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Forecast Measurement and Evaluation

by George Palmatier



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As companies improve planning and control through the implementation of such processes as Sales and Operations Planning (S&OP) and Demand Planning, the issue of forecast accuracy always surfaces. The following questions often arise:

- How should we measure forecast accuracy?
- How good a forecast should we expect?
- How do we measure the effectiveness of our demand planning process?

The Importance of Forecasting - Companies striving for operational excellence and a competitive advantage realize the impact forecasting has upon the ability of a company to satisfy its customers and to simultaneously manage its resources. Effective forecasting helps management resolve the dilemma of more demanding customer requirements and greater shareholder expectations. To resolve this dilemma, managers are expected to provide better customer service with fewer resources. In this environment, the importance of effective forecasting is elevated. In manufacturing and distribution companies, a forecast is not simply a projection of future business; it is a request for product (or a request for resources to ensure supply of a product). In simple terms, this is how the forecast works: If a product is in the forecast, you can expect the product (or resource) to be available. If it is not in the forecast, you should not expect the product to be available. With this concept of a forecast as a request for product, forecast accuracy becomes crucial to ensuring satisfactory, or exemplary, customer service. Forecast accuracy also becomes critical to the proper utilization of resources. For example, when product is requested and not sold or the sale is delayed, resources have been tied up unnecessarily. When a product has not been forecasted but the company must still meet the customer demand, often this is accomplished at a considerably higher cost – a poor use of resources.

Why Measure Forecast Accuracy? First and foremost, we need to measure forecast accuracy if we wish to improve. Measurements are used to make improvements to the specific forecast as well as to the demand planning process. An effective demand planning process measures forecast accuracy in different ways for different purposes. A detailed measure of forecast accuracy at the item level identifies individual products that are outside an established tolerance. This enables us to review – and correct – the individual product forecasts. The earlier a significant forecast error is identified, the quicker we can respond to the real market demand.

Aggregate measures at a product family level are used to determine whether there is a problem with the total (aggregate) product forecast. When a problem surfaces, a more detailed forecast review can be initiated. An aggregate measure is also used as an indicator of the quality of the forecast. It answers the following questions: Is the forecast reliable? Is the forecast getting better or worse? Does the demand planning process need attention? The aggregate forecast is the sum of the individual item forecasts. As such it also serves as a test for reasonableness. Further, it is used to quantify the overall marketing, sales and business plans. A recurring forecast problem is an indication of a poor demand planning process or, possibly, a tremendously uncertain market. If the company has an effective demand planning process and significant product forecast errors persist, then a review of tactics and strategies to deal with the uncertainties is required.

Since actual customer demand will almost always vary from the forecast either in quantity, timing, or both, it is necessary for companies to have tactics and strategies to deal with these variations. These tactics and strategies include: carrying a buffer inventory, varying delivery lead time, maintaining the ability to flex capacity, and managing demand. Most companies utilize a combination of these approaches. However, it is important that the approach chosen occurs through a managed process. Because these decisions have considerable impact on customer service, cost, and resource requirements, it should not be left up to chance which tactics or strategies are utilized. Sales and Operations Planning is the management process used by many companies to ensure a managed approach to these tactics and strategies.

Issues to be considered when implementing these tactics include; customer service objectives, inventory levels, product pricing, product rationalization, manufacturing costs, promotional costs, and a variety of related items. Since customer demands are not static, the competition's tactics are not static, and product availability is not static, the demand planning process must deal with these dynamic conditions. Forecast accuracy plays a key role in determining tactics and strategies to deal with variability and uncertainty. For example, if a product has widely fluctuating demand with large forecast errors, it may be necessary to increase the inventory to maintain customer service objectives. Conversely, it may be possible to reduce inventories if a product has a predictable demand pattern.

In review, forecast measurements are required to: identify forecast problems to ensure quick resolution, measure the quality of the forecast in order to improve the demand planning process, and stimulate a tactical and strategic review of how to deal with demand uncertainties and variables.

Coping with Forecasting Inaccuracies - Even with the best demand processes, there will always be forecast inaccuracies, and there will always be uncertainty. Fortunately many companies today recognize the importance of the replanning capabilities of Integrated Business Management, the tremendous value in cycle-time reduction, and a managed set of tactics and strategies through Sales and Operations Planning to deal with errors and uncertainty. By taking advantage of these tools, companies are satisfying their customers and their shareholders at the same time.

Measurement Criteria - An effective forecast measurement process meets certain criteria:

1. It should be "owned" by those responsible for achieving the forecast. Sales and Marketing should develop (or at least agree with) the measurement methodology.
2. The forecast measurements should be easily understood. Unfortunately, it is common to find forecast measurements that are so complicated that sales and marketing simply disavow the validity of the measurement and, thereby, take no accountability for the forecast.
3. The measurements should identify forecast problems quickly and easily at both the aggregate and detail levels which helps to prioritize items requiring forecast review.

What should be measured? The following items should be measured: product family or group aggregate forecast, mix forecast, individual item forecast, and overall forecast quality.

Product Family Forecast – The product forecast provides the company's management team with visibility of the actual demand versus forecast. This information is used in the Sales and Operations Planning process. By measuring product family forecast error, management can see which product families are on plan and which families require review of the marketing and sales plans.

Mix Forecast – It is possible to have a product family forecast that is within a reasonable tolerance but has a problem with the forecast mix. An aggregate product family forecast is an arithmetic comparison of the total items sold versus the total items forecast. Some of the individual items will be over forecast and some will be under forecast, so the "overs and unders" will tend to cancel each other out. It can appear that everything is in balance when, in fact, considerable deviations are occurring at the item level. Since customers do not purchase in "aggregate," management needs to know the quality of the mix forecast and track it over time. This measurement would normally be visible at Sales and Operations Planning.

Individual Item Forecast – By comparing the actual product sold versus the forecast at the individual item level, an exception report can be generated to highlight those items which require attention. This item level report is critical because forecast adjustment must ultimately be made at the individual item level.

Overall Forecast Quality – An additional measurement may also be used as a general indication of the quality of the forecast. This is the number of items that fall within an established forecast accuracy tolerance. By tracking this measurement over time, management can see whether the overall forecast is improving.

Month	1	2	3	4	5	6
Family A	261	253	240	257	243	243
Item 1	55	58	63	66	48	42
Item 2	102	98	86	79	67	66
Item 3	15	17	13	16	18	15
Item 4	56	45	40	53	62	69
Item 5	33	35	38	43	48	51

Figure 1: Forecast of Demand - Item and Family. Note Family A is the sum of Items 1-5

Forecast Measurement Versus Time – A common question about measuring forecast accuracy is: When should accuracy be measured? The objective in forecasting is to provide sufficient information in sufficient detail in sufficient time for manufacturing to economically respond to change; therefore, response time should be taken into consideration in making forecast accuracy measurements. Most companies establish “time fences” or “decision points” to delineate the economic response times for manufacturing. The greater the stability of demand on manufacturing inside these time fences, the more economically the product can be produced. (See Figure 2, Forecast Measurement and Time Fences.)

A logical approach to measuring the forecast is to measure the actual customer demand against the forecast at the time fence or decision point. Please note that this has little to do with the ability to forecast accurately at that instant in time. It has everything to do with a primary purpose of forecasting to enable manufacturing to economically respond.

As manufacturing companies reduce their cycle times and become better able to economically respond more quickly, the time fences move closer in and the need to forecast accurately far into the future is diminished.

How to Make Forecast Measurements – The preceding discussion sets the framework for specific recommendations on how to make forecast measurements. There is literally an infinite number of ways to measure and present forecast measurements. The following measurements represent my personal recommendations, based on more than 25 years of experience and observing many companies’ demand planning processes:

1. **Product Family Forecast** – This is the most visible measurement in the family-by-family review used in Sales and Operations Planning (S&OP). The basic measurement is the family forecast at the last S&OP meeting (last month) compared to the actual customer demand for that same month. This is not a measure of the family forecast at the time fence (unless coincidentally there is a one-month time fence). The family measure at the time fence is a supporting forecast measurement. The marketing and sales organization is expected to communicate the most likely demand as they see it across the entire planning horizon, not just at the time fences.

Forecast Measurement and Time Fences

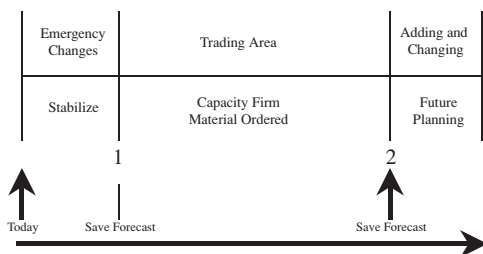


Figure 2: Forecast Measurement and Time Fences

2. **Mix Forecast** – This measure uses the sum of the absolute deviations of the forecast at the individual item level. To determine the absolute deviation, the actual customer demand is compared with the forecasted demand by item in a product family. The sum of the item level absolute deviations for that family is then divided by the sum of the item level forecasts and multiplied by 100. This calculation provides a percentage of the mix deviation by family. This data is tracked family by family, month by month, as an indicator of mix forecast accuracy by product family.

3. **Individual Item Forecast** – The actual customer demand is compared against the forecasted demand for the past month, item by item. The data can be presented in unit deviations or percentage

deviations from forecast. This information can be listed in descending order from the largest deviation in units or percentage to identify and prioritize problem items that require review. This measurement should be made at least monthly but is also useful on a weekly or daily basis to highlight significant problems early.

4. **Overall Forecast Quality Measurement** – By establishing tolerances for individual item level forecast deviation, a report can be generated showing the number of items falling outside (or inside) the tolerances. This can be displayed in total or by product family. By establishing ranges of forecast deviation, the items can be collected by deviation range and a graphical presentation made. This can be displayed by family or in total and observed over time. This display also helps

to identify bias in the forecast by observing the number of items above forecast versus the number of items below forecast.

Overall Forecast Quality – Care must be taken not to overwhelm the demand planning process with too many measurements. The above are basic measurements to be made on an ongoing basis to ensure that the process is in control and improving. The measurements are not difficult to make once a forecasting data base is established.

Additional Measurements for Evaluation and Measurement – The discussions, thus far, have centered around product forecasts in units. It is often desirable to analyze and evaluate the forecast and its accuracy from the following perspectives.

Units Versus Dollars – It is desirable to make similar kinds of measures as described above from a currency perspective. Normally, forecasts will be in units and then multiplied times the appropriate selling price to determine forecasted dollars (or other currency). Depending upon the assumptions regarding selling price, the unit forecast may be highly accurate only to find that the financial forecast has significant deviation. Therefore, it is desirable to measure the financial forecast accuracy as well as the unit forecast.

Sales Region – Since the demand plan must be executed by the selling organization, it is desirable to make measures by sales region. The measurements by region are useful to better understand deviations from plan and to improve the sales planning process. This, in turn, helps increase sales. A word of caution is in order when involving the selling organization in the demand planning process. Remember that a sales person's primary job is to sell. The demand planning process should provide the sales people better tools to plan the sale and measure their results. Forecasting should not become an administrative burden to the sales organizations. It is important to include key members of the sales force in the design of the sales forecasting system to insure it provides benefits to the sales people.

Market Segment – Often it is desirable to view the forecast and results by market or market segment. This is especially true if your market plan calls for specific goals and objectives by market segment. Deviations from plan can be identified early and appropriate action taken. This method of measurement has a significant advantage; one of the primary benefits of a proper demand planning process is a better understanding and better control of a company's marketplace.

Total Market and Market Share – Frequently, one of the more predictable variables in marketing is market share. Market share changes are often slow to occur and, therefore, can be used to provide a different view of the forecast of demand. Some companies are fortunate in that industry data on total market and market share is readily available making this measurement a relatively easy task. If market share data is not readily available, first a forecast of the total market is required. Next an assumption of market share versus time is multiplied against the total market. This can be compared against the product forecast in total, by region, or by market segment as appropriate. Using a forecast of the total market and market share can prove invaluable in specific product forecasts. Similarly, if one can determine the key factors that affect the business, a forecast of those key factors (causal forecasting) can be used in developing and evaluating product demand forecasts.

Forecast Accuracy Expectations/Forecast Evaluation – I am often asked, "What should my forecast accuracy be?" This is not an easy question to answer because there are many variables which need to be taken into consideration in answering that question (e.g., volume of business, number of items for sale, number of customers, average order size, frequency of ordering, number of options and permutations of products, number of distribution centers, pricing policy, numbers of new products, etc.)

The following are some general guidelines based upon the experience of numerous companies. These are not presented as the "right answer" to the question but more as a benchmark for your consideration. The numbers presented reflect a mythical company with an average number of customers and average number of products sold at average volume, with average order quantities, average frequency of ordering, etc. Further, the guidelines are not meant to imply excellent forecast accuracy but, rather, average forecast accuracy performance. The guidelines provided are what one could potentially expect with a "reasonable" demand planning effort in a mythical "average" company.

Product Family Forecast – Month-to-month family level errors are expected to average between 0 and 20 percent. A rolling, three-month forecast error would be expected to fall within 10 percent for each product family. The rolling, three-month forecast minimizes the impact of customer order timing on the measurements. Month-to-month measures may vary simply due to timing of orders.

To make the three-month measurement, sum the forecasted demand for three months; at the end of the three-month period, sum the actual customer demand for the forecasted period. Then subtract the actual customer demand from the forecasted demand for the three-month period. Take this variance, and divide by the three-month sum of the forecasted demand, and multiply times 100 to give a percentage error. The measurement should be made and tracked month by month as time passes, dropping the oldest month and adding the new month.

Mix Forecast – Monthly product family mix forecast deviations should be expected to come between 0 and 30 percent at a one-month time fence.

Individual Item Level Forecasts – Item forecasts will vary greatly depending upon the volume of sales, the number of customers, average order quantities (often affected by pricing policy), number of distribution centers, time fences, etc. To more effectively evaluate item level forecasts, it is desirable to do an ABC analysis by volume. An ABC analysis simply uses the Pareto Principle which states that there are a critical few and trivial many. The idea is to focus on the critical few. The analysis categorizes the products into categories; A items are the high-volume items, usually representing about 70 to 80 percent of the dollar volume but only about 15 to 20 percent of the items. B items are the medium volume items which may represent about 30 percent of the items and 15 percent of the dollar value. C items may represent about 55 percent of the items but only 5 percent of the dollar value. (See Figure 3, ABC Analysis.)

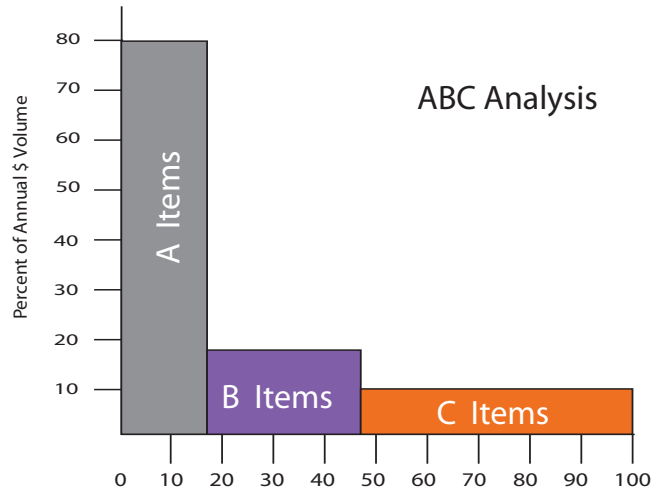


Figure 3: ABC Analysis Percent of Items

ABC Analysis – On A items, you can expect to see individual item level forecasts by month at a one-month time fence

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
Month 1	251	253	240	257	243	243			
Month 2	*244	255	246	263	255	249	238		
Month 3		*262	258	267	264	255	251	259	
Month 4			*242	255	263	255	251	259	260
Month 5				*257	261	255	251	253	259
Month 6					*249	247	245	250	259
Month 7						*241	240	250	253
Month 8							*246	250	253
Month 9								*250	253
Month 10									*246

* = actual demand

Figure 4: Stagger Diagram - Evaluating Forecast changes

with total deviations of 0 to 20 percent; deviations of 0 to 35 percent on B items; and widely-varying deviations from 0 to 250 percent on C items depending largely upon volume, order quantity, and order frequency. If you sell a low-volume product with infrequent orders, you may wish to use the three-month rolling average. Recognize that this measurement should be more accurate than a month-by-month measurement.

Evaluating Changes to the Forecast – Since forecasts are dynamic, it is often difficult to analyze what forecast changes have occurred over time. A useful presentation is one called the “stagger” presentation. It provides visibility of the forecast at different increments in time (e.g., monthly). By using the stagger presentation, it is possible to see how a forecast varied over time and at what period in time the forecast was most accurate. (See Figure 4, Stagger Diagram.) I strongly recommend that the assumptions upon which the forecast is based be documented and visible in the evaluation process. The documented assumptions, coupled with the stagger diagram, provide a good evaluation tool.

Eliminate Detail Forecasting Through Customer Linking – In the 1980s and early 1990s, we witnessed a tremendous increase in Customer Linking/Supplier Scheduling. Relations between many customers and suppliers have changed significantly. Teamwork and “partnering” are rapidly becoming the norm up and down the supply chain. One of the significant benefits of Customer Linking is that the supplier no longer has to forecast the item level demand for that customer. Through an improved communication process and well-defined customer/supplier agreements, the customer tells you, or agrees with, a time-phased communication of demand. Updating the customer’s purchasing plan (your forecast) is defined in the customer/supplier agreement. With the customer communicating what they will purchase and updating it according to the agreement, there is no longer any need for the supplier to forecast that customer’s item level demand. The forecast is being replaced with ordering information supplied by the customer. With all members of the supply chain participating, the supply chain becomes more efficient and more effective at responding to market changes. This customer linking activity has increased between trading partners over the past decade under the banner of Collaborative Planning Forecasting and Replenishment (CPFR).



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Effectiveness of the Demand Planning Process – In determining the effectiveness of the Demand Planning process, it is important not to focus entirely on forecast accuracy. The following are some questions that should be asked:

1. Does the demand planning process lead to a commitment to sell and manufacture to the plan?
2. Does it lead to an improved understanding of the customers and the marketplace?
3. Does it lead to improved relationships with customers?
4. Does it result in improved communications between all departments in the company that, in turn, enhance the performance of each department?
5. Does the process enable the company to operate with one set of numbers eliminating second guessing? An effective process builds a stronger management team – working together to achieve common goals.

For Further Information

- *Enterprise Sales and Operations Planning*, by George E. Palmatier with Colleen Crum.
- *Demand Management; Best Practices*, by Colleen Crum with George E. Palmatier.
- *The Marketing Edge; The New Leadership Role of Sales and Marketing in Manufacturing*, by George E. Palmatier and Joseph S. Shull.
- Attend the Oliver Wight Sales and Operations / Demand Management Classes
- Or contact George Palmatier for an assessment of your Demand Planning process.



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