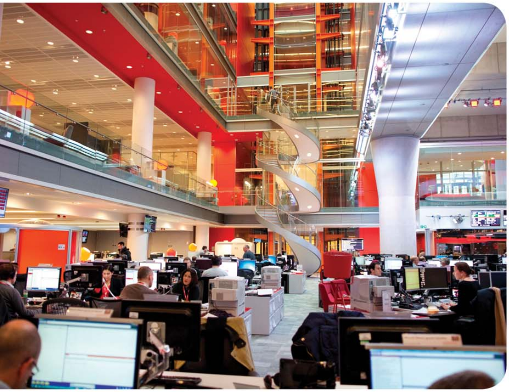
Operations Management

Twelfth Edition



William J. Stevenson

Week number

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

FIGURE 12.3
A master schedule for end item X

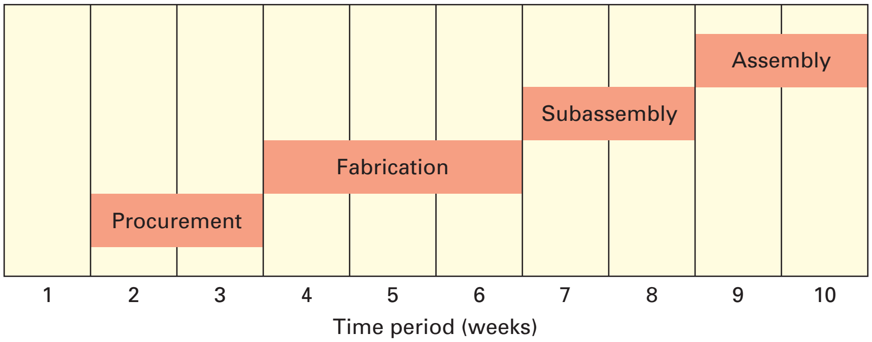


FIGURE 12.4
The planning horizon must cover the cumulative lead time

The quantities in a master schedule come from a number of different sources, including customer orders, forecasts, and orders from warehouses to build up seasonal inventories.

The master schedule separates the planning horizon into a series of time periods or time *buckets,* which are often expressed in weeks. However, the time buckets need not be of equal length. In fact, the near-term portion of a master schedule may be in weeks, but later portions may be in months or quarters. Usually, plans for those more distant time periods are more tentative than near-term requirements.

Although a master production schedule has no set time period that it must cover, most managers like to plan far enough into the future so they have some general idea of probable upcoming demands for the near term. It is important, though, that the master schedule cover the *stacked* or **cumulative lead time** necessary to produce the end items. This amounts to the sum of the lead times that sequential phases of the production or assembly process require, as illustrated in Figure 12.4, where a total of nine weeks of lead time is needed from ordering parts and raw materials until final assembly is completed. Note that lead times include move and wait times in addition to setup and run times.

Cumulative lead time
The sum of the lead times that sequential phases of a process require, from ordering of parts or raw materials to completion of final assembly.

The Bill of Materials

A **bill of materials (BOM)** contains a listing of all of the assemblies, subassemblies, parts, and raw materials that are needed to produce *one* unit of a finished product. Thus, each finished product has its own bill of materials.

Bill of materials (BOM)
One of the three primary inputs of MRP; a listing of all of the raw materials, parts, subassemblies, and assemblies needed to produce one unit of a product.

The listing in the bill of materials is hierarchical; it shows the quantity of each item needed to complete one unit of its parent item. The nature of this aspect of a bill of materials is clear when you consider a **product structure tree**, which provides a visual depiction of the subassemblies and components needed to assemble a product. Figure 12.5 shows an *assembly diagram* for a chair and a simple product structure tree for the chair. The end item (in this case, the chair, the finished product) is shown at the top of the tree. Just beneath it are the subassemblies, or major components, that must be put together to make up the end item. Beneath each major component are the necessary lesser components. At each stage moving down the tree are the components (parts, materials) needed to make one unit of the next higher item in the tree.

Product structure tree
A visual depiction of the requirements in a bill of materials, where all components are listed by levels.

A product structure tree is useful in illustrating how the bill of materials is used to determine the quantities of each of the ingredients (requirements) needed to obtain a desired number of end items. Items at the lowest levels of a tree often are raw materials or purchased parts, while items at higher levels are typically assemblies or subassemblies. Product-structure trees for items at the lowest levels are the concerns of suppliers.

Let's consider the product structure tree shown in Figure 12.6. End item X is composed of two Bs and one C. Moreover, each B requires three Ds and one E, and each D requires four Es. Similarly, each C is made up of two Es and two Fs. These *requirements* are listed by *level,*

FIGURE 12.5
Assembly diagram and product structure tree for chair assembly

Bill of Materials

Level		Quantity
0	Chair	1
1	Leg assembly	1
2	Legs	2
2	Cross bar	1
1	Seat	1
1	Back assemby	1
2	Side rails	2
2	Cross bar	1
2	Back supports	3

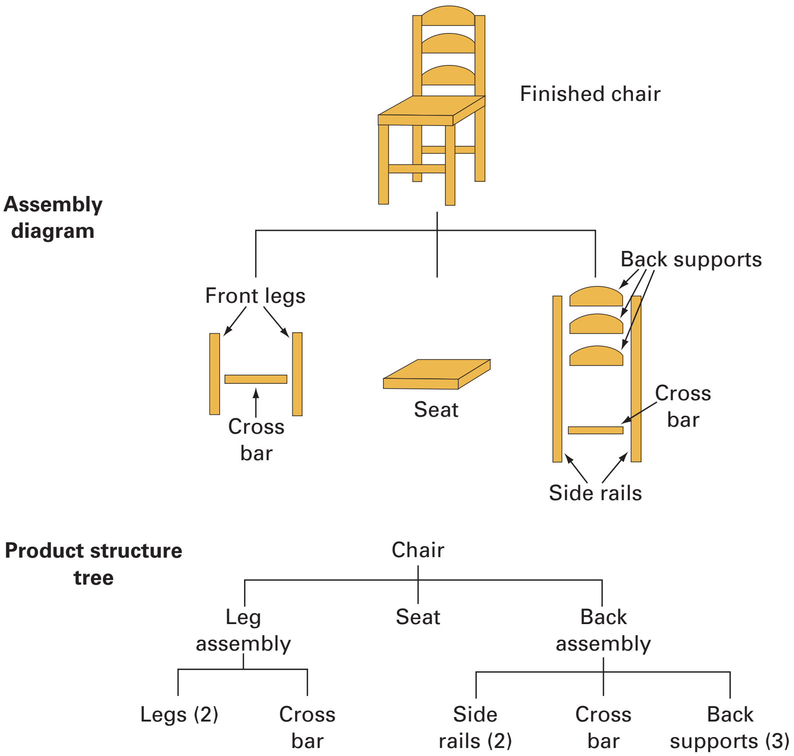
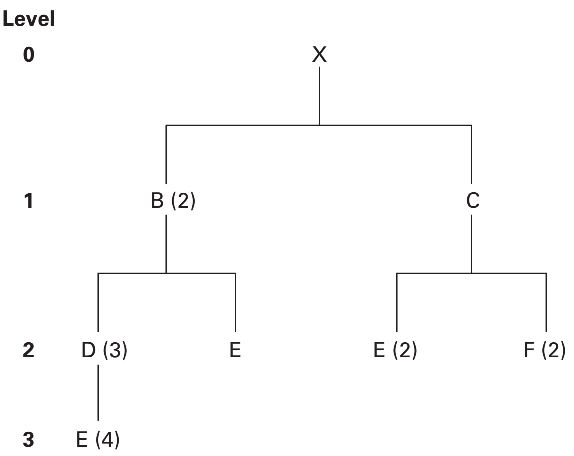


FIGURE 12.6
A product structure tree for end item X



beginning with 0 for the end item, then 1 for the next level, and so on. The items at each level are *components* of the next level up and, as in a family tree, are *parents* of their respective components. 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.

EXAMPLE 1

eXcel
mhhe.com/stevenson12e

Use the information presented in Figure 12.6 to do the following:

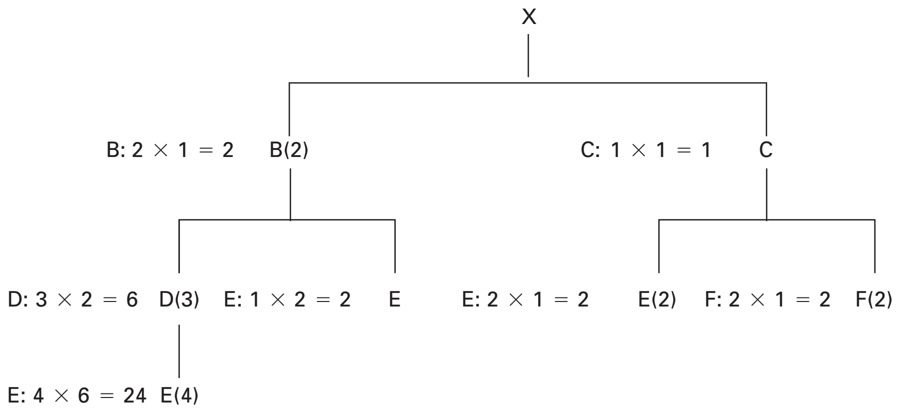
a. Determine the quantities of B, C, D, E, and F needed to assemble one X.

b. 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

SOLUTION

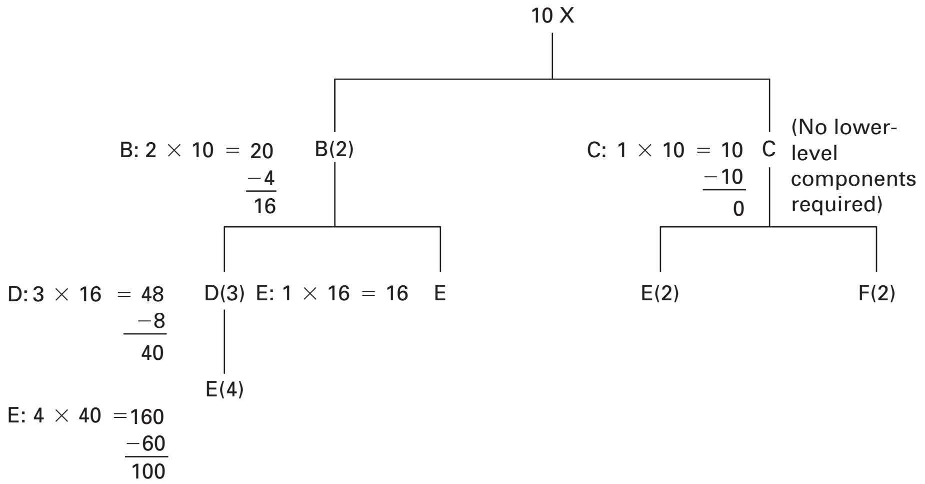
a.



Thus, one X will require

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.

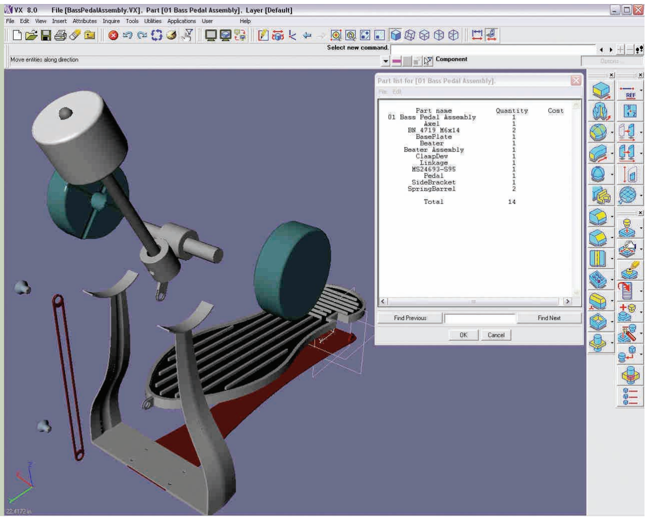


Thus, given the amounts of on-hand inventory, 10 Xs will require

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

Determining total requirements is usually more complicated than Example 1 might suggest. For one thing, many products have considerably more components. For another, the issue of *timing* is essential (i.e., when must the components be ordered or made) and must be included in the analysis. Finally, for a variety of reasons, some of the components/subassemblies may be on hand (i.e., currently in inventory). Consequently, in determining total requirements, the amounts on hand must be *netted out* (i.e., subtracted from the apparent requirements) to determine the true requirements as illustrated in Example 1.

VX Corporation's CAD/CAM software can be used not only for design specification but also to prepare parts lists. This screen shows a parts list for a bass drum pedal along with a three-dimensional view of the product subassemblies.



Low-level coding Restructuring the bill of materials so that multiple occurrences of a component all coincide with the lowest level at which the component occurs.

When an MRP system calculates requirements, the computer scans a bill of materials by level. When a component such as E in Figure 12.6 appears on more than one level, **low-level coding** is used so that all occurrences of that component appear on the lowest level at which the component appears. In Figure 12.6, conceptually that would be equivalent to lengthening the vertical line for the two appearances of E at level 2 so that all three occurrences line up at level 3 in the tree.

Comment It is extremely important that the bill of materials accurately reflect the composition of a product, particularly since errors at one level become magnified by the multiplication process used to determine quantity requirements. As obvious as this might seem, many companies find themselves with incorrect bill-of-material records. These make it impossible to effectively determine material requirements; moreover, the task of correcting these records can be complex and time-consuming. Accurate records are a prerequisite for effective MRP.

The Inventory Records

Inventory records One of the three primary inputs in MRP; includes information on the status of each item by time period.

Inventory records refer to stored information on the status of each item by time period, called *time buckets.* This includes quantities on hand quantities ordered. It also includes other details for each item, such as supplier, lead time, and lot size policy. Changes due to stock receipts and withdrawals, canceled orders, and similar events also are recorded in this file.

Like the bill of materials, inventory records must be accurate. Erroneous information on requirements or lead times can have a detrimental impact on MRP and create turmoil when incorrect quantities are on hand or expected delivery times are not met.

12.4 MRP PROCESSING

LO12.3 Explain how requirements in a master production schedule are translated into material requirements for lower-level items.

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. You can see the time-phasing of requirements in the assembly time chart in Figure 12.7. For example, raw materials D, F, and I must be ordered at the start of week 2; part C at the start of week 4; and part H at the start of week 5 in order to be available for delivery as planned.

MRP processing combines the time phasing and "explosion" into a sequence of spreadsheet sections, where each section has the following format: