5

Demand Management

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Demand management activities in any global supply chain consist of three activities: demand management, demand planning, and sales forecasting management (Mentzer and Moon 2004b). The role of sales forecasting changes depending on the position in the supply chain that a company occupies. Any supply chain has only one point of **independent demand**—or *the amount of product demanded (by time and location) by the end-use customer of the supply chain.* Whether this end-use customer is a consumer shopping in a retail establishment or online (B2C), or a business buying products for consumption in the process of conducting their business operations (B2B), these end-use customers determine the true demand for the product that will flow through the supply chain.

The company in the supply chain that directly serves this end-use customer directly experiences this independent demand. All subsequent companies in the supply chain experience a demand that is tempered by the order fulfillment and purchasing policies of other companies in the supply chain. This second type of supply chain demand is called **derived demand** because it is not the independent demand of the end-use customer but rather a *demand that is derived from what other companies in the supply chain do to meet their demand from their immediate customer (i.e., the company that orders from them).*

The derived demand for one company is often the dependent demand of their customers. **Dependent demand** is the *demand for the component parts that go into a*

product. Often called bill of materials (BOM) forecasting, this is usually demand that is dependent on the demand for the product in which it is a component. The exception is when different amounts of a component part go into different versions of the product; this requires a special kind of forecasting, called statistical BOM forecasting. For example, the manufacturer of a large telecommunications switch may have 50 different component parts that can go in each switch, with the number of each component included varying from 0 to 5, depending on the customer order. Thus, the independent demand of customers for the switch, and the independent demand of customers for various switch configurations (and their resulting BOM), must be forecast to determine the dependent demand for each component part.

It is important to note that only one company in any given supply chain is directly affected by independent demand. The rest are affected by derived or dependent demand (or both). Equally important, the techniques, systems, and processes necessary to deal with derived and dependent demand are quite different from those of independent demand.

Recognizing the differences between independent, dependent, and derived demand, recognizing which type of demand affects a particular company, and developing techniques, systems, and processes to deal with that company's particular type of demand can have a profound impact on global logistics, supply chain costs, and customer service levels. We first explore the implications of independent and derived demand, followed by a model of the demand management function in global supply chain management. We will then move on to the role of sales forecasting management within demand management.

Derived Versus Independent Demand

Figure 5.1 depicts a traditional supply chain, with a retailer serving the end-use customer, a wholesaler supplying the retailer, a manufacturer supplying the wholesaler, and a supplier providing raw materials to the manufacturer. The source of independent demand for this supply chain is 1,000 units for the planning period. However, the retailer (as is typically the case) does not know this with certainty. In fact, the retailer has a reasonably good forecasting process and forecasts end-use customer demand to be 1,000 units for the planning period. Since the forecast has typically experienced ±10% error in the past, the retailer places an order to his or her supplier (the wholesaler) for 1,100 units (i.e., 1,000 units for expected demand and 100 units for safety stock to meet expected forecasting error). It is critical to note in this simple example of a typical, *unmanaged* supply chain that the demand the wholesaler experiences is 1,100 units, not 1,000.

The wholesaler, in turn, has a reasonable forecasting system (note that the wholesaler is not forecasting end-use customer independent demand but is inadvertently forecasting retailer derived demand) and forecasts the demand affecting the wholesaler at 1,100 units. Again, the wholesaler believes forecasting error to be approximately ±10%, so the wholesaler orders 1,100 plus 10% (or 1,210 units) from the manufacturer. If the manufacturer and the supplier both assume the same ±10% forecasting error, then they will each add 10% to their orders to their

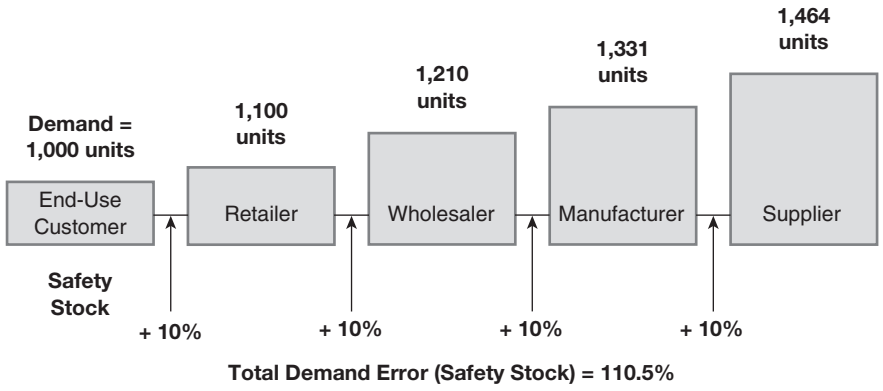

Figure 5.1 Demand Error in a Traditional Supply Chain

suppliers. Note that we are assuming here, for simplicity's sake, that there is no BOM. If there were, the logic would still hold, but the illustration would become unnecessarily complicated.

As Figure 5.1 illustrates, simple failure to recognize the difference between independent demand (which needs to be forecast) and derived demand (which can be derived and planned)—even in a supply chain where forecasting error is only ±10%—adds greatly to the safety stock carried in the supply chain. In fact, since each member of the supply chain only needed 1,000 units to meet the actual demand, plus 100 units for the potential forecasting error, this particular supply chain is carrying 705 too much inventory ((210 – 100) + (331 – 100) + (464 –100) = 705), or a 16.0% supply-chain-wide inventory overstock ((705/4,400) = 16.0%) for the actual end-use customer demand. Inventory carried for total demand error (safety stock) in this supply chain is 1,105 (100 + 210 + 331 + 464), or 110.5% of actual end-use customer demand!

This example allows us to introduce the supply chain concept of **demand planning**, which is *the coordinated flow of derived and dependent demand through companies in the supply chain.* Demand planning is illustrated in the supply chain shown in Figure 5.2. End-use customer demand is the same as in Figure 5.1, and the retailers' faith in their forecast (±10%) is unchanged. What has changed, however, is that the other companies in the supply chain are no longer even attempting to forecast the demand of their customers. Rather, each member of the supply chain receives point-of-sale (POS) demand information from the retailer, and the retailer's planned ordering based on this demand. Combined with knowledge of the time-related order flows through this supply chain, each company can plan its processes (including orders to their suppliers). The result is that each member of the supply chain carries 1,100 units in inventory—a systemwide reduction in inventory of 13.81% from 5,105 (i.e., 1,100 for the retailer, 1,210 for the wholesaler, 1,331 for the manufacturer, and 1,464 for the supplier) to 4,400 (i.e., 1,100 each for the retailer, wholesaler, manufacturer, and supplier). More important, the inventory carried for forecasting error (safety stock) drops from 1,105 to 400 (from total

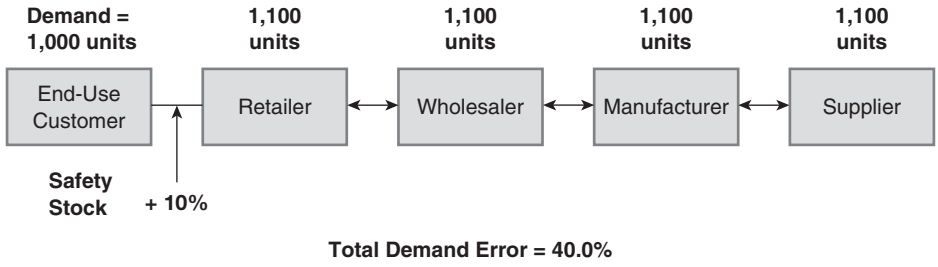

Figure 5.2 Demand Error in a Demand Planning Supply Chain

demand error of 110.5% to 40.0%)—for a reduction of total demand error inventory (safety stock) of 63.8% ((1,105 – 400)/1,105).

Note, however, that the inventory reductions are not uniform across the supply chain. Whereas the supplier has a reduction in safety stock of 78.4% (from 464 to 100), the retailer experiences no reduction. In fact, the farther up the supply chain, the greater the safety stock reduction. This illustrates a paradox of demand planning in any supply chain—the very companies that are most needed to implement supply chain demand planning (i.e., implementation of systems to share with suppliers real-time POS information held by retailers) have the least economic motivation (i.e., inventory reduction) to cooperate. This leads us to the concept of demand management.

Demand management is *the creation across the supply chain and its markets of a coordinated flow of demand.* Much is implied in this seemingly simple definition. First, the traditional function of marketing creates demand for various products but often does not share these demand-creating plans (such as promotional programs) with other functions within the company (forecasting, in particular), much less with other companies in the supply chain.

Second, the role of demand management is often to decrease demand. This may sound counterintuitive, but demand often exists for company products at a level management cannot realistically (or profitably) fulfill. Demand management implies an assessment of the profit contribution of various products and customers (all with capacity constraints in mind—including the capacity of all components in the BOM), emphasizing demand for the profitable ones, and decreasing demand (by lessening marketing efforts) for the unprofitable ones.

Finally, as we mentioned earlier, considerable supply chain savings can result from demand planning, but the rewards are not always consistent with the need to obtain collaboration from all companies in the supply chain. Thus, an aspect of demand management is **supply chain relationship management,** which is *the management of relationships with supply chain partners to match performance with measurements and rewards so that all companies in the supply chain are fairly rewarded for overall supply success (measured as cost reduction and increased customer satisfaction).*

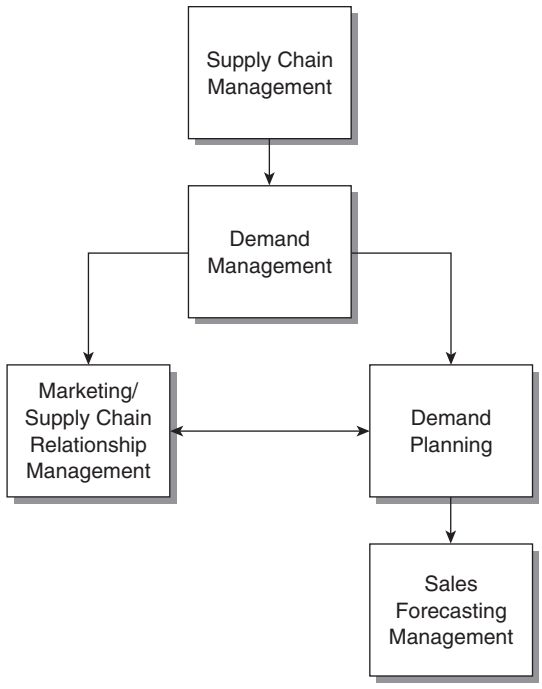

Figure 5.3 Demand Management in Supply Chain Management

A Model of Supply Chain Demand Management

This leads us to an overall model of the role of demand management, demand planning, and sales forecasting management in the supply chain. Figure 5.3 illustrates these roles. Global supply chain management has many aspects, only one of which is demand management. As previously illustrated, demand management encompasses the traditional marketing functions, along with the coordination of marketing activities with other functions in the company and the supply chain. However, the traditional demand creation role of marketing is tempered in demand management by a desire to coordinate the flow of demand across the supply chain (demand planning) and to create incentives for supply chain partners to help manage these flows (supply chain relationship management). Demand planning is concerned with the coordination across the global supply chain of derived and dependent demand. Sales forecasting management is concerned with the independent demand that occurs in any global supply chain.

Forecasts Versus Plans Versus Targets

We define a **sales forecast** as a projection into the future of expected demand, given a stated set of environmental conditions. This should be distinguished from *plans,*

which we define as a set of specified managerial actions to be undertaken to meet or exceed the sales forecast. Examples of plans include production plans, procurement plans, distribution plans, and financial plans. Both the sales forecast and the plans should be distinguished from the *sales target*, which we define as sales goals that are established to provide motivation for sales and marketing personnel.

Note that our definition of a sales forecast does not specify the technique (quantitative or qualitative), does not specify who develops the forecast within the company, nor does it include managerial plans. The reason for this is that *many companies confuse the functions of forecasting, planning, and target-setting.* Plans for the level of sales to be achieved should be based on the forecast of demand, but the two management functions should be kept separate. Similarly, target-setting should be done with a realistic assessment of expected future demand in mind, and this assessment comes from the sales forecast. In other words, the functions of planning and target-setting should be informed by forecasts of demand, but should not be confused with sales forecasting.

Note that these definitions imply different performance measures for sales forecasts than for plans. Since the purpose of sales forecasting is to make projections of demand given a set of specified environmental assumptions, one of the key measures of sales forecasting performance is accuracy of the forecast, and one of the key methods to explain variances in accuracy is how the environment varied from the one defined. This explanation is not intended to excuse forecast inaccuracy; rather it helps us understand the business environment and forecast more accurately in the future.

In contrast, the goal of plans is not accuracy but rather to effectively and efficiently meet forecasted demand. In addition, whereas forecasts are meant to be accurate, targets are meant to be met or exceeded. A mistake made by many companies is to confuse the sales forecast, where the objective is accuracy, with the sales target, where the objective is to at least meet—and, ideally, exceed—the goal or quota. In other words, companies should never be guilty of confusing forecasting with the firm's motivational strategy.

Sales and Operations Planning

In many companies, sales forecasting is an integral part of a critical process for matching global demand and supply that is sometimes referred to as sales and operations planning or S&OP (Mentzer and Moon 2004a). Figure 5.4 offers a simplified picture of how sales forecasting contributes to the S&OP process. As seen in Figure 5.4, an enterprise can be thought of as consisting of two primary functions: a demand function and a supply function. Demand is the responsibility of sales and marketing. In many companies, the sales organization is responsible for generating and maintaining demand from large end-use customers, or from wholesale or retail channel partners. Marketing is usually responsible for generating and maintaining demand from end consumers. Supply is the responsibility of a number of functions, including manufacturing, procurement, logistics or distribution, human resources, and finance. It is also the responsibility of a variety of suppliers, who

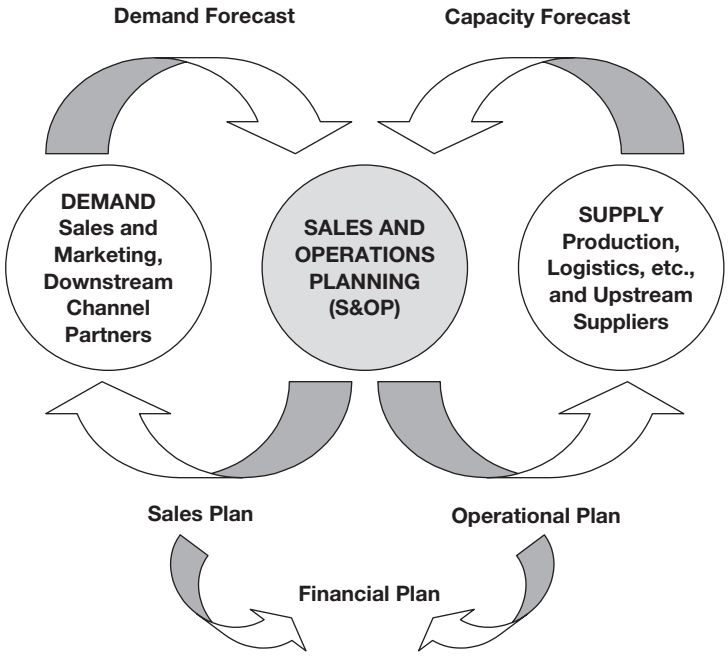

Figure 5.4 S&OP: The Junction Box

must provide raw materials, component parts, and packaging. The S&OP process provides a "junction box" where information can flow between the demand side and the supply side of an enterprise.

As shown in Figure 5.4, critical input to the S&OP process is the sales forecast, which is, as defined above, the projection into the future of expected demand. The sales forecast should originate in the demand side of the enterprise, since it is the demand side of the enterprise (i.e., sales and marketing) that is responsible for generating demand, and who should have the best perspective on what future demand will be. In addition to the sales forecast, which originates in the demand side of the company, another critical input to the S&OP process is a **capacity plan**. A capacity plan is a projection into the future about what supply capabilities will be, given a set of environmental assumptions. This input is provided by the supply side of the enterprise, and documents both long- and short-term supply capabilities. The process that occurs inside the S&OP process—the junction box—is the matching of future demand projections (i.e., the sales forecast) with future supply projections (i.e., the capacity plan).

Out of the S&OP process come three critical plans—the operational plan, the demand plan, and the financial plan. As discussed above, the operational plan consists of manufacturing plans, procurement plans, distribution plans, and human resource plans. These various operational plans can be short-term in nature, such as a monthly production schedule. They can be long-term in nature, such as extended contracts for raw materials, or even plans to expand manufacturing capacity. The second critical plan that emerges from the S&OP process is the

demand plan, where sales and marketing make plans about what should be sold and marketed, and when, given the supply capabilities of the firm. As mentioned above, demand plans may involve suppressing demand for products or services that are capacity constrained, or shifting demand away from low-margin products to high-margin items. These plans must be reconciled with the financial plan, which manages resource costs against performance projections.

Other authors have discussed how to effectively manage the S&OP process within organizations (see, e.g., Lapide 2002), but this is beyond the scope of this chapter. It is important, however, to understand the critical role that sales forecasting plays in the overall planning activities of the firm. Without accurate and credible estimates of future demand, it is impossible for organizations to effectively manage their global supply chains.

Why Is a Sales Forecast Needed?

If we can simply set a sales goal and expect marketing and sales to exceed it, why do we even need a sales forecast in the first place? This is a question many managers ask and often answer incorrectly (i.e., we do not need a forecast), to their eventual sorrow.

The correct answer is that every time we develop a plan of any kind, we first make a forecast. This is true of individuals, as well as profit and nonprofit companies, government organizations, and in fact, any entity that makes a plan. It can be as simple as planning what we will wear tomorrow. When we decide to lay out wool slacks and a sweater for the next day, we are forecasting it will be cool. If we add an umbrella to our ensemble, we are forecasting rain. The plan was predicated on the forecast, whether we consciously thought about it or not.

This is not much different from a company making financial plans based on expected sales and the costs of meeting those sales. The trick is to not get caught in the trap of making "inadvertent sales forecasts." Inadvertent sales forecasts are made when we are so intent on developing the plan that we simply assume what sales will be, rather than giving any concentrated thought to and analyzing the market conditions that will be necessary to create this level of sales.

One great example of such an inadvertent forecast came from a manufacturer in the grocery products industry. The owner of the company explained to us that the sales plan called for an increase in sales of 5% for the next year. However, we had also been told that this industry in this country was not growing and that any attempt to grab market share from the competition was only met by countermoves that caused greater promotional expenditures, but no shift in market share. "Wait a minute," we said to the owner. "How can industry size not change, market share not change, but sales grow? It does not take a math major to figure out that this is not going to work." The answer was that management would simply have to motivate everyone to work harder to achieve the (mathematically impossible) plan. Of course, it is obvious what happened—no amount of motivation is going to overcome an impossible situation, and the sales plan was not achieved. It was not achieved because it was based on an inadvertent and uninformed forecast. This is also a

classic example of management confusing forecasting, planning, and target-setting. In this case, no reasonable *forecast* would predict a 5% increase in sales. The 5% increase should have been seen for what it was—a stretch *goal.*

Let's look at one more example. A large regional distributor of food products to restaurants develops an elaborate annual profit plan. Hundreds of person-days go into the development of this plan, but it always starts with such comments as, "We need profits to increase next year by 6%. Let's figure out how much sales have to be to achieve that goal." Note that the term *goal* sneaked into that quotation. Where these executives should have started was to ask about market and environmental conditions facing the company during the planning horizon, and what levels of sales could be expected based on these conditions. The plan then becomes one of determining what marketing and sales efforts will be necessary to meet and exceed these projections to a level necessary to achieve the profit plan. The plan cannot drive the forecast; it has to be the other way around.

The *sales forecasting level* is the focal point in the corporate hierarchy where the forecast is needed. A corporate forecast, for instance, is a forecast of overall sales for the corporation. The *sales forecasting time horizon* generally coincides with the time frame of the plan for which it was developed. If, for instance, we continue the example just given, a corporate plan may be for the next two years and, thus, we need a sales forecast for that two-year time horizon. The *sales forecasting time interval* generally coincides with how often the plan is updated. If our two-year corporate sales plan must be updated every three months (not an unusual scenario), we can say the level is corporate, the horizon is two years, and the interval is quarterly. The *sales forecasting form* is what needs to be forecast or planned. Some functions need to know what physical units are to be produced and shipped, whereas other functions need to know the dollar equivalents of these units, and still other functions need to plan based on total weight or volume. These constitute the *forms* a sales forecast (and a plan) can take.

The Tools of Sales Forecasting Management

Just as any modern management function must make use of the state of the art in techniques to get the job done, the information systems available to it, the latest in managerial processes and approaches to managing the function, and methods of measuring and rewarding performance, so must sales forecasting management.

Sales Forecasting Techniques

A myriad of forecasting techniques exist and are available to the sales forecasting manager. In fact, it often seems that too many techniques are available, and the choice decision can border on information overload (at last count, there were over 70 different time-series techniques alone). Such a scenario often causes decision makers to give up any hope of understanding the full field of techniques; they consistently use only one or two with which they are familiar, whether these techniques are appropriate for the forecasting situation or not.

Fortunately, this scenario can be considerably simplified. To understand the sales forecasting technique selection process, the sales forecasting manager needs to understand the characteristics of a relatively small set of groups of techniques, and to realize in what situations each group of techniques works best. Once the technique group has been chosen, selection of the specific technique to use is a much more straightforward decision, which can be influenced by a great deal of research that has looked at which techniques are most often used and when they work best (McCarthy et al. forthcoming).

The common categories for sales forecasting techniques are based on whether the technique uses subjective or statistical analysis, whether endogenous data (a forecasting term that means only using the history of sales and not any other factors, which may explain changes in sales) or exogenous data (a forecasting term meaning the use of other data, such as price or promotional changes, competitive actions, or economic measures, to explain the changes in sales) are analyzed, and whether these data are actually analyzed by the forecaster or simply input to a technique for calculation of the forecast. These characteristics lead to three broad categories of sales forecasting techniques: time-series, regression (also called correlation, and incorrectly called causal, techniques), and judgmental (also called qualitative or subjective techniques).

Time-Series Techniques

Time-series techniques are based on the interrelationship of four data patterns: level, trend, seasonality, and noise. *Level* is a horizontal sales history, or what sales patterns would be if there was no trend, seasonality, or noise. *Trend* is a continuing pattern of a sales increase or decrease, and that pattern can be a straight line or a curve. *Seasonality* is a repeating pattern of sales increases and decreases such as high sales every summer for air conditioners, high sales of agricultural chemicals in the spring, or high sales of toys in the fall. The point is that the pattern of high sales in certain periods and low sales in other periods repeats itself every year. *Noise* is random fluctuation—that part of the sales history that a time-series technique cannot explain. This does not mean the fluctuation could not be explained by regression analysis or judgment; it means the pattern has not happened consistently in the past, so the time-series technique cannot pick it up and forecast it.

Time-series techniques arrive at a forecast by assuming one or more of these patterns exist in a previous sales history and projecting these patterns into the future. Exponential smoothing is a common time-series technique.

Time-series techniques are often simple and inexpensive to use and require little data storage. Many of the techniques also adjust very quickly to changes in sales conditions and, thus, are appropriate for short-term forecasting. Time-series techniques, however, will probably be less accurate than correlation analysis if the forecaster utilizes a time-series technique that assumes data patterns do not exist but are, in fact, in the sales history. Simple exponential smoothing assumes, for example, that the sales history consists of only level and noise. If trend and seasonality exist in the sales history, simple exponential smoothing will consistently err in its forecast.

Regression (Correlation) Analysis

Correlation analysis is a statistical approach to forecasting that seeks to establish a relationship between sales and exogenous variables that affect sales, such as advertising, product quality, price, logistics service quality, and/or the economy. Past data on exogenous variables and sales data are analyzed to determine the strength of their relationship (e.g., every time the price goes up, sales of the product go down is a strong negative relationship). If a strong relationship is found, the exogenous variables can then be used to forecast future sales. Corporate, competitive, and economic variables can be used together in a correlation analysis forecast, thus giving it a broad environmental perspective. Correlation analysis can also provide statistical value estimates of each variable. Thus, variables contributing little to the forecast can be dropped.

Correlation analysis is potentially one of the most accurate forecasting techniques available, but it requires a large amount of data. These large data demands also make correlation analysis slow to respond to changing conditions. Understanding the advantages and disadvantages of correlation analysis helps clarify when it is more useful—as in longer-range (greater than six-month time horizon) corporate-level forecasts for which a large amount of data on exogenous variables is readily available.

Qualitative (Subjective) Techniques

The previously discussed techniques (time-series and correlation analysis) are based on the idea that historical demand may follow some patterns, and the goal of the techniques is to identify and numerically document these patterns, then project these patterns into the future. However, it is often the case that the future will not look exactly like the past. For example, there may be no historical demand data available, as is the case with new products. There may also be new conditions that arise, such as a changing competitive landscape or changes in distribution patterns, that make previous demand patterns less relevant. Thus, there is a need for qualitative, or subjective, forecasting techniques. Subjective techniques are procedures that turn the opinions of experienced personnel (e.g., marketing planners, salespeople, corporate executives, and outside experts) into formal forecasts. An advantage of subjective techniques is that they take into account the full wealth of key personnel experience and require little formal data. They are also valuable when little or no historical data is available, such as in new product introductions.

Subjective forecasting, however, takes a considerable amount of key personnel time. Because of this drawback, subjective techniques are typically used as a part of long-range, corporate-level forecasting, or for adjustment purposes in short-range product forecasting. For example, the forecast committee of one auto parts manufacturer with whom we have worked meets once a quarter to subjectively generate a three-year forecast and once a month to subjectively adjust the product forecasts by product line (e.g., all product forecasts in a particular product line may be raised by 3%). Individual product forecasts by inventory location, however, are left to an appropriate time-series technique determined by the forecast managers. Individual

product forecasts by the forecast committee would be a waste of valuable executive time.

Sales Forecasting Systems

Many companies with which we have worked have asked us to advise them on the sales forecasting system they should use. Invariably, when we are asked this question, we ask them to describe the management process by which the sales forecasts are developed. Often, there is no answer—the company is trying to develop a systems solution without an understanding of the management process! This is a backward approach to sales forecasting management.

In many companies, there is no one person who understands the entire sales forecasting process. Many individuals understand bits and pieces of the process, but few understand the *entire* process. Without such an understanding, it is not possible to design and implement a system to augment this process. In fact, the sales forecasting system should be a communication and analysis framework (template) that can be laid over the sales forecasting management process. The company has to define the process first. An example should help illustrate this concept.

One global manufacturer of industrial products with which we worked has multiple product lines sold all over the world by a direct sales force. Many of these products are sold to customers in numerous industries. Thus, we may have a product that is sold by one salesperson in Australia to a particular industry and another salesperson in Europe who sells the same product for a different use in another industry. This has led to a worldwide sales force that specializes in certain products, in certain industries, and in certain geographic areas.

Given this multifaceted complexity of the sales forecasting environment, the company wanted a system that allowed development of a quantitative forecast, with qualitative adjustment by geographic territory by industry by the sales force, with adjustment by product line by marketing managers, and with overall planning adjustments by upper management. This led to a definition of their sales forecasting process that is illustrated in Figure 5.5. The process starts with a computer-model-generated forecast. These sales forecasts are broken down by product, industry, and geographic territory and sent electronically to the sales force. Each salesperson is provided with a quarterly report of economic and market trends in his or her industry and asked to make adjustments to the quantitative forecasts. When adjustments are made, the salesperson is asked to electronically record the logic behind his or her adjustments.

The total of all sales force adjustments are electronically transmitted back to the forecasting group, where they are combined. Marketing managers then receive the adjusted forecasts for the product lines in their markets. Again, the marketing managers are asked to qualitatively adjust these forecasts and record their logic.

These forecast adjustments are received and compiled by the forecasting group and transmitted to management for adjustment at the division level. Once the upper management adjustments are received, the forecasts are broken down to the level and horizon appropriate for each functional planning area and transmitted electronically for use in planning.

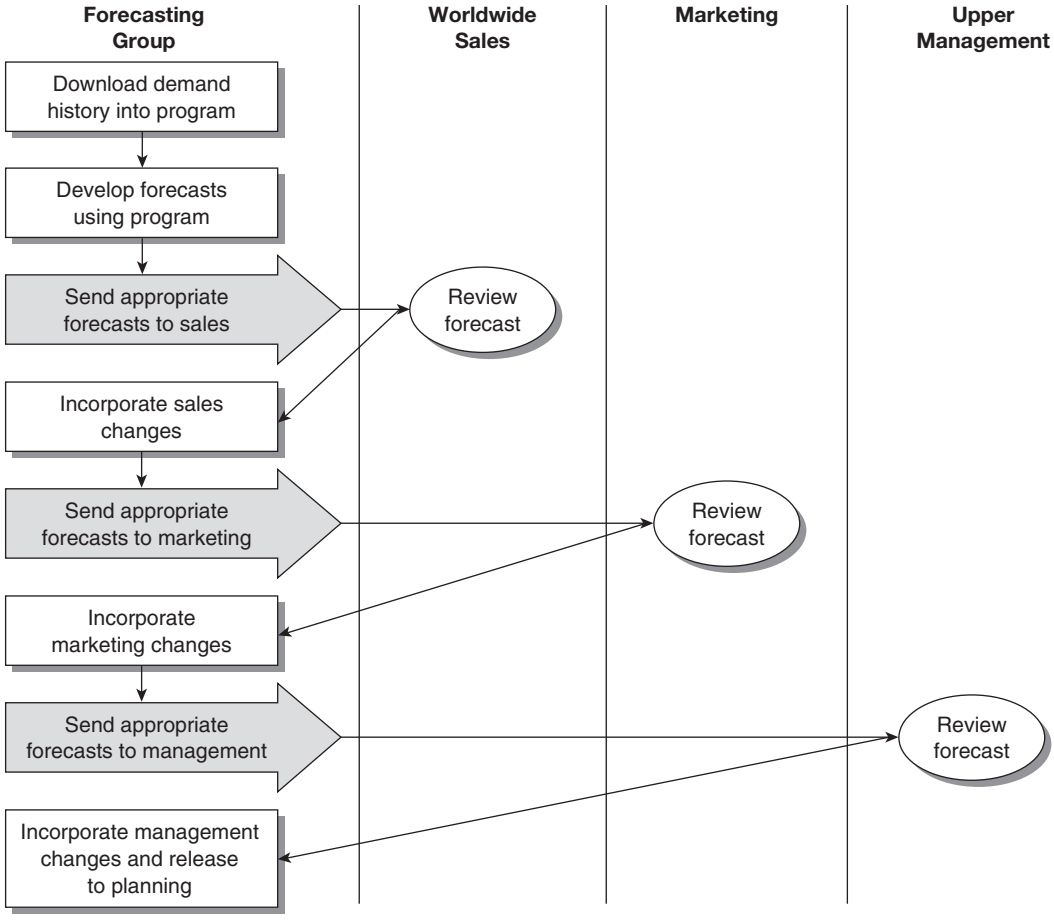

Figure 5.5 Example of a Sales Forecasting Process

Note that this process has laid over it the systems template to transmit all information electronically, pull information necessary for the computer model forecasts from appropriate data sources within the company and the supply chain, aggregate and disaggregate to the level and horizon needed at each step, and compare each forecast and adjustment with the actual demand once it is received.

Sales Forecasting Management Questions

There are a number of questions (listed in Table 5.1) you should ask yourself about your company. They must be answered for each company in their unique way, and should be constantly reexamined. The answers to these questions should tell you much about how the sales forecasting function should operate to efficiently and effectively help your company conduct the business of demand management.

Table 5.1 Sales Forecasting Management Questions

1. Customer base narrow or broad?
2. Data characteristics (shipments, sales, and demand, age, detail, external data, quality)?
3. Number of forecasts (horizons and intervals, products, channels, locations)?
4. Number of new products?
5. Regional differences?
6. Seasonality?
7. Sophistication of personnel (systems and forecasting) and systems?
8. Sales forecasting budget?
9. Accuracy needed?

Narrow or Broad Customer Base

The first question to ask is, Is your company's customer base narrow or broad? A narrow customer base simply means the sales of the company (regardless of the unit or dollar volume) go to a relatively small number of customers. An example of a broad customer base is the consumer markets served by packaged goods manufacturers, whereas an example of a narrow customer base is one served by a manufacturer of specialized industrial components. One company with which we have worked produces a product that is only sold directly to automobile assembly plants in North America. Thus, even though this is a company with annual dollar sales in excess of $50 million, its customer base is only 56 customers (the number of automobile assembly plants in North America).

The narrower the customer base, the more likely a company can rely on direct customer contact information to produce more qualitatively oriented sales forecasts. In the example just given, the sales forecasting function calls the production scheduling department of each of its 56 customers each month and asks for the schedule of car production, which is sent by electronic data interchange (EDI). From this information, a very accurate, qualitative sales forecast can be derived.

Contrast this example with a large manufacturer of consumer products that sells to all the 45 million households in the United States. Such a broad customer base makes any appreciable customer contact impossible (even if we surveyed 1 million homes, we would still have only contacted about 2% of our customers!) and causes more reliance on quantitative forecasting (i.e., time-series and regression) techniques. Thus, the narrower the customer base, the more a company can rely on direct customer contact qualitative techniques, and the broader the customer base, the more reliance will be placed on quantitative techniques (time-series and regression), with qualitative adjustments.

Data Characteristics

The second set of questions concerns the type, availability, and quality of data:

1. What data are available to your company for use in the forecasting function? Specifically, do you have data available on shipment history, order history, and/or end-consumer demand (e.g., POS data)?
2. How old are the data (i.e., how many weeks, months, or years are contained in the data)?
3. At what level of detail are the data?
4. What data external to your company can you obtain to facilitate sales forecasting (i.e., external factors that might affect product demand for use in a regression model)?
5. How accurate are the available data?

Sales, Shipments, and Demand

The answer to the first question determines what we will forecast. It is important to distinguish between sales, shipments, and demand. Although called sales forecasting, this function is really about forecasting demand. *Demand* is what our customers would buy from us if they could; *sales* is our ability to accept orders from our customers; and *shipments* is what our operations system can actually deliver to our customers. Suppose, for example, that demand for one of our products next month is 10,000, but our salespeople (due to uncertainty about delivery time commitments) can only confirm 9,000 units in actual sales. Suppose, further, that our production/logistics system can only produce and deliver 7,500 units of those ordered (sold). If our information system only collects and records shipments, our historical record of this month will show shipments of 7,500 units, *and nothing else*! What will be lost is the fact that we actually sold 1,500 units more, and could have sold 2,500 units more, if the capacity to produce and deliver had been available. With only this shipments history available to the forecasting function, we will continue to forecast "demand" to be 7,500 units per month, never recognize the lost sales each month, and never increase capacity to capture this extra true demand. However, if the only data we have are a history of what we have shipped in the past, these are the data we will have to use until more meaningful demand data can be gathered—but the commitment should be immediately made to begin gathering this more accurate sales and demand data.

Data Age

How much historical data is available largely defines the sales forecasting techniques that can be used. If less than one year of data is available, only the more simplistic fixed model time-series techniques (TIME SERIES) are going to work—any time-series technique that considers seasonality needs at least two years

of data (so it can identify two complete seasonal patterns) to begin forecasting effectively. Open model time-series (OMTS) techniques typically need at least four years of data, whereas regression typically needs at least five periods of data for each variable in the regression equation (so if we had sales as one variable and advertising, price, and trade promotions as the three independent variables, we would need at least 4 variables times 5, or 20 periods of data). Of course, many companies have such a short life cycle for their products that many of these techniques are simply never practical.

Data Level

The level of detail of the data refers to the planning detail required. If we are forecasting annual dollar sales by product line for a marketing plan, data at the same level and time horizon are fine. However, if we also need weekly unit forecasts by stock-keeping unit by location (SKUL), annual product line data will be of little help. Since we need sales forecasts for a number of different functional plans, data at the level of detail corresponding to each of these planning needs are necessary.

This level of detail is called the **forecasting hierarchy** and is defined as all the planning levels and time horizons and intervals at which forecasts are needed. Figure 5.6 illustrates one such forecasting hierarchy for a company with which we have worked. In this company, the logistics function needs forecasts by week, by SKUL (SKU); the production and purchasing functions need forecasts biweekly, by stock-keeping unit; the sales function needs dollar sales by product by quarter; the marketing function needs annual dollar sales for the next year by product line and for the next five years by division; and finance needs annual dollar sales for the next five years by strategic business unit (SBU) and for the overall corporation. The data detail required for developing a forecast for each of these functions must match each planning level, horizon, and interval. The figure is drawn as a triangle to represent the number of forecasts that are required at each level of the hierarchy. Many more forecasts are required at the SKUL level than at the SKU level, more at the SKU than at the product level, and so on.

External Data Availability

Finally, the availability of data on factors external to the actual sales history determines whether or not regression analysis can be used. If the only data available are concerned with sales, shipments, or demand history, there is no information on which to build a regression model. Historical data on factors such as price, advertising, trade and consumer promotions, economic activity, and competitive actions (for just a few examples) must be available.

Data Quality

Corporate records are not always as trustworthy as we would like them to be. Invoices sometimes do not get entered, when they are entered they are entered with errors, or demand is recorded in the wrong period. All these are examples of data quality problems.

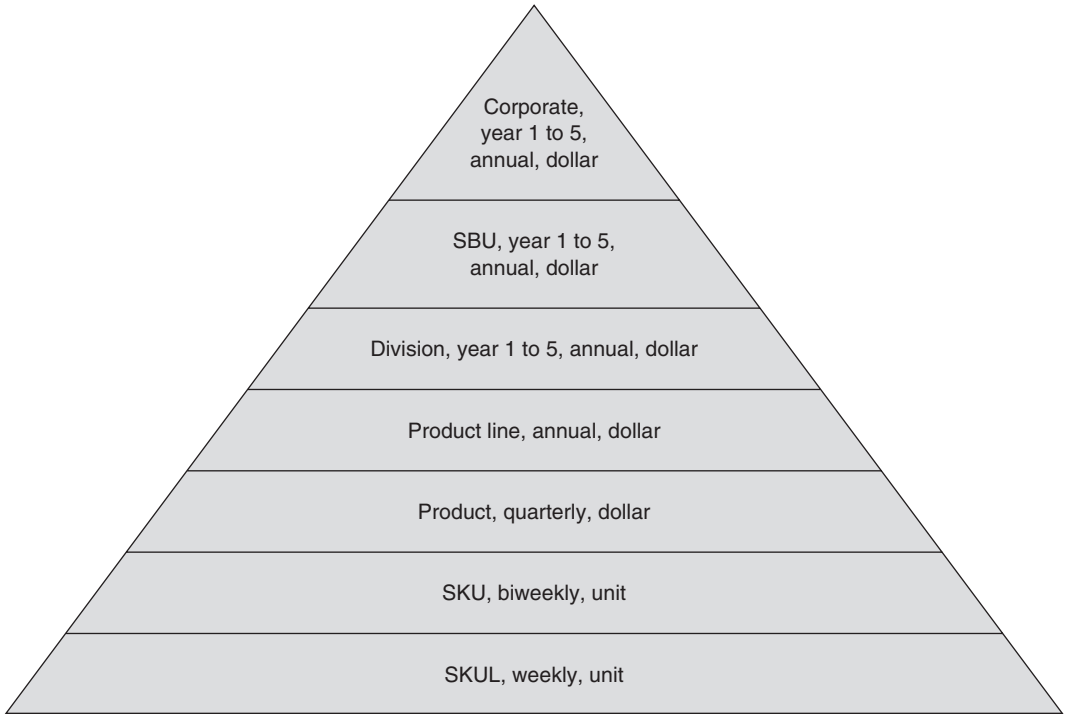

Figure 5.6 Example of a Forecasting Hierarchy

One company with which we worked was quite proud of their EDI system of recording their distributors' POS demand. However, when we interviewed distributors for this company, we found that these POS orders were actually taken and filled by a paper system and entered into the electronic system later. During high-demand months, distributors "simply do not have the time to keep the system up-to-date—we are too busy selling." The result was that many orders did not get entered into the system until the month after the demand occurred. Of course, this resulted in inaccurate data on monthly demand patterns.

Number of Forecasts

The third set of questions concerns how many forecasts you need, and this is a function of the following:

1. At what levels, time horizons, and intervals are forecasts required?
2. How many products, that is, product lines and product items (SKUs), must be forecast?
3. In how many distribution channels are your products marketed?
4. How many product/location combinations (e.g., by sales regions, distribution centers, individual customers) must be forecast?

Levels, Horizons, and Intervals

As discussed earlier, different functional areas require forecasts at different levels, time horizons, intervals, and forms. How the various functions answer these questions of how many forecasts are required and how often they are required will begin to define the forecasting hierarchy.

Number of Products

To understand the impact of forecasting different numbers of products, contrast the forecasting process for a company that manufactures a group of specialized industrial components with the forecasting process for an apparel manufacturing company that must forecast the numerous SKUs generated by multiple size, color, style, and fabric combinations. Limited product line companies can devote considerably greater attention to any one forecast than broad line companies that have literally thousands of products to forecast for each of the levels, horizons, and intervals mentioned in the previous question. For example, one telephone company we worked with in the 1980s had essentially only one product to forecast—new phone installations. With no local competition, this was the only forecast relevant to all the planning functions, and thus, a team of three people devoted their full attention to developing one forecast each month. This team could put considerably greater time into using sophisticated OMTS and regression analysis than a company like Brake Parts, Inc., which has several hundred thousand products to forecast each month (Mentzer and Schroeter 1993).

Distribution Channels

The third question in this set considers companies that have multiple channels for the same product. For example, an automotive parts manufacturer may market a certain product directly to original equipment manufacturers, through a separate channel under its own brand name, and through a large retailer channel under the brand name of that retailer. Thus, this one product is now marketed through three separate channels, each with its own demand patterns and, therefore, forecasting needs.

Product and Location Combinations

Similarly, the difference between the number of SKUs and SKULs can dramatically change the number of forecasts that are required. The number of forecasts needed to meet the planning needs of all business functions is determined by the number of products we produce *and* the number of locations where they are shipped or sold.

New Products

Similarly, the number of new products introduced in a given planning horizon affects how we will forecast. Are these variations on existing products or truly new

products? Not surprisingly, we have found that the forecasting of genuinely new products is cited by many companies as one of the most difficult forecasting problems they face. At its best, new product forecasting is a leap into the future with little or no historical information to tell us which way to leap. New product forecasting can take a great deal of sales forecasting personnel time, can hurt the credibility of the forecasting group through poor new product forecasting accuracy, and can reduce the morale of the forecasting group. It is, however, a necessary function in the competitive environment of most global supply chains.

Regional Differences

Regional differences in demand for products increase the number of forecasts to be made and the analysis required. For example, manufacturers of agricultural chemicals have a very different market in the United States than in Canada. The much shorter growing season in Canada creates entirely different market behaviors that must be forecast differently.

Seasonality

Similarly, the degree of seasonality of the products we market affects the techniques used to forecast. Many time-series techniques and regression do not consider seasonality and, thus, either should not be used in highly seasonal situations or should be used in conjunction with techniques that do consider seasonality.

Personnel and Systems Sophistication

How sophisticated are the personnel involved in the sales forecasting function? Do they have educational backgrounds in statistics or econometrics? What is their level of experience and knowledge regarding the industry in which your company does business? If the answers to these questions are on the lower side, additional training of sales forecasting personnel is probably in order (statistical/quantitative analysis training for those with business experience, and business experience/qualitative analysis training for those with statistical backgrounds), and the sophistication of the techniques used should be limited until such training is obtained.

How sophisticated are the hardware and software systems available for use in forecasting? Are there electronic interfaces among the systems (hardware and software applications) in use by producers and users of the sales forecasts? Without such interconnectivity, many of the benefits that accrue from sales forecasting systems cannot be realized.

Budget

Similarly, without a commitment to the sales forecasting budget, these training and systems problems will probably not get fixed. Interestingly, in our studies of hundreds of companies, few felt their sales forecasting budget was adequate.

Accuracy Needed

Finally, what level of accuracy is required for the various forecasts? That is, what are the consequences of forecasting error at various levels (e.g., SKULL), time horizons, and time intervals? We have found that forecasting accuracy is often considered to be like customer service—the more the better. However, true analysis of sales forecasting management often produces the conclusion that the benefit of improved accuracy is not worth the cost. The costs of training, new systems, and improved techniques should all be weighed against the improvements in supply chain costs, planning costs, and customer service levels. In most cases, the return on investment (ROI) on such investments is dramatic, but it should still be evaluated to determine what is an acceptable level of sales forecasting accuracy for each business function in each level, horizon, and interval.

Demand Management: An Iterative Process

An integral part of any demand management process is an implementation of an iterative process of sales forecasting and planning. Many companies use the business plan to drive the sales forecast—a naive approach, as the forecast should be driven by the realities of the marketplace, not the financial needs of the corporation. More sophisticated companies develop the sales forecast independently of the business plan, but when the forecast and the plan diverge, the forecast is made to "fit" the plan.

In fact, companies that are effective at sales forecasting and business planning start with the sales forecasting process. Remember our definition of a sales forecast: *a projection into the future of expected demand, given a stated set of environmental conditions.* Given expected economic and competitive conditions *and* initial marketing, sales, production, and logistics plans, we make a projection of future expected demand. From this base, the business plan can be developed. When the resultant business plan does not meet the financial needs and goals of the company, we iterate back to the sales forecast and examine what additional efforts in marketing or sales can be undertaken to increase the demand forecast and what additional efforts can be undertaken by production or logistics to increase capacity to the level necessary to meet the business plan. It is this iterative process of sales forecast to business plan back to sales forecast to business plan, and so, on that ensures a business plan that is based on the financial *and* marketplace realities facing the company, its production and logistics capacities, and its global supply chain.

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