

CHAPTER 4

PRODUCTION AND SUPPLY CHAIN MANAGEMENT INFORMATION SYSTEMS

LEARNING OBJECTIVES

After completing this chapter, you will be able to:

- Describe the steps in the production planning process of a high-volume manufacturer, such as Fitter Snacker
- Describe Fitter Snacker's production and materials management problems
- Explain how a structured supply chain management planning process enhances efficiency and decision making
- Understand how production planning data in an ERP system can be shared with suppliers to increase supply chain efficiency

INTRODUCTION

In Chapter 2, you learned that Enterprise Resource Planning (ERP) has its roots in materials requirements planning (MRP) processes and software. Materials requirements planning, and the extension of that process to partners in the supply chain, are important parts of today's ERP systems. In fact, effective supply chain management is critical to the success of companies such as Fitter Snacker. In this chapter, we will first examine how Fitter manages its production activities, and then we will explore some supply chain management functions in an ERP system. We will also we will look at the broader concept of supply chain management.

In Chapter 3, we looked at Fitter's sales order process, and we assumed that Fitter had enough snack bars in its warehouse to fill a typical order. Like most unintegrated manufacturing operations, however, Fitter often has problems scheduling production. Consequently, sometimes its warehouse is not adequately stocked, and customer orders cannot be filled in a timely fashion—leading to customer dissatisfaction and lost sales. In this chapter, you will explore Fitter's supply chain management problems and learn how ERP can help solve them.

PRODUCTION OVERVIEW

To efficiently meet customer demand, Fitter must develop an estimate of customer demand, and then develop a production schedule to meet that forecasted demand. Developing a production plan is a complicated task, but the end result answers two simple questions:

- How many of each type of snack bar should we produce, and when?
- What quantities of raw materials should we order so we can meet that level of production, and when should they be ordered?

Developing a good production plan is just the first step: Fitter must also be able to execute the plan and make adjustments when customer demand does not meet the forecast. An ERP system is a good tool for developing and executing production plans because it integrates the functions of production planning, purchasing, materials management/warehousing, quality management, sales, and accounting. To support even better supply chain management, companies can connect ERP systems to supplier and customer information systems as well.

In this chapter, we will use spreadsheet examples to illustrate the logic that Fitter should be using to plan and schedule production of its NRG bars. First, we will look at Fitter's current production process, as well as some of the associated problems that are due to Fitter's unintegrated systems. We will use spreadsheets to further explore the planning and scheduling logic required at each stage of the production planning process, and then we will examine the SAP ERP screens that implement this logic in an ERP environment. Throughout the chapter, you will develop a deeper understanding of why using an integrated information system is superior to using unintegrated systems.

The goal of production planning is to schedule production economically so a company can ship goods to its customers by the promised delivery dates in the most cost-efficient manner. There are three general approaches to production:

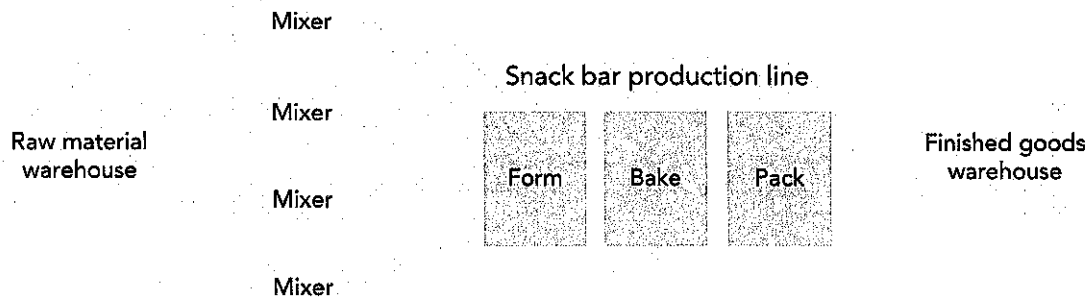
- *Make-to-stock*—Items are made for inventory (the “stock”) in anticipation of sales orders; most consumer products (for example, cameras, canned corn, and books) are made this way.
- *Make-to-order*—Items are produced to fill specific customer orders; companies usually take this approach when producing items that are too expensive to keep in stock or items that are made or configured to customer

specifications. Examples of make-to-order items are airplanes and large industrial equipment.

- *Assemble-to-order*—Items are produced using a combination of make-to-stock and make-to-order processes; the final product is assembled for a specific order from a selection of make-to-stock components. Personal computers are a typical assemble-to-order product.

Fitter's Manufacturing Process

Fitter uses make-to-stock production techniques to produce its snack bars. The manufacturing process is illustrated in Figure 4-1.



Source Line: Course Technology/Cengage Learning.

FIGURE 4-1 Fitter's manufacturing process

The snack bar production line can produce 200 bars per minute—or 12,000 bars per hour. Each bar weighs 4 ounces, which means the line produces 48,000 ounces (or 3,000 pounds) of bars per hour. The entire production line operates on one shift a day. The next section describes Fitter's production process in more detail.

Fitter's Production Sequence

Raw materials are taken from the warehouse to one of four mixers. Each mixer mixes dough in 500-pound batches. Mixing a batch of dough requires 15 minutes of mixing time, plus another 15 minutes to unload, clean, and load the mixer for the next batch of dough; therefore, each mixer can produce two 500-pound batches of dough per hour. That means the four mixers can produce a total of 4,000 pounds of dough per hour—more than the production line can process. Because only three mixers need to be operating at a time to produce 3,000 pounds of snack bars per hour, a mixer breakdown will not shut down the production line.

After mixing, the dough is dumped into a hopper (bin) at the beginning of the snack bar production line. A forming mechanism molds the dough into bars, which will weigh 4 ounces each. Next, an automated process takes the formed bars on a conveyor belt through an oven that bakes the bars for 30 minutes. When the bars emerge from the oven, they are individually packaged in a foil wrapper, and each group of 24 bars is packaged into a display box. At the end of the snack bar line, display boxes are stacked on pallets (for larger orders the display boxes are first packed into shipping boxes, which are then stacked on the pallets).

Switching the production line from one type of snack bar to the other takes 30 minutes—for cleaning the equipment and changing the wrappers, display boxes, and shipping cases. Each night, a second shift of employees cleans all the equipment thoroughly and sets it up for the next day's production. Thus, changing production from NRG-A on one day to NRG-B the next day can be done at the end of the day without a loss of capacity. (**Capacity** is the maximum amount of bars that can be produced.) On the other hand, producing two products in one day results in a half-hour loss of capacity during the changeover.

Fitter's Production Problems

Fitter has no problems *making* snack bars, but it does have problems deciding *how many* bars to make and *when* to make them. The manufacturing process at Fitter suffers from a number of problems, ranging from communication breakdowns and inventory issues to accounting inconsistencies, mainly stemming from the unintegrated nature of its information systems.

Communication Problems

Communication breakdowns are an inherent problem in most companies, and they are magnified in a company with an unintegrated information system. For example, at Fitter, Marketing and Sales personnel do a poor job of sharing information with Production personnel. Marketing and Sales frequently excludes Production from meetings, neglects to consult Production when planning sales promotions, and often fails to even alert Production of planned promotions. Marketing and Sales also typically forgets to notify Production when it takes an exceptionally large order.

When Production must meet an unexpected increase in demand, several things happen. First, warehouse inventories are depleted. To compensate, Production must schedule overtime labor, which results in higher production costs for products. Second, because some materials (such as ingredients, wrappers, and display boxes) are custom products purchased from a single vendor, a sudden increase in sales demand can cause shortages or even a stockout of these materials. Getting these materials to Fitter's plant might require expedited shipping, further increasing the cost of production. Finally, unexpected spikes in demand result in high levels of frustration for Production staff. Production personnel are evaluated on their performance—how successful they are at controlling costs, keeping manufacturing lines running, maintaining quality control, and operating safely. If they cannot keep production costs down, Production staff receive poor evaluations. Managers are especially frustrated when an instant need for overtime follows a period of low demand. With advance notice of a product promotion by Marketing and Sales, Production could use slack periods to build up inventory in anticipation of the increase in sales.

Inventory Problems

As noted earlier, Fitter's week-to-week and day-to-day production planning is not linked in a systematic way to expected sales levels. When deciding how much to produce, the production manager applies rules developed through experience. Her primary indicator is the difference between the normal amount of finished goods inventory that should be stocked and the actual inventory levels of finished goods in the warehouse. Thus, if NRG-A or NRG-B inventory levels seem low, the production manager schedules more bars for production. However, she does not want too many bars in inventory because they have a

limited shelf life. Her judgment is also influenced by the information she hears informally from people in Marketing and Sales about expected sales levels.

The production manager's inventory data are maintained in an Access database. Data records are not updated in real time and do not flag inventory that has been sold but not yet shipped. (Such inventory is not available for sale, of course, but employees cannot determine this by looking at the database; thus, workers do not know the level of inventory that is available to ship at any given moment). This is problematic if the Wholesale Division generates unusually large orders or high volumes of orders. For example, two large Wholesale Division orders arriving at the same time can deplete the entire available inventory of NRG-A bars. If Production is manufacturing NRG-B bars at that time, it must halt production of those bars so it can fill the orders for NRG-A. This means delaying production of NRG-B bars and losing production capacity due to the unplanned production changeover.

The production manager lacks a systematic method not only for meeting anticipated sales demand, but also for adjusting production to reflect actual sales. Marketing and Sales does not share actual sales data with the Production Department, partly because this information is hard to gather on a timely basis and partly because of a lack of trust between the Sales and Production departments (as a result of prior negative experiences). If Production had access to sales forecasts and real-time sales order information, the manager could make timely adjustments to production, if needed. These adjustments would allow inventory levels to come much closer to what is actually needed.

Accounting and Purchasing Problems

Production and Accounting do not have a good way to calculate the day-to-day costs of Fitter's production. Manufacturing costs are based on the number of bars produced each day, a number that is measured at the end of the snack bar production line. For the purpose of figuring manufacturing costs, Fitter uses **standard costs**, which are the normal costs of manufacturing a product; standard costs are calculated from historical data, factoring in any changes in manufacturing that have occurred since the collection of the historical data. For each batch of bars it produces, Fitter can estimate direct costs (materials and labor) and indirect costs (factory overhead). The number of batches produced is multiplied by the standard cost of a batch, and the resulting amount is charged to manufacturing costs.

Most manufacturing companies use standard costs in some way, but the method requires that standards be adjusted periodically to conform with actual costs. (These adjustments will be discussed in Chapter 5.) Fitter's actual raw material and labor costs often deviate from the standard costs, in part, because Fitter is not good at controlling raw materials purchases. The production manager cannot give the purchasing manager a good production forecast, so the purchasing manager works on two tracks: First, she tries to keep raw materials inventories high to avoid stockouts. Second, if she is offered good bulk-quantity discounts on raw materials such as oats, she will buy in bulk, especially for items that have long lead times for delivery. These purchasing practices make it difficult both to forecast the volume of raw materials that will be on hand and to calculate an average cost of the materials purchased for profitability planning. Fitter also has trouble accurately forecasting the average cost of labor for a batch of bars because of the frequent need for overtime labor.

Thus, Production and Accounting must periodically compare standard costs with actual costs and then adjust the accounts for the inevitable differences, which is always a tedious and unpleasant job. The comparison should be done at each monthly closing, but Fitter often puts it off until the closing at the end of each quarter, when its financial backers require legitimate financial statements. The necessary adjustments are often quite large, depending on production volumes and costs during the quarter.

Exercise 4.1

- a. A convenience store chain offers to buy a very large amount of its store brand health bars (the NRG-B bars with a customized wrapper). The chain wants a lower-than-normal price because the proposed order is quadruple the size of its regular order. The marketing manager asks managers from Production, Purchasing, and Accounting whether the terms of the proposed deal will be profitable. Will the managers in these areas be able to provide a reliable answer on short notice?
- b. The production manager notes that current warehouse inventory levels are fairly high, so the production line does not need to be run for a full eight hours each day during the coming week. For several reasons, however, she plans to run the line for eight hours a day anyway. If the line shuts down workers would still need to be paid during the idle time and overhead costs would continue to be incurred as well. Running the line full time decreases the average cost of bars actually produced (indirect costs can be spread over more bars). In addition, some warehoused raw materials will spoil if they are not used soon. Is the production manager's reasoning logical? Why, or why not?

THE PRODUCTION PLANNING PROCESS

In this section, you will examine a systematic process for developing a production plan that takes advantage of an ERP system. Spreadsheet calculations are presented to explain and illustrate the key steps, and the corresponding screens in the SAP ERP system follow the spreadsheet data.

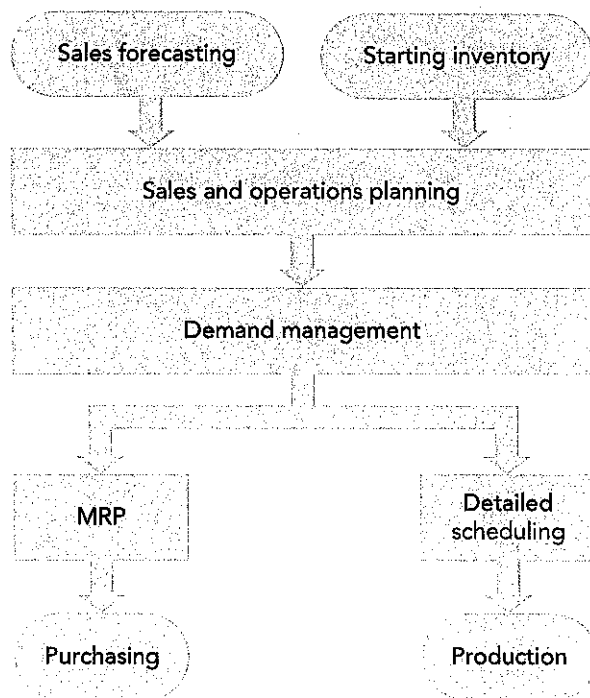
Production planners are employees who interact with the inventory system and the sales forecast to determine how much to produce. Planners follow three important principles:

- Using a sales forecast, and taking into account current inventory levels, create an aggregate (combined) production plan for all products. Aggregate production plans help to simplify the planning process in two ways: First, plans are made for groups of related products rather than for individual products. Second, the time increment used in aggregate planning is frequently a month or a quarter, while the production plans that will actually be executed operate on a daily or weekly basis. Aggregate plans should consider the available capacity in the facility.
- Break down the aggregate plan into more specific production plans for individual products and then into smaller time intervals.
- Use the production plan to determine raw material requirements.

Production planners aggregate products into product groups to reduce the number of variables they must consider when developing a production plan. Developing production groups can be complicated. For example, cereal manufacturers can group together different package sizes, or they might group together product brands (such as kids' cereals, health cereals, and so on). A consumer products company may group by product type (e.g., shampoo, laundry detergent, and disposable diapers). The aggregate production plan for Fitter will combine the only two products, NRG-A and NRG-B bars, into one group to illustrate the process. The plan will be developed using a monthly time increment. Ultimately, the monthly production plan will be disaggregated to determine weekly raw materials orders and daily production schedules.

The SAP ERP Approach to Production Planning

The SAP ERP approach to the production planning process is shown in Figure 4-2. Refer to this figure throughout this discussion to track the stages in the production planning process.



Source Line: Course Technology/Cengage Learning.

FIGURE 4-2 The SAP ERP production planning process

The information at each stage of the production process flows through the following steps, which are explained in detail in the upcoming sections:

- *Sales forecasting* is the process of predicting future demand for a company's products.
- *Sales and operations planning (SOP)* is the process of determining what the company will produce. In the diagram, the Sales forecasting and Starting

inventory levels are inputs to this process. At first glance, it might seem that a company should just make products to match forecasted sales, but developing the production plan is often more complicated than that because capacity must be considered. Many products have seasonal demand, and to meet demand during peak periods, production planners must decide whether to build up inventory levels before the peak demand, increase capacity during the peak period, subcontract production, or use some combination of these approaches.

- In the *Demand management* step, the production plan is broken down into smaller time units, such as weekly or even daily production figures, to meet demand for individual products.
- The *Materials requirements planning (MRP)* process determines the amount and timing of raw material orders. This process answers the questions: “What raw materials should we be ordering so we can meet a particular level of production?” and “When should we order these materials?”
- In the *Purchasing* step, the quantity and timing information from the MRP process is used to create raw materials purchase orders, which are transmitted to qualified suppliers.
- The *Detailed scheduling* process uses the production plans developed during the demand management step as an input for a production schedule. The detailed scheduling method used depends on the manufacturing environment. For Fitter, the detailed production schedule will determine when the production line will switch between the NRG-A and NRG-B bars.
- The *Production* process uses the detailed schedule to manage daily operations, answering the questions: “What should we be producing?” and “What staffing do we need to produce those products?”

Let’s take a more detailed look at each of these steps in the production process.

Sales Forecasting

Currently, Fitter Snacker has no formal way of developing a sales forecast and sharing it with Production. SAP’s ERP system would allow it to take an integrated approach to sales forecasting. Whenever a sale is recorded in SAP’s ERP Sales and Distribution (SD) module, the quantity sold is recorded as a consumption value for that material. These consumption values can be updated on a weekly or monthly basis, as desired. If more detail is needed, the Logistics Information system that is part of SAP ERP can record sales with more detail (for example, by region or sales office), or data can be stored in the separate Business Warehouse (BW) system for more detailed analysis. With an integrated information system, accurate historical sales data are available for forecasting.

A range of forecasting techniques can be used to predict consumer demand. One simple forecasting technique is to use a prior period’s sales and then adjust those figures for current conditions. To make a forecast for Fitter, we can use the previous year’s sales data in combination with information on this year’s marketing initiatives to predict future sales. Look at the forecasts that were created for January through June, shown in Figure 4-3.

Sales forecasting		Jan.	Feb.	March	April	May	June
Previous year (cases)		5734	5823	5884	6134	6587	6735
Promotion sales (cases)						300	300
Previous year base (cases)		5734	5823	5884	6134	6287	6435
Growth:	3.0%	172	175	177	184	189	193
Base projection (cases)		5906	5998	6061	6318	6476	6628
Promotion (cases)							500
Sales forecast (cases)		5906	5998	6061	6318	6476	7128

Source Line: Course Technology/Cengage Learning.

FIGURE 4-3 Fitter's sales forecast for January through June

The sales data in Figure 4-3 are for shipping cases, which contain 12 display boxes with 24 bars each, for a total of 288 bars. Note in Figure 4-3 that the forecast starts with the previous year's sales levels, to reflect Fitter's seasonal sales fluctuations (sales are higher in the summer when more people are active). Also note that there was a special marketing promotion last year. The estimated impact of this promotion was an increase in sales of 300 cases for May and June. To get accurate base figures for last year's sales, this promotional increase must be subtracted from the previous year's sales numbers.

Fitter's Marketing and Sales Department anticipates a 3 percent growth in sales over last year, based on current trends and on research reported in trade publications. In addition, Fitter will be launching a special marketing promotion at the end of May to increase sales at the beginning of the summer season. As shown in Figure 4-3, Fitter marketing experts think the promotion will result in a sales increase of 500 cases for June.

Exercise 4.2

Following the format of the spreadsheet in Figure 4-3, develop a spreadsheet to forecast Fitter's sales for July through December. Calculate the base projection using the previous year's values (shown in Figure 4-4), and factor in the 3 percent estimated growth rate. Assume that the special marketing promotion last year resulted in an increase in sales of 200 cases for July, and that a special marketing promotion this year will result in an increase in sales for July of 400 cases.

Sales volume	July	Aug.	Sept.	Oct.	Nov.	Dec.
Previous year	6702	6327	6215	6007	5954	5813

Source Line: Course Technology/Cengage Learning.

FIGURE 4-4 Fitter's sales for last year, July through December

Sales and Operations Planning

Sales and operations planning (SOP) is the next step in the production planning process. The input to this step is the sales forecast provided by Marketing and Sales. The output is a production plan designed to balance demand with production capacity. The production plan becomes the input to the next step, demand management. The goal is to develop a production plan that meets demand without exceeding capacity and that maintains

“reasonable” inventory levels (neither too high nor too low). This process requires judgment and experience.

A sales and operations plan is developed from a sales forecast, and it determines how Manufacturing can efficiently produce enough goods to meet projected sales. In Fitter's case, there is no way to make this determination, because Fitter does not produce a formal estimate of sales. If Fitter had an ERP system, the calculation would be done as described here.

We know that Fitter can produce 200 bars per minute, so we can estimate the production capacity required by the sales forecast. Figure 4-5 shows Fitter's sales and operations plan for the first six months of the year.

Sales and operations planning		Dec.	Jan.	Feb.	March	April	May	June
1) Sales forecast			5906	5998	6061	6318	6476	7128
2) Production plan			5906	5998	6061	6318	6650	6950
3) Inventory		100	100	100	100	100	274	96
4) Working days			21	20	23	21	21	22
5) Capacity (shipping cases)			6999	6666	7666	6999	6999	7333
6) Utilization			84%	90%	79%	90%	95%	95%
7) NRG-A (cases)	70.0%		4134	4199	4243	4423	4655	4865
8) NRG-B (cases)	30.0%		1772	1799	1818	1895	1995	2085

Source Line: Course Technology/Cengage Learning.

FIGURE 4-5 Fitter's sales and operations plan for January through June

The first line in Figure 4-5 is the sales forecast, which is the output of the sales forecasting process shown in Figure 4-3. The next line is the production plan, which the production planner develops—in a trial-and-error fashion—by observing the effect of different production quantities on the lines in the spreadsheet that calculate inventory levels and capacity utilization (the amount of plant capacity that is being consumed).

The third line, inventory, calculates what the inventory should be based on the previous periods inventory, sales forecast, and production plan. The plan in this example assumes an inventory of 100 cases as of the end of December. Adding production of 5,906 cases to this inventory and subtracting the forecast sales of 5,906 cases will leave an inventory of 100 cases at the end of January, if things go according to plan. The production planner has developed a plan that maintains a minimum planned inventory of approximately 100 cases. This inventory, called *safety stock*, is planned so if sales demand exceeds the forecast by no more than 100 cases, sales can be met without altering the production plan. Notice that in May, the production plan is greater than the May sales forecast and the inventory is 274. Why? Because the planner wants to build up inventory to handle the increased demand in June, which results from the normal seasonal increase in snack bar sales and additional demand from the planned promotional activities.

The fourth line shows the number of working days in a given month, an input based on the company calendar. Using the number of working days in a month, the available capacity each month is calculated in terms of the number of shipping cases:

- $200 \text{ bars per minute} \times 60 \text{ minutes per hour} \times 8 \text{ hours per day} = 96,000 \text{ bars per day}$
- $96,000 \text{ bars per day} \div 24 \text{ bars per box} \div 12 \text{ boxes per case} = 333.3 \text{ cases per day}$

- Multiplying the number of working days in a month times the production capacity of 333.3 shipping cases per day gives you the monthly capacity in shipping cases, which is shown in line 5.

With the available capacity (assuming no overtime) now expressed in terms of shipping cases, it is possible to determine the capacity utilization for each month by dividing the production plan amount (line 2) by the available capacity (line 5). The result is expressed as the utilization percentage (line 6). This capacity calculation shows whether Fitter has the capacity necessary to meet the production plan. While higher levels of capacity utilization mean that Fitter is producing more with its production resources, this percentage must be kept below 100 percent to allow for production losses due to product changeovers, equipment breakdowns, and other unexpected production problems. The sales and operations plan in Figure 4-5 shows that Fitter's highest level of capacity utilization is 95 percent in May and June.

The last step in sales and operations planning is to disaggregate the plan, that is, to break it down into plans for individual products. Lines 7 and 8 in Figure 4-5 disaggregate the planned production shown in line 2, based on the breakdown of 70 percent NRG-A and 30 percent NRG-B snack bars. This 70/30 breakdown was established using previous sales data for these products. The monthly production quantities in lines 7 and 8 are the output of the sales and operations planning process, and they are the primary input to the demand management process.

Suppose that Fitter is regularly able to achieve production levels at 90 percent of capacity. If the sales forecast requires more than 90 percent capacity, Fitter management can choose from among the following alternatives to develop a production plan:

- Fitter might choose not to meet all the forecasted sales demand, or it might reduce promotional activities to decrease sales.
- To increase capacity, Fitter might plan to use overtime production. Doing that, however, would increase labor cost per unit.
- Inventory levels could be built up in earlier months, when sales levels are lower, to reduce the capacity requirements in later months. Doing that, however, would increase inventory holding costs and increase the risk that NRG bars held in inventory might pass their expiration date before being sold by retailers.
- To find the right balance, management might try a hybrid approach to the capacity problem: reduce sales promotions slightly, increase production in earlier months, and plan for some overtime production.

The monthly production quantities (in lines 7 and 8 of Figure 4-5) create some inventory in May to meet June's sales; in addition, some overtime production is likely in May and June because capacity utilization is over 90 percent.

This example illustrates the value of an integrated system: it provides a tool for incorporating data from Marketing and Sales and Manufacturing and for evaluating different plans. Whereas Marketing and Sales may want to increase sales, the company might not increase its profits if overtime costs or inventory holding costs are too high. This sort of planning is difficult to do without an integrated information system, even for small companies like Fitter. Having an integrated information system helps managers of all functional areas meet corporate profit goals.

Sales and Operations Planning in SAP ERP

In SAP ERP, the sales forecast can incorporate historical sales data from the Sales and Distribution (SD) module, or the forecast can be created using input from plans developed in the Controlling (CO) module. In the CO module, profit goals for the company can be set, which can then be used to estimate the sales levels needed to meet the profit goals. Figure 4-6 shows the sales and operations planning screen from the SAP ERP system. The title of this screen is “Create Rough-Cut Plan.” Rough-cut planning is a common term in manufacturing for aggregate planning. As described above, rough-cut plans are disaggregated to generate detailed production schedules.

Create Rough-Cut Plan

Characteristics

Product group: NRE-GRUP NRE-A 200 NRE-B Group

Plant: PT

Version: 200-Version 200 New, active

SOP: plan individual product group		M 10/2011	M 11/2011	M 12/2011	M 01/2012	M 02/2012	M 03/2012	M 04/2012	M 05/2012
Planning table	Un								
Sales	CS								
Production	CS								
Stock level	CS								
Target stock level	CS								
Own supply	...								
Target own supply	...								

Source Line: SAP AG.

FIGURE 4-6 Sales and operations planning screen in SAP ERP

The sales forecast is entered in the first row (Sales) of the rough-cut plan. Data can be entered manually by the user, a sales forecast can be transferred from a profitability analysis performed in the CO module, or the user can perform a forecast in this screen, calling up historical sales data from the SAP ERP system. The second row, Production, represents the production that is planned to meet the sales forecast. Production figures can also be entered manually, or the SAP system can generate values that meet sales goals. The third row shows inventory as the Stock level. The gray shading of that row indicates it is a calculated result. The fourth row allows for the entry of a Target stock

level. If the user enters a value in this row, then SAP ERP will propose production levels to meet the Target stock level. Once the Target stock level is entered, the system will calculate the number of days' worth of supply, so the fifth row (Days' supply) is a calculated result. The sixth row lets the user specify a target stock level in terms of the number of days of demand it would cover, known as Target days' supply. The SAP system uses the factory calendar, which specifies company holidays and planned shutdowns, to determine the number of working days in a month when calculating the Target days' supply.

If the sales plan (the first line in Figure 4-6) is to be developed using forecasting tools, the SAP ERP system can provide the planner with historical sales values based on sales data stored in the system. Without an integrated system such as SAP, the planner would likely have to request sales figures from the Sales Department, and he or she might not be sure how accurate the data were. Figure 4-7 shows how the SAP ERP system displays historical sales figures.

Period	Val. M	Corr. Value
M 12/2011	4224	4224
M 01/2012	4120	4120
M 02/2012	4501	4501
M 03/2012	4104	4104
M 04/2012	4286	4286
M 05/2012	4111	4111
M 06/2012	4884	4884
M 07/2012	4442	4442

Source Line: SAP AG.

FIGURE 4-7 Historical sales figures in SAP

In addition to providing the historical sales values from the Sales and Distribution module, this screen allows the planner to “correct” the sales values. For example, sales may have been low in the past due to unusual weather conditions, or the planner might know that sales would have been higher if the company was able to meet all the demand. The sales figures used for forecasting should represent the best estimate of what *demand* was in the past, not necessarily what the actual sales were.

The SAP ERP system can automatically graph these data to help the planner determine if there are any unusual patterns in the historical sales values that require investigation. The planner can correct these values as well, to adjust sales values that were unusually high or low, or to back out (or subtract) the effects of previous sales promotions. After the sales forecast is made, it can be adjusted to incorporate increased sales from

planned sales promotions. Once the historical data are acceptable, the user can select one of the SAP ERP tools shown in Figure 4-8 to prepare the forecast.

Forecast: Model Selection
X

Periods

☒ Period interval

Forecast	From	10/2011	To	10/2012
Historical data	From	10/2004	To	09/2011

☐ No. of periods

No. of forecast periods	4
No. of historical values	40

Forecast execution

☐ Constant model	☐ Seasonal model
☐ Trend model	☐ Season, trend model
☒ Aut. model selection	☐ Historical

Forecast parameters

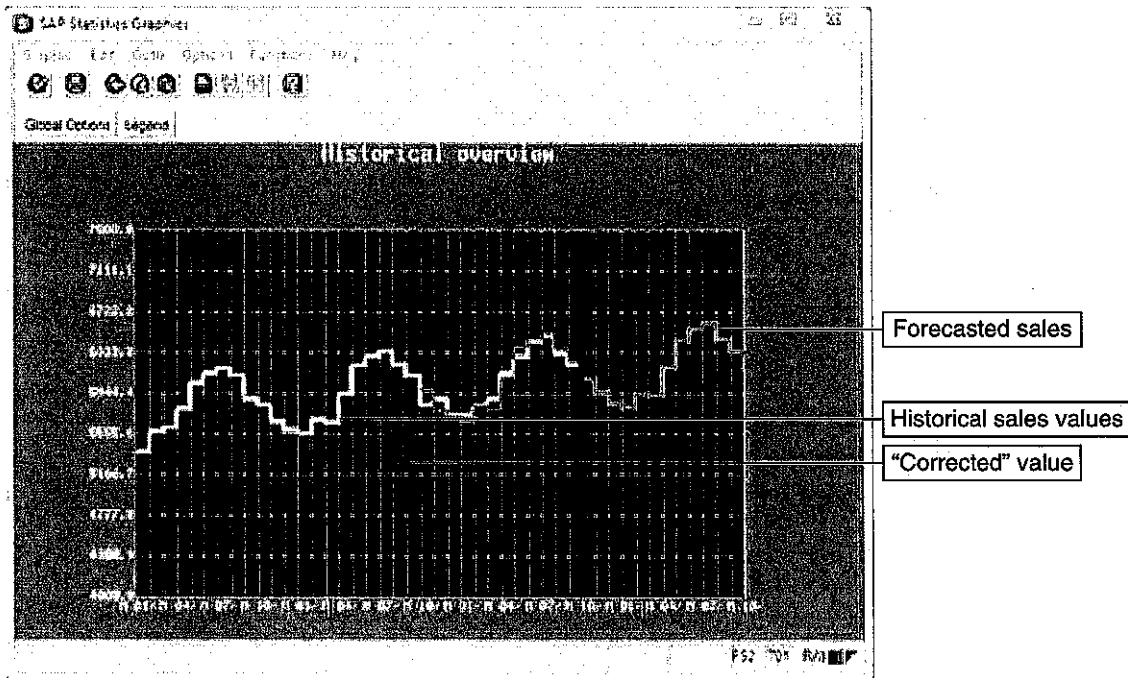
Profile SAP

Forecasting
 Historical...
 Forecast profile...
 Version...

Source Line: SAP AG.

FIGURE 4-8 Forecasting model options in SAP ERP

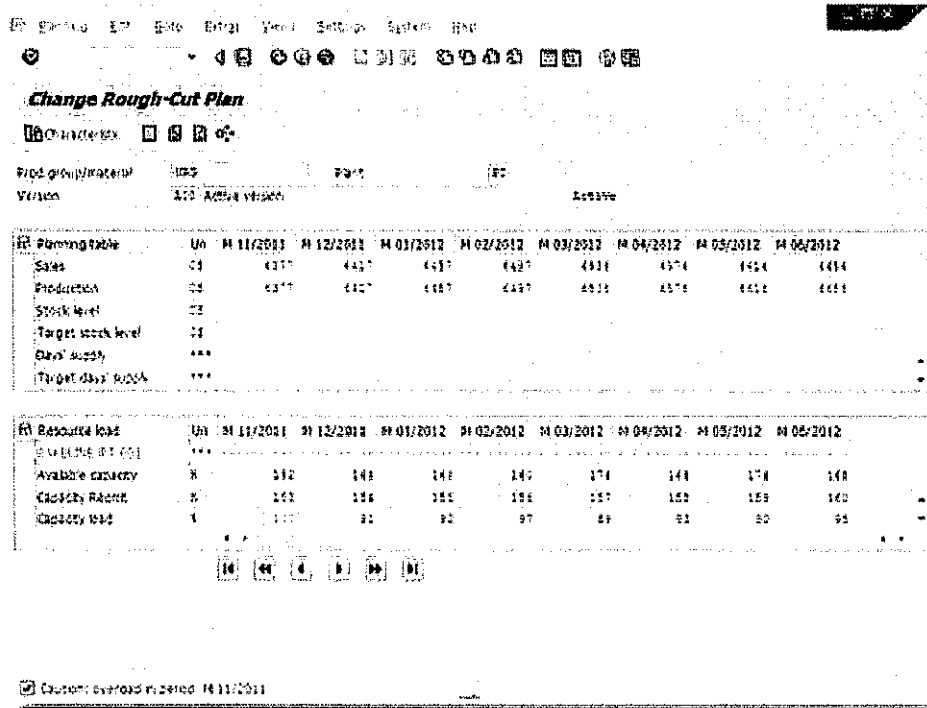
This screen allows the user to specify a number of forecasting parameters, including whether the model should allow for trends and seasonal variations. Once the SAP ERP system generates a forecast, the planner can view the results graphically, as shown in Figure 4-9. While the SAP ERP system also provides the standard statistical measures of forecast accuracy, human judgment is frequently the best determinant of whether the forecast results make sense.



Source Line: SAP AG.

FIGURE 4-9 Forecasting results presented graphically in SAP ERP

Another feature of the SAP ERP sales and operations planning process is the integration of rough-cut capacity planning. A sample screen is shown in Figure 4-10.



Source Line: SAP AG.

FIGURE 4-10 Sales and operation plan with rough-cut capacity calculation in SAP ERP

Rough-cut capacity planning applies simple capacity-estimating techniques (like those shown in the spreadsheet example in Figure 4-5) to the production plan to see if the production plan is feasible. Frequently, rough-cut capacity planning techniques are applied to critical resources—those machines or production lines where capacity is usually limited. For a company with a simple manufacturing process, these estimates can be very precise. For more complex manufacturing processes, these estimates will not be completely accurate, but they will ensure that the production plans are at least reasonable. Managers can use SAP ERP's more sophisticated planning tools at the detailed scheduling level, when the plans that are developed will actually be converted into manufacturing decisions.

While an integrated ERP system like SAP can provide sophisticated tools to support the sales and operations planning process, the plan will only be successful if the interested parties are committed to the process. If Marketing and Sales and Manufacturing cannot agree on sales forecasts, promotions, and production plans, then the company will find it is overstocking some items, running out of others, and spending a lot of money on overtime production and expedited shipping. Successful sales and operations planning depend on developing a culture of cooperation between Marketing and Sales and Manufacturing; that requires continuous support, encouragement, and enforcement from top management. As you will learn in Chapter 7, changing a company's culture is usually a much more difficult challenge than the technical challenge of installing new hardware and software.

ANOTHER LOOK

Sales and Operations Planning for Blood Banks

Sales and operations planning (SOP) is typically used in for-profit manufacturing organizations; however a recent article in the *Journal of Blood Services Management* suggests there could be significant advantages to applying sales and operations planning concepts to the blood-banking process. The supply chain necessary to supply blood is significant and complex. For example, the nonprofit America's Blood Centers is a network of more than 600 donor centers supplying over 3,500 hospitals and healthcare facilities in North America.

In the article "Benefits to Blood Banks of a Sales and Operations Planning Process," authors Donald A. Keal and Phil Hebert make the argument that sales and operations planning concepts are applicable to blood-banking systems. The key reason, they argue, is that sales and operations planning is a process "that links high-level strategic plans to day-to-day operations." Through the use of sales and operations planning, managers can better manage change by proactively addressing potential problems and opportunities.

One of the unique features of blood banking is that there are customers at both ends of the supply chain. Blood donors are the suppliers but are also customers for the donation centers. While there are still a significant number of blood plasma centers that pay for donations, most blood donation is unpaid. On the distribution end, while hospital patients are the recipients of donated blood, the healthcare provider is the blood bank's customer.

(continued)

The authors provide an example of how sales and operations planning could impact the supply and demand of a particular blood product, single-donor platelets (SDPs). As with any business, a blood center must quickly identify variations in forecasted supply and demand and take action to lessen the potential negative effects of those variations. For instance, if the demand for SDPs at a blood center falls below projections, "the excess SDPs may be exported if they have sufficient shelf life remaining, or donors may be rescheduled to reduce supply. If SDP demand spikes, recruitment and collections may have to work overtime to recruit more donors."

Blood banks may not be for-profit companies, but they cannot operate at a loss either. The authors note that an advantage of a sales and operations planning process is that it requires performance measurement. By using measurements, such as RONA (return on net assets), a blood center can help blood centers avoid situations in which "the cost per unit (CPU) collected is higher than the sales cost of a unit to the health care provider or what an imported unit would cost."

One of the major challenges to applying the sales and operations planning process to blood banks is data accuracy. The authors note that it is not uncommon to have data inconsistencies between the blood management system and the financial system. Without accurate and consistent data, the results of the sales and operations planning process would not be valid.

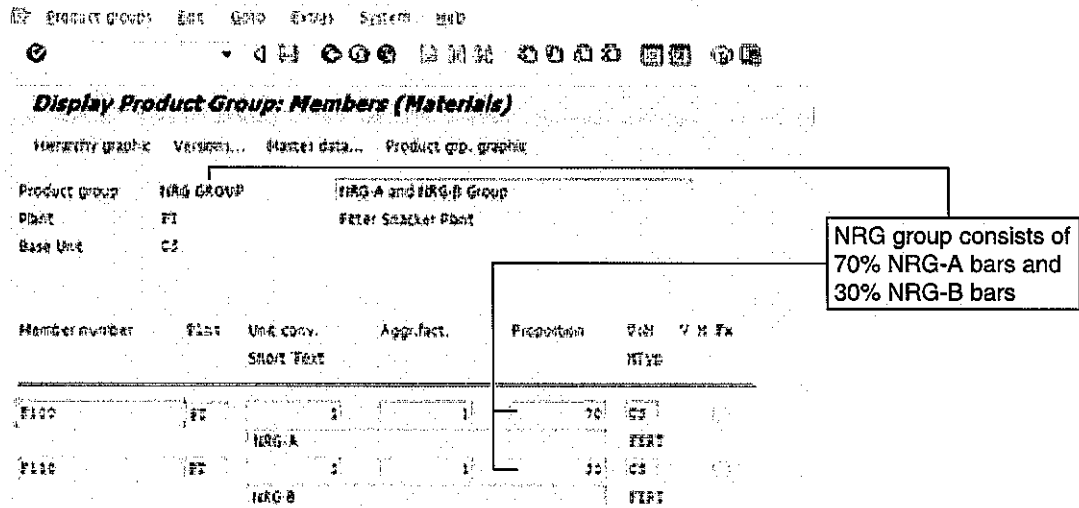
Question:

1. Write a memo to the director of a blood donation center in your geographic area recommending the implementation of the sales and operations planning process to their blood banking system. Explain the benefits of such a system, and make sure that you identify and address arguments that might be made against your proposal. Specifically address the issue of performance measures in a nonprofit environment.

Disaggregating the Sales and Operations Plan in SAP ERP

As mentioned previously, companies typically develop sales and operations plans for product groups. Product groups are especially important for companies that have hundreds of products, because developing unique plans for hundreds of individual products is extremely time consuming. Furthermore, it would be hard to develop that many different plans in a coordinated fashion while also taking in consideration production capacity. Fitter's product group is very simple; 70 percent of the group consists of NRG-A bars, and 30 percent consists of NRG-B bars.

Figure 4-11 shows how product groups are defined in the SAP ERP system. The system allows any number of products to be assigned to a product group. Product groups can have other product groups as members, as well, so complicated aggregations can be defined.

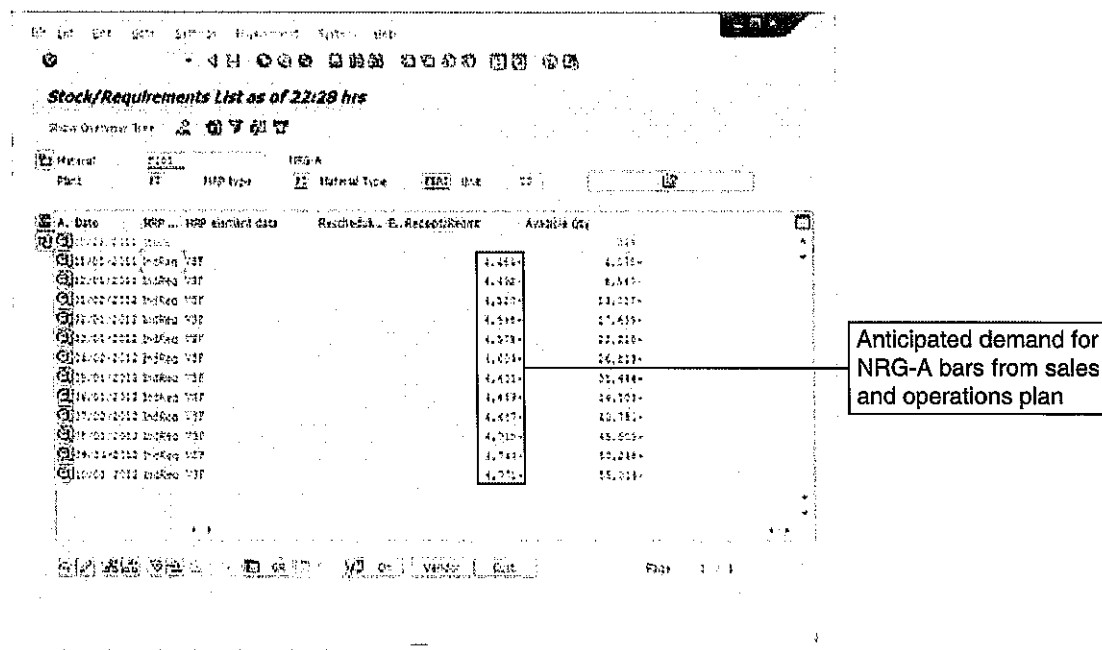


Source Line: SAP AG.

FIGURE 4-11 Product group structure in SAP ERP

When the sales and operations plan is disaggregated, the production plan quantities specified for the group are transferred to the individual products that make up the group, according to the percentages defined in the product group structure.

The results of the disaggregation process can be seen in the Stock/Requirements List screen shown in Figure 4-12.



The Stock/Requirements List screen displays the inventory level for an individual product, including all planned additions and reductions. In Figure 4-10, the production plan for November is 6,377. Seventy percent of 6,377 is 4,464, which is shown in Figure 4-12 as an independent requirement (IndReq). The independent requirements are the output of the disaggregation of the sales and operations plan, and they are used in master production scheduling to determine the schedule for finished product production.

Exercise 4.3

Using the Fitter sales forecast for July through December that you created in Exercise 4.2, develop a spreadsheet for sales and operations planning for those same months. Use the format of the spreadsheet shown in Figure 4-5. The number of working days for each month is shown in Figure 4-13.

	July	Aug.	Sept.	Oct.	Nov.	Dec.
Working days	20	23	21	21	20	21

Source Line: Course Technology/Cengage Learning.

FIGURE 4-13 The number of working days at Fitter, July through December

For your production plan, try to keep the capacity utilization at 95 percent or less. To disaggregate the plan for the group into plans for NRG-A and NRG-B bars, use 70 percent of sales for NRG-A bars and 30 percent for NRG-B bars.

Demand Management

The demand management step of the production planning process links the sales and operations planning process with the detailed scheduling and materials requirements planning processes. The output of the demand management process is the **master production schedule (MPS)**, which is the production plan for all finished goods. For Fitter, the master production schedule is an input in the detailed scheduling process, which determines which bars the company should make and when it should make them. The master production schedule is also an input to the materials requirements planning process, which determines what raw materials to order to support the production schedule.

The demand management process splits Fitter's monthly production planning values into finer time periods. Figure 4-14 shows January's production plan by week and by day.

	Week 1	Week 2	Week 3	Week 4	Week 5	
Demand management	1/3-1/7	1/10-1/14	1/17-1/21	1/24-1/28	1/31	2/1-2/4
Monthly demand NRG-A	4134	4134	4134	4134	4134	4199
NRG-B	1772	1772	1772	1772	1772	1799
Working days in week	5	5	5	5	1	4
Working days in month	21	21	21	21	21	20
MPS NRG-A	984	984	984	984	1037	
Weekly demand NRG-B	422	422	422	422	444	

Demand management	Jan 3	Jan 4	Jan 5	Jan 6	Jan 7
Monthly Demand NRG-A	4134	4134	4134	4134	4134
NRG-B	1772	1772	1772	1772	1772
Working days in month	21	21	21	21	21
MPS NRG-A	197	197	197	197	197
Daily demand NRG-B	84	84	84	84	84

Source Line: Course Technology/Cengage Learning.

FIGURE 4-14 Fitter's production plan for January: The first five weeks of production are followed by a day-by-day disaggregation of Week 1

Fitter will use the weekly plan (which is derived from the sales and operation plan in Figure 4-5) for purchasing materials management. Daily plans will be used for the product(s) that are to be produced on the snack bar line. To get the results shown in Figure 4-14, the following calculations were performed:

- For the weekly plan, the MPS plan for NRG-A bars in Week 1 was calculated as: $(4,134 \text{ cases in January [the monthly demand from Figure 4-5]} \div 21 \text{ working days in month of January}) \times 5 \text{ working days in Week 1} = 984.3 \text{ cases per week}$.

This figure was rounded to 984 cases in Figure 4-14.

- Because Week 5 consists of the last day in January and the first four days in February, the MPS for NRG-A bars in Week 5 was calculated as:
 - $(4,134 \text{ cases in January [monthly demand]} \div 21 \text{ working days in month of January}) \times 1 \text{ working day in Week 5} = 196.9 \text{ cases}$
 - $(4,198 \text{ cases in February [monthly demand]} \div 20 \text{ working days in month of February}) \times 4 \text{ working days in Week 5} = 839.6 \text{ cases}$
 - Week 5 Total = $196.9 + 839.6 = 1,036.5 \text{ cases}$

In Figure 4-14, the master production schedule (MPS) cases for Week 5 were rounded to 1,037 for the NRG-A bars.

In Figure 4-14, the daily production plan values for NRG-A and NRG-B bars were calculated by taking the monthly production plan value and dividing it by the number of working days in the month.

Notice that the demand management process involves no user input. Input is from the sales and operations planning step. The SAP ERP software also uses information from the factory calendar (working days in week and month) to calculate the MPS.

Fitter does not currently do this sort of planning because it has no way to formally share sales forecast data between Marketing and Production. The company cannot relate its possible sales to its capacity and to the time available to make the product. Thus, Fitter cannot produce an accurate master production schedule.

The MPS is an input to the detailed scheduling and materials requirements planning processes. Materials requirements planning (MRP) is discussed next, followed by a discussion of detailed scheduling.

Exercise 4.4

Develop a weekly production plan for August, like the one for January shown in Figure 4-14. For the weekly sales periods, the last week will include two days in September. The factory calendar information is shown in Figure 4-15.

	Week 1	Week 2	Week 3	Week 4	Week 5	
Demand management	8/1–8/5	8/8–8/12	8/15–8/19	8/22–8/26	8/29–8/31	9/1–9/2
Working days in week	4	5	5	5	3	2
Working days in month	20	20	20	20	20	23

Source Line: Course Technology/Cengage Learning.

FIGURE 4-15 Fitter's factory calendar for August

Materials Requirements Planning (MRP)

Materials requirements planning (MRP) is the process that determines the quantity and timing of the production or purchase of subassemblies and raw materials required to support the master production schedule. The materials requirements planning process answers the questions, "What quantities of raw materials should we order so we can meet that level of production?" and "When should these materials be ordered?" In this section, you will see how Fitter could accurately plan its raw materials purchases if it had an ERP system.

In Fitter's case, all product components (ingredients, snack bar wrappers, and display boxes) are purchased, so the company could use the materials requirements planning process to determine the timing and quantities for purchase orders. To understand materials requirements planning, you must understand the bill of material, the material's lead time, and the material's lot sizing, which we will discuss in the following sections.

Bill of Material

The **bill of material (BOM)** is a list of the materials (including quantities) needed to make a product. The BOM for a 500-pound batch of the NRG-A or NRG-B bars is shown in Figure 4-16.

Ingredient	Quantity	
	NRG-A	NRG-B
Oats (lb.)	300	250
Wheat germ (lb.)	50	50
Cinnamon (lb.)	5	5
Nutmeg (lb.)	2	2
Cloves (lb.)	1	1
Honey (gal.)	10	10
Canola oil (gal.)	7	7
Vit./min. powder (lb.)	5	5
Carob chips (lb.)	50	
Raisins (lb.)	50	
Protein powder (lb.)		50
Hazelnuts (lb.)		30
Dates (lb.)		70

Source Line: Course Technology/Cengage Learning.

FIGURE 4-16 The bill of material (BOM) for Fitter's NRG bars

The BOM for Fitter's NRG bars is fairly simple because all ingredients are mixed together to form the dough; there are no intermediary steps. Many other products, however, are produced by joining component parts into subassemblies that are then joined to form the finished product. It is obviously more complicated to calculate the raw material requirements for products with more complex BOMs.

Lead Times and Lot Sizing

The BOM can be used to calculate *how much* of each raw material is required to produce a finished product. Determining the *timing* and *quantity* of purchase orders, however, requires information on lead times and lot sizing.

For example, if a manufacturer orders a make-to-stock item, the **lead time** is the cumulative time required for the supplier to receive and process the order, take the material out of stock, package it, load it on a truck, and deliver it to the manufacturer. The manufacturer might also include the time required to receive the material into its warehouse (unloading the truck, inspecting the goods, and moving the goods into a storage location).

Lot sizing refers to the process of determining production quantities (for raw materials produced in-house) and order quantities (for purchased items). In Fitter's case, many raw materials can only be ordered from a supplier in certain bulk quantities. For example, because Fitter uses large quantities of oats, the most cost-effective way to purchase oats is in bulk hopper-truck quantities, which means that the material must be ordered in 44,000-pound quantities. Wheat germ, however, is used in smaller quantities, and to avoid having wheat germ become stale, Fitter orders it in 2,000-pound bulk containers. Protein powder is packaged in 50-pound bags that are loaded 25 to a pallet, so the most cost-effective way to order protein powder is by the pallet load (1,250 pounds).

Let's look at the materials requirements planning process using oats, which have a two-week lead time and must be ordered in hopper-truck quantities (multiples of 44,000 pounds). To determine when and how many pounds of oats should be ordered, we will

start with the weekly master production schedule for NRG-A and NRG-B bars, and then we will complete the following steps:

1. Convert the quantities of NRG bars from cases to 500-pound batches.
2. Multiply the number of batches by the pounds-per-batch quantities (which are given in the BOM) to get the gross requirements for each raw material.
3. Subtract the existing raw material inventory and purchase orders that have already been placed from the gross requirements, to determine the net requirements.
4. Plan orders in multiples of the 44,000-pound lot size, allowing for the two-week lead time required for oats, to meet the net requirements in Step 3.

These calculations are summarized in Figure 4-17. This view of the data is frequently called an **MRP record**, which is the standard way of viewing the MRP process on paper.

Oats Lead time = 2 weeks		Week 1	Week 2	Week 3	Week 4	Week 5
MPS (cases)	NRG-A	984	984	984	984	1037
	NRG-B	422	422	422	422	444
MPS (500 lb. batches)	NRG-A	142	142	142	142	149
	NRG-B	61	61	61	61	64
Gross requirements (lb)		57,850	57,850	57,850	57,850	60,700
Scheduled receipts		44,000	44,000			
Planned receipts				88,000	44,000	44,000
On hand	29,650	15,800	1,950	32,100	18,250	1,550
Planned orders		88,000	44,000	44,000		

Source Line: Course Technology/Cengage Learning.

FIGURE 4-17 The MRP record for oats in NRG bars, Weeks 1 through 5

The first two rows of the MRP record are the MPS that was the output from the demand management step (shown in Figure 4-14). These NRG production quantities are shown in terms of shipping cases. The first step is to convert the MPS from shipping cases to 500-pound batches. Each shipping case weighs 72 pounds (not including packaging), so to convert shipping cases to 500-pound batches, multiply the number of shipping cases by 72 pounds per case, and then divide by 500 pounds per batch. Thus, producing 984 shipping cases of NRG-A bars in Week 1 of the year will require 142 batches, as shown in the third row of Figure 4-17.

The next row in Figure 4-17 is Gross requirements. The Gross requirements figures are calculated by multiplying the MPS quantity (in production batches) by the pounds of oats needed for a batch of snack bars. Fitter uses 300 pounds of oats per batch of NRG-A bar and 250 pounds of oats per batch of NRG-B bar. This information is derived from the BOM (Figure 4-16). Therefore, for Week 1, Fitter needs:

- NRG-A: 142 batches $\times$ 300 lb. per batch = 42,600 lb. oats
- NRG-B: 61 batches $\times$ 250 lb. per batch = 15,250 lb. oats
- Total = 57,850 lb. oats

The next row in Figure 4-17 is Scheduled receipts. This row shows the expected timing of orders of materials that have already been placed, meaning that the supplier has

been given the purchase order and is in the process of fulfilling it. There is a two-week lead time for oats, so for oats to be available in Week 1 and Week 2 of the year, oats orders must be placed in the last two weeks of the previous year.

The next row, Planned receipts, shows when planned orders will arrive. The Planned receipts row is directly related to the Planned orders row at the bottom of the record. A planned order is one that has not been placed with the supplier but will need to be placed to prevent Production from running out of materials. Because there is a two-week lead time for oat orders, the quantities in the planned orders row will be available for production in two weeks, which is indicated by an entry in the Planned receipts row.

The arrows in Figure 4-17 show the relationship between planned orders and planned receipts. For example, the materials requirements planning calculation suggests that an order for 88,000 pounds of oats should be placed in Week 1 so it will arrive in Week 3. To say it differently: the planned order for 88,000 pounds of oats in Week 1 will not be available for use until Week 3, which is shown by the planned receipt of 88,000 pounds in Week 3. There is only one order, but it shows up in two places on the MRP record.

The next row in Figure 4-17 is the On hand row. The first number in this row (29,650) is the inventory of oats on hand at the beginning of Week 1. The On hand number in the Week 1 column (15,800) is a projection of the inventory that will be on hand at the end of Week 1 (and therefore at the beginning of Week 2)—accounting for the beginning inventory, gross requirements, and planned and scheduled receipts. In the case of Week 1, the initial inventory of 29,650 pounds, plus the 44,000 pounds of scheduled receipts, minus the 57,850 gross requirement, leaves 15,800 pounds of oats available at the start of Week 2.

The last row is the Planned orders row. This is the quantity that the MRP calculation recommends ordering, and it is the output from the MRP process that purchasing uses to determine what to order to produce the product, and when to order it.

Many times, a planner will need to intervene to tell the system to adjust the planned order. For example, notice that the on-hand quantity of oats in Week 2 is only 1,950 pounds. In the best case scenario, assume the line is producing the NRG-B bar (as that bar uses less oats). At 250 pounds per batch, 1,950 pounds of oats would be enough oats for 7 full batches. The production line can produce 6 batches an hour, so 7 batches of dough would only support the production line for 70 minutes. If the scheduled order does not arrive early enough on the first day of Week 2, the production line could be shut down. When the purchase order scheduled to arrive in Week 1 was ready to be placed (two weeks prior to the beginning of Week 1), the planner should have evaluated that order, considering the low inventory level projected for the beginning of Week 2. The planner might have decided to place an order for two hopper-truck loads of oats, instead of the planned order for one load. Or he could have ensured that the scheduled receipt shown in Week 2 would actually be delivered at the end of Week 1.

Planning factors such as lead times are just estimates, so planners must evaluate the planned orders suggested by the materials requirements planning calculation before allowing the program to automatically turn them into purchase orders.

Notice once again the need for software to help with this kind of calculation. Of course, a human being can do these computations, but with many products and constituent materials, the calculations become very tedious and prone to error. Even for a small company such as Fitter, doing the calculations with reasonable speed and accuracy requires software help. Notice also the information needed to do the MRP calculation: starting with a sales forecast, the software works down to the master production schedule and then to a schedule of required raw materials.

Exercise 4.5

Develop an MRP record, similar to the one in Figure 4-17, for wheat germ for the five weeks of January. Wheat germ must be ordered in bulk-container quantities, so the planned orders must be in multiples of 2,000 pounds. Use a lead time of one week and an initial on-hand inventory of 3,184 pounds; assume that an order of 8,000 pounds is scheduled for receipt during Week 1. Are there any weeks when you, as a planner, would consider placing an order above or below the minimum required? Why? (Assume that there are no problems with storage capacity or shelf life.)

Exercise 4.6

Fitter's purchasing policy has been to carry high levels of inventory to avoid stockouts. Why can inventory levels be lower with an integrated ERP system and MRP-based purchasing? If you had to calculate the financial advantage of this change, how would you do it?

Materials Requirements Planning in SAP ERP

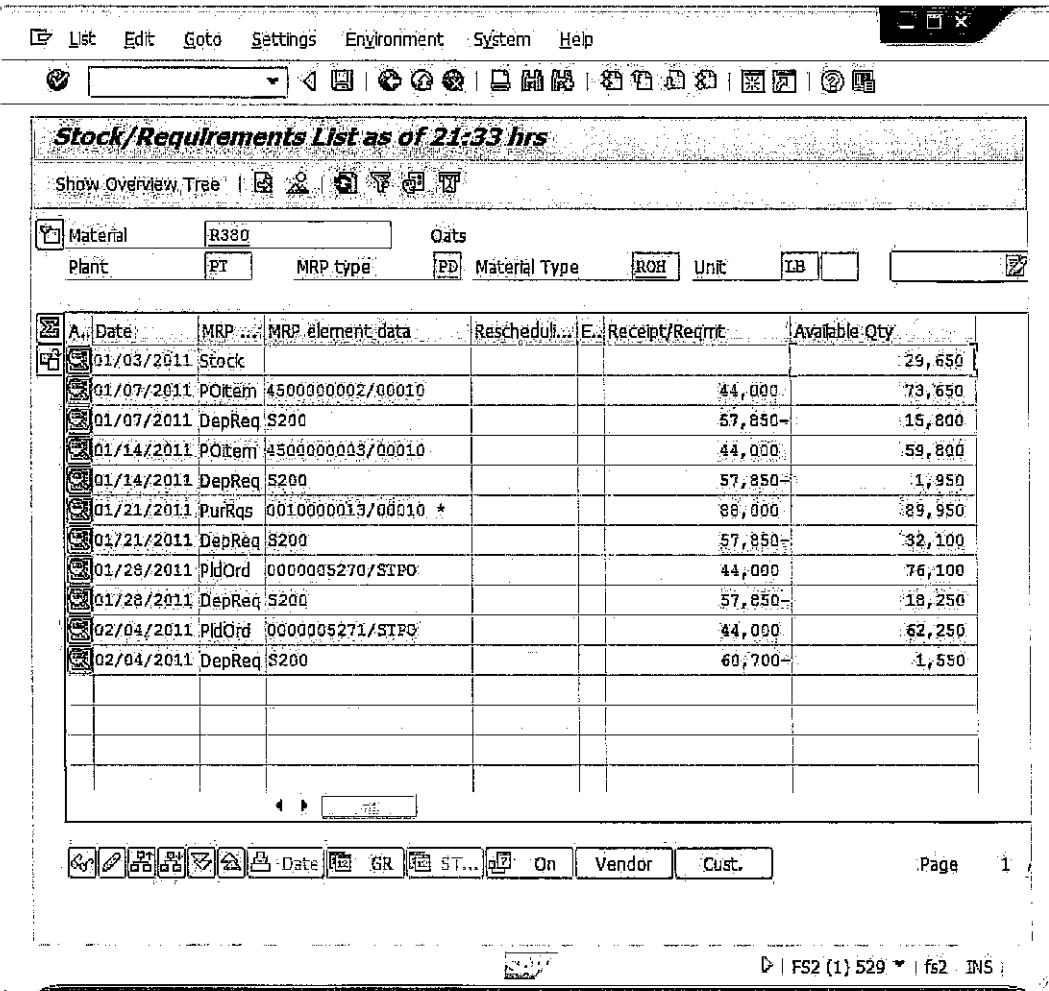
The MRP list in SAP ERP looks very much like a Stock/Requirements List, which you saw in Figure 4-12 (for NRG-A bars). The MRP list shows the results of the MRP calculations, while the Stock/Requirements List shows those results plus any changes that have occurred since the MRP list was generated (planned orders converted to purchase orders or production orders, material receipts, and so on). Because the materials requirements planning calculations are time consuming to process for a company producing hundreds of products using thousands of parts, the materials requirements planning process is usually only repeated every few days—or perhaps weekly. The Stock/Requirements List, however, allows the users of the system to see what is happening (and what will happen) with a material in real time.

Compare the data shown in the MRP record in Figure 4-17 with the MRP list for oats in Figure 4-18 and the Stock/Requirements List in Figure 4-19.

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FIGURE 4-18 The MRP List screen in SAP ERP

The MRP list in the third column of Figure 4-18 shows purchase orders (POItem), planned orders (PldOrd), and dependent requirements (DepReq). Dependent requirements represent the demand for oats created by the planned orders for snack bars—the demand for oats *depends* on the production plans for snack bars. The materials requirements planning process creates planned orders to meet these dependent requirements. The planned orders are recommendations by the system to create orders (in this case, purchase orders) for oats.



Source Line: SAP AG.

FIGURE 4-19 The Stock/Requirements List screen in SAP ERP

The Stock/Requirements List shown in Figure 4-19 shows purchase orders (POitem), planned orders (PldOrd), and dependent requirements (DepReq), but it also shows purchase requisitions (PurRqs). When a planner decides that it is time for a planned order to become a purchase order, the planned order is converted to a purchase requisition, which is a request to Purchasing to create a purchase order. The planner can convert a planned order to a purchase requisition from the Stock/Requirements List screen by double-clicking the planned order line. This action calls up the Additional Data for MRP Element window, shown in Figure 4-20.

Additional Data for MRP Element	
Plnd order	10000005275 External proc.
Order type	LS
Order date	01/23/2011
Planned opening	01/20/2011
Order type	LS

Planned order release and receipt dates

Option to convert planned order to purchase requisition

Source Line: SAP AG.

FIGURE 4-20 Conversion of a planned order to a purchase requisition

From this window, the planner can create a purchase requisition or review the planned order and make changes before creating the requisition. SAP ERP also provides the ability to mass-process planned orders by converting groups of planned orders to purchase orders simultaneously. The materials requirements planning process can also be configured to automatically create purchase requisitions; for example, all planned orders created within one week of the MRP calculation could be automatically converted to purchase requisitions.

Once a purchase requisition is created, an employee in the Purchasing department must turn it into a purchase order. One of the important steps in creating a purchase order is choosing the best vendor to supply the material. An integrated information system such as SAP can facilitate this process. Figure 4-21 shows the Source Overview screen, which provides access to information that can help the Purchasing employee select the vendor.

Vendor	Name	Info/agent	Item	Unit price	Qty	Release date	Price
100000	Climax Cereals	5100102100		0.10 USD	11/24/2011	0000 01	
100000	Grand Rapids	5100102100		0.10 USD	11/24/2011	0000 00	
100000	Oxymore Oats	5100102100		0.10 USD	11/24/2011	0000 00	

Options to evaluate vendors

Source Line: SAP AG.

FIGURE 4-21 Source Overview screen for supplier selection

From this screen, the Purchasing employee can view information about each vendor, simulate the price (the SAP system estimates the price from each vendor, which might include quantity discounts and transportation costs), and look at the vendor evaluation—the company's rating of the vendor. The SAP ERP system can be configured to rate vendors based on a number of performance criteria, including quality of goods provided

and on-time delivery. The evaluation scores for each vendor are updated automatically as materials are received. The integrated information system allows Purchasing to make the best decision on a vendor based on relevant, up-to-date information.

Once the Purchasing employee decides which vendor to use, the purchase order is transmitted to the vendor. The SAP ERP system can print out a paper order that can be mailed to the vendor. More likely, however, the system will be configured to either fax the order to the vendor, transmit it electronically through EDI (electronic data interchange), or send it via email.

Detailed Scheduling

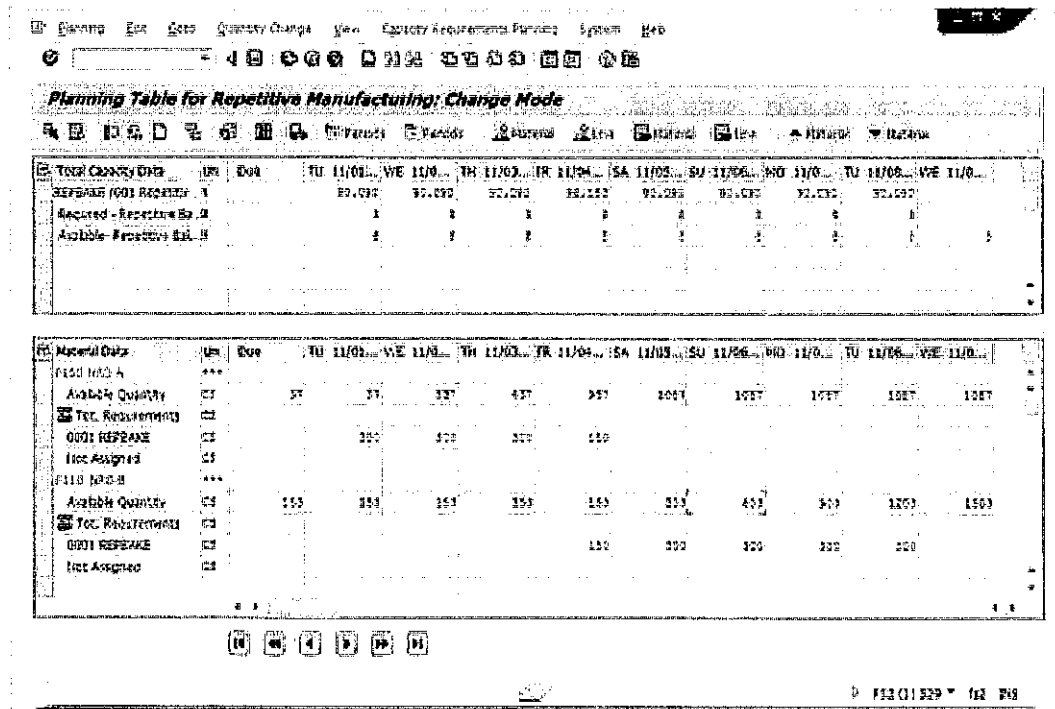
Finally, let's examine the last portion of the production process, detailed scheduling. The aggregate production plan for product groups developed in sales and operations planning is disaggregated to individual products in finer time increments through the demand management process. In detailed scheduling, a detailed plan of what is to be produced needs to be developed, considering machine capacity and available labor. Detailed scheduling is complex and will not be presented here in spreadsheet form, but we will discuss the important concepts and issues.

A key decision in detailed production scheduling is determining how long the production runs for each product should be. Longer production runs mean that fewer machine setups are required, reducing production costs and increasing the effective capacity of the equipment. On the other hand, shorter production runs can be used to lower the inventory levels for finished products. Thus, the production run length requires a balance between setup costs and holding costs to minimize total costs to the company.

Because the capacity of the Fitter production mixers is much greater than that of the snack bar production line, scheduling mixer production is not an issue. Because the dough must be mixed before the snack bar production line can start, employees who run the mixers at Fitter begin working 30 minutes before the employees who run the production line. During that time, four batches of dough can be mixed so they are ready when the production line starts. With a bit of a head start and a detailed schedule for the production line, it is a simple matter for the personnel operating the mixers to keep ahead of the production line. Thus, the key step for Fitter is to develop a detailed production schedule for the snack bar production line.

The manufacturing process that Fitter uses is known as repetitive manufacturing. **Repetitive manufacturing** environments typically have production lines that are switched from one product to another similar product. Most packaged consumer goods are produced in repetitive manufacturing environments. In repetitive manufacturing, production lines are scheduled for a period of time, rather than for a specific number of items, although it is possible to estimate the number of items that will be produced over a period of time.

For Fitter, the production schedule for a week might be to produce NRG-A bars from Monday morning until the end of day Wednesday, then change over to NRG-B bars for all of Thursday until Friday at noon, when the production line will be switched back to NRG-A bars. Given this schedule, it is possible to estimate the number of bars that will be produced. Figure 4-22 shows the repetitive manufacturing planning screen in the SAP ERP system.



Source Line: SAP AG.

FIGURE 4-22 Repetitive manufacturing planning table in SAP ERP

This screen allows the planner to view capacity, production schedule length, and quantity produced in one screen. Between November 1 and November 8, NRG-A bars are being produced for 3½ days, and NRG-B bars are being produced for 4½ days. The fourth line of the bottom screen shows that a total of 1,050 cases of NRG-A snack bars will be produced from November 1 through November 4 ($300 + 300 + 300 + 150 = 1,050$), and then production will change over to NRG-B bars from November 4 through November 8 (this screen assumes production shifts continue through the weekend).

The top section of the screen shows the production line capacity requirements for the plan in the bottom section of the screen. The plan shown will require 90.090% of the available capacity of 8 hours per day for all days except November 4, when the capacity requirement will be 96.153%. The second line in the top section of the screen (Required-Repetitive Bakeline) shows the number of hours of capacity used by the plan (rounded to the nearest hour) while the third line (Available-Repetitive Bakeline) shows the planned capacity of the baking line.

In some companies, responsibility for inventory costs belongs to a Materials Management group, and capacity utilization performance is the responsibility of a Production group. Generally, the Materials Management group wants short production runs to keep inventory levels down, while the Production group wants long production runs to keep capacity utilization high. In these circumstances, the decision regarding production run length can become a source of organizational bickering, instead of a decision that minimizes total costs for the benefit of the company.

This conflict points out another advantage of production planning in an ERP system. Because the goal of the company is to maximize profit, the duration of production runs should be decided by evaluating the cost of equipment setup and holding inventory. An integrated information system simplifies this analysis by automatically collecting

accounting information that allows managers to better evaluate schedule trade-offs in terms of costs to the company.

Providing Production Data to Accounting

In Chapter 1, you learned that for a company to be successful functional areas must share data. Accounting needs to know what Manufacturing has produced and what resources were used in producing those products, to determine which products, if any, are producing a profit—and then provide information for management to determine how to increase profits. In manufacturing plants, ERP systems do not directly connect with production machines. For example, in Fitter's case, SAP ERP could not directly read the number of bars that came off the packing segment of the snack bar line. The data must be gathered in some way and then entered into SAP ERP for inventory accounting purposes.

Data can be entered into SAP ERP through a PC on the shop floor, scanned using bar-code or RFID technology (discussed in more detail in Chapter 8), or entered using a mobile device. SAP ERP is an open-architecture system, meaning that it can work with automated data-collection tools marketed by third-party hardware and software companies.

In an integrated ERP system, the accounting impact of a material transaction can be recorded automatically. For example, when a shipment of oats arrives at the Fitter plant, someone in the Receiving Department must verify the material and the quantity and quality of the shipment before it is accepted. Once Fitter accepts the shipment, Receiving must notify the SAP ERP system of the arrival and acceptance of the material. This communication is done by completing a goods receipt transaction, which is shown in Figure 4-23.

The screenshot displays the SAP ERP 'Goods Receipt' transaction for Purchase Order 4500000003. The interface includes a menu bar at the top with options like 'Goods Receipt', 'Enter', 'System', and 'Help'. Below the menu, the title bar reads 'Goods Receipt Purchase Order 4500000003 - Bret Wagner'. The main area is divided into several sections:

- Document Overview:** Shows 'Document Date' as 10/25/2011, 'Posting Date' as 10/25/2011, and 'Delivery Note' as 'EE of Lading'. It also includes a 'Ver-200' field with the value 'On-Hand-200'.
- Table of Receipt Lines:** A table with columns 'Line', 'Mat. Short Text', 'OK', 'Qty in Unit', 'E-Proc', 'Batch', and 'Valu'. The first line shows '1' for the line number, 'OATS' for the material short text, and '10.00' for the quantity in units.
- Material Information:** A section at the bottom with fields for 'Material' (OATS), 'Vendor Material No.', 'Material Group', and 'Batch'. The 'Batch' field contains the value '1000'.

The bottom of the screen features a status bar with the text 'EAT in Order Unit'.

Source Line: SAP AG.

FIGURE 4-23 Goods Receipt screen in SAP ERP

The Receiving department must match the goods receipt with the purchase order that initiated it, to make sure the exact materials ordered have been received, so Accounting can pay the vendor. It is possible for the quantity of material entered in the goods receipt to differ from the quantity specified on the purchase order. Depending on the configuration settings, the SAP ERP system might block entry of the receipt if the discrepancy is too large. If the discrepancy is small, then the receipt may be allowed, with the difference posted to the correct variance account, which allows the transaction to be processed but maintains a record for management to review, to see if there is a consistent problem with a vendor over shipping or “shorting” an order (consistently shipping less than was ordered).

When the receipt is successfully recorded, the SAP ERP system immediately records the increase in inventory levels for the material. On the Accounting side of the system, this causes the value of the inventory shown in the general ledger account to automatically increase as well. This is an important feature of an integrated information system: the goods receipt is recorded once, but the information is immediately available to both Manufacturing and Accounting—and the information is consistent. An integrated information system also has the ability to adjust for changes in material costs. If the cost of the material changes frequently, the system can be configured to reevaluate the value of all the inventory of the material that the company has.

For example, suppose Fitter has 10,000 pounds of cinnamon that it bought at \$3 per pound. The company would value its inventory of cinnamon at \$30,000. Then suppose the price of cinnamon rises to \$4 per pound, and Fitter purchases 1,000 pounds of cinnamon at the higher price. What is the value of the 11,000 pounds of cinnamon that Fitter now owns? The SAP ERP system can be configured to use a moving average formula to reevaluate the inventory based on the current market prices. Depending on the exact nature of the formula, the cinnamon would be valued at somewhere between the \$3 per pound previously assumed and the \$4 per pound that was just paid. The system can perform this calculation automatically each time material is received.

Using an ERP system to record data does not necessarily make the shop-floor accounting data more accurate. The ERP system allows employees to enter data in real time, but the system requires employees to follow the process. If employees can take material out of inventory without recording the transaction, then the real-time information in the ERP system is worthless. Technologies such as bar-code scanners and RFID tags can help in this process, but accurate data require both a capable information system and properly trained and motivated employees. However, when done accurately, capturing data for manufacturing and inventory purposes on the shop floor means that it is captured at the same time for accounting and inventory management purposes—eliminating any need to reconcile Accounting and Manufacturing records.

Exercise 4.7

Briefly describe how the implementation of SAP ERP might change the relationship between Production and Warehousing at Fitter.

ERP AND SUPPLIERS

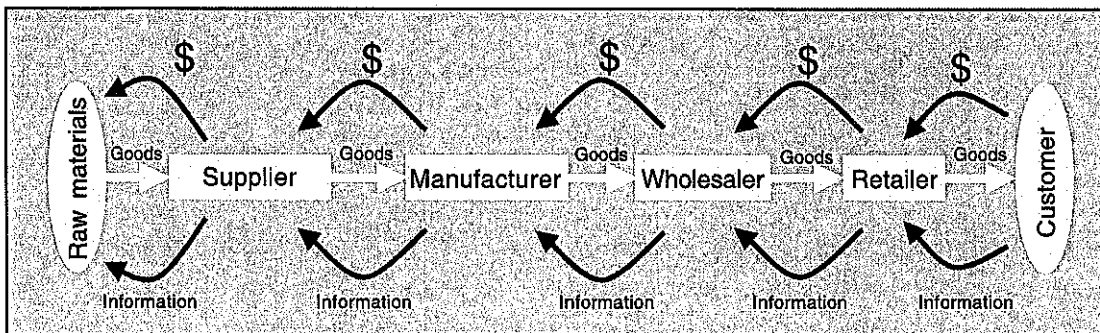
Fitter is part of a supply chain that starts with farmers growing oats and wheat and ends with a customer buying an NRG bar from a retail store. Previously, companies used competitive bidding to achieve low prices from suppliers, which frequently led to an

adversarial relationship between suppliers and their customers. In recent years, more companies have begun to realize that they are part of a supply chain, and if the supply chain is more efficient, all participants in the chain can benefit. Collaboration can frequently achieve more than competition, and ERP systems can play a key role in collaborative planning.

Working with suppliers in a collaborative fashion requires trust among all parties. A company opens its records to its suppliers, and suppliers can read certain company data because of common data formats. Working with suppliers in this way cuts down on paperwork and response times. Reductions in paperwork, savings in time, and other efficiency improvements translate into cost savings for the company and the suppliers. ERP lets companies and suppliers share information (sales, inventory, production plans, and so on) in real time throughout the supply chain. This allows all parties to eliminate from the supply chain costs that do not add value to the product (such as inventory, overtime, changeovers, and spoilage), while simultaneously improving customer service.

The Traditional Supply Chain

The term **supply chain** describes all the activities that occur between the growing or mining of raw materials and the appearance of finished products on the store shelf. The supply chain for Fitter's NRG bars starts with farmers growing oats and wheat, and it ends with a customer buying a bar from a retail store. In a traditional supply chain, information is passed through the supply chain reactively, as participants change their product orders—as illustrated in Figure 4-24.



Source Line: Course Technology/Cengage Learning.

FIGURE 4-24 Supply chain—from raw materials to customer

For example, a retailer sees an increase in the sales of Fitter's bars and orders a larger quantity of bars from the wholesaler. If a number of retailers increase their orders, the wholesaler will increase its orders from Fitter. When Fitter gets larger orders from wholesalers, it must increase production to meet the increased demand. To increase production, Fitter will order more raw materials from suppliers.

Because of the time lags inherent in a traditional supply chain, it might take weeks—or even months—for information about Fitter's increased need for raw materials to reach Fitter's suppliers. Raw material suppliers might require time to increase *their* production to meet Fitter's larger orders, resulting in temporary shortages for the supplier. And unusual events such as the "Oprah effect" (where a product is endorsed by a famous name

and causes a huge upsurge in demand) can also result in shortages. For example, the Amazon Kindle quickly sold out after the famous talk-show host Oprah Winfrey claimed it was one of her favorite items.

By contrast, if the participants in the supply chain are part of an integrated process, information about the increased customer demand can be passed quickly through the supply chain, so each link in the chain can react quickly to the change.

EDI and ERP

The development of supply chain strategies does not necessarily require an ERP system. Before ERP systems were available, companies could be linked with customers and suppliers through electronic data interchange (EDI) systems. Recall from Chapter 2 that EDI is the computer-to-computer exchange of standard business documents (such as purchase orders) between two companies. A well-developed ERP system, however, can facilitate supply chain management because the needed production planning and purchasing systems are already in place. In addition, the integration of accounting data in the ERP system (described in the next chapter) allows management to evaluate changes in the market and make decisions about how those changes should affect the production plan. With an ERP system, sharing production plans along the supply chain can occur in real time. Using the Internet can make this communication even faster and cheaper than using private EDI networks.

ANOTHER LOOK

Complexities of Supply Chain Management

Over the last few decades, a number of industry trends have focused on making supply chains more efficient and effective. The first of these started in the 1980s when techniques developed at the Toyota Motor Company, now commonly referred to as *lean manufacturing*, started to be accepted and copied by companies around the world. The main idea embodied in lean manufacturing—or the Toyota Production System (TPS)—is that waste must be eliminated. While that seems obvious, the TPS identified inventory resulting from “overproduction” as waste. Much of industrial practice, especially in the United States, was focused on the idea that efficiency should be measured by having each machine produce to its maximum capacity. The TPS approach was that a company should produce exactly what is required when it is required. The TPS emphasized “pull” systems, where customer demand triggers production, rather than “push” systems, where planning methods like MRP are frequently used to push material through the supply chain to the customer in anticipation of demand.

A second important trend has been a decrease in vertical integration of companies. **Vertical integration** means the extent to which a company produces the components and assemblies used in the products it manufactures. In the auto industry, vertical integration reached its peak with Henry Ford and the River Rouge manufacturing complex, where iron ore was deposited at one end of the facility and finished cars rolled out the other. In the 1920s and 1930s, Ford owned iron ore mines and ore freighters, rubber plantations, and a host of businesses and industries that supplied its automobile assembly plants. The goal was to achieve high quality and low costs. Today, efficiency

(continued)

and technology has driven many manufacturers to reduce their level of vertical integration. According to Steve Rodgers, president of AMPA, the Canadian Auto Parts Manufacturers' Association, "65 to 75 percent of the overall component cost of a car comes from outside suppliers." The auto manufacturers now focus on overall design of the vehicle and allow the suppliers to develop the expertise in the braking systems, interiors, and so on, which are then plugged into the designs.

A third trend is supply base rationalization, an effort to determine the "appropriate" number of suppliers a company should have. Many large firms have thousands of suppliers. However, the rationalization concept says that better supplier relationships can be developed when there are fewer suppliers to manage, and costs will be reduced when a smaller number of suppliers have higher production volumes. In 2008, Ford's Senior Vice President of Global Purchasing announced that Ford would be reducing its supply base from over 2,000 suppliers to 700 to 800 over a period of years.

These trends—lean manufacturing, reduced vertical integration, and supply base rationalization—have been implemented by manufacturers in a number of industries over the past 30 years and have resulted in higher efficiencies and reduced cost. But these savings have not come without a cost: increased exposure to disruption. This increased risk was highlighted by the earthquake and tsunami in Japan on March 14, 2011. In addition to the tragic loss of human life and destruction of property, the disaster forced many global companies to severely reduce or shut down production. Japanese-based companies such as Toyota were obviously affected, but the integrated nature of global supply chains meant that the effect of the earthquake rippled throughout the world. For example, the three largest shipbuilders in the world are located in Korea and are dependent on Japanese steel, and the Japanese steel industry was significantly impacted by the Fukushima nuclear power plant disaster, which was triggered by the tsunami that followed the earthquake. (The explosions, fire, and core meltdowns at the power plant made it the worst nuclear disaster since the 1986 Chernobyl explosion.)

Toyota, which has led many of these supply chain trends, is now planning to lead the way in reducing supply chain risk. In September 2011, they announced plans to create a robust supply chain that would recover within two weeks in the event of another massive disruption. This plan consists of three fundamental steps. First, Toyota intends to push for further standardization of parts across Japanese automakers so they can share common components, which could, in turn, be manufactured in several locations. The second element in the plan is the development of technology that would provide more options for parts that require unique materials or components that are only available from one source. Finally, Toyota plans to make each region in the world independent in its parts procurement so that a disaster in Japan would not affect production overseas.

Supply chains have always been complex, but now in addition to speed and efficiency, flexibility and risk reduction must be considered priorities.

Question:

1. What are other potential causes of supply chain disruption? How can ERP systems help minimize the impact when disruptions occur?

The Measures of Success

Performance measurements (sometimes referred to as **metrics**) have been developed to show the effects of better supply chain management. One measure is called the **cash-to-cash cycle time**. This term refers to the time between paying for raw materials and collecting cash from the customer. In one study, the cash-to-cash cycle time for companies with efficient supply chain management processes was a month, whereas the cycle averaged 100 days for those companies without effective supply chain management.

Another metric is total supply chain management costs. These costs include the cost of buying and handling inventory, processing orders, and supporting a company's information systems. In one study, companies with efficient supply chain management processes incurred costs equal to 5 percent of sales. By contrast, companies without supply chain management incurred costs of up to 12 percent of sales.

Other metrics have been developed to measure what is happening between a company and its suppliers. For example, Staples, the office-supply company, measures three facets of the relationship. **Initial fill rate** is the percentage of an order that the supplier provided in the first shipment. Another metric is **initial order lead time**, which is the time needed for the supplier to fill the order. Finally, Staples measures **on-time performance**. This measurement tracks how often the supplier met agreed-upon delivery dates.

Improvements in metrics such as these lead to improvements in overall supply chain cost measurements.

Exercise 4.8

Assume a manufacturer of residential lawn and garden equipment is considering investing in hardware and software that will improve linkages with suppliers. Management expects to save 5 percent of sales by tightening up the supply chain in the first year, 3 percent in the second year, and 1 percent in the third year. The company's annual sales are \$1 billion. The company's chief financial officer insists that the investment must pay for itself in cost savings in three years. To meet this requirement, how much should the chief information officer be allowed to spend on improving the supply chain? Explain your answer.

ANOTHER LOOK

Supply Chain Going Green

The retail giant Walmart is trying to compel its suppliers to “go green” as part of its efforts to build a more environmentally sustainable global supply chain. As it did with promoting EDI and RFIDs in the early stages of those technologies, Walmart is leading the curve with its sustainability efforts. In 2008, Walmart’s CEO, Lee Scott, told a large gathering in China, “A company that cheats on overtime and on the age of its labor, that dumps its scraps and chemicals into our rivers, that does not pay its taxes or honor its contracts—will ultimately cheat on the quality of its products. And cheating on the quality of products is the same as cheating on customers. We will not tolerate that at Walmart.”

As part of this initiative, Walmart will survey its 100,000 global suppliers and ultimately create a “sustainability product index,” which will allow the company to evaluate suppliers on their sustainability efforts. Suppliers anxious to keep Walmart as a customer will be motivated to improve their rating on the sustainability index. Some experts think Walmart can change the business climate on sustainability. According to Harvard Professor Rosabeth Moss Kanter, Walmart’s determination to use its considerable influence to raise the standards for environmental sustainability “shows that a single company using its unique clout can accelerate public action to reduce greenhouse gases and reverse climate change.”

Walmart’s new initiative translates into a new burden on suppliers. By some estimates, the company’s efforts to improve sustainability could increase the cost of products by 1–3 percent, due, in part, to new requirements that suppliers label products with a green index. However, these costs may be offset if the suppliers, as part of their efforts to reduce their impact on the environment, can also improve their supply chain efficiency.

Question:

1. Do you think consumers will be willing to pay increased prices to ensure their products are sustainably produced and packaged? Would you be willing to pay the extra cost? How much extra?

Chapter Summary

- An ERP system can improve the efficiency of production and purchasing processes. Efficiency begins with Marketing and Sales sharing a sales forecast. A production plan is created based on that forecast and shared with Purchasing so raw materials can be ordered properly.
- Companies can do production planning without an ERP system, but an ERP system that contains materials requirements planning capabilities allow a company to link Production to Purchasing and Accounting. This data sharing increases a company's overall efficiency.
- Companies are building on their ERP systems and integrated systems philosophy to practice supply chain management, a strategy by which a company looks at itself as part of a larger process that includes customers and suppliers. Using information more efficiently along the entire chain can result in significant cost savings. Because of the complexity of the global supply chain, developing a planning system that effectively coordinates information technology and people and that can help a company manage uncertainty is a considerable challenge.

Key Terms

bill of material (BOM)	MRP record
capacity	on-time performance
cash-to-cash cycle time	repetitive manufacturing
initial fill rate	rough-cut planning
initial order lead time	standard costs
lead time	supply chain
lot sizing	vertical integration
master production schedule (MPS)	
metrics	

Exercises

1. In which industries is supply chain management important? In which industries is it not? Why, or why not?
2. Recall from Chapter 1 that a business process cuts across functional lines. When a customer orders a product, such as a custom-built car, the Supply Chain Management function must interact with other functional areas in a company to complete this order. List the functional areas involved in this process. What information must pass between those areas and Supply Chain Management to fill the customer's needs?
3. Create a two-column list, and in the first column, list Fitter's flawed supply chain management process. In the second column, list the ways in which an ERP system could alleviate some of these problems.
4. Metrics are used to measure improvements in supply chain management. What are the benefits of tracking metrics? How often should they be calculated and recorded? Does it depend on the industry? Does it depend on the competitive environment? Why?

5. What are potential sources of risk in Fitter's supply chain? How should Fitter prepare to minimize these risks. Research this topic on the Internet, and use examples to support your reasoning.
6. Compare customer relationship management and supply chain management. How are they similar? How are they different? In which functional areas do they have the most impact? In answering, consider the kinds of technologies used in each.

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