Microsoft

Improving the Accuracy of Your Forecasts

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EIM

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This report is the third in a series of white papers designed to help forward-thinking distributors increase efficiency, customer service, and profitability with smart inventory management strategies based on tried and proven methods and best practices.

It's tough being a distributor in today's market:

- **Increased competition.** Competition continues to increase as new distribution channels evolve and existing distribution channels expand. Twenty years ago most distributors existed on "market islands." They may have had a few competitors but they knew how these other firms conducted business. A number of developments including the Internet, dynamic data processing capabilities, and faster, more reliable transportation have drastically changed the distribution environment. Customers have more options to choose from when looking for sources of supply.
- **Lower margins.** This "buyers market" has forced many distributors to lower their profit margins in order to remain competitive.
- **More customer demands.** Lower margins are not the only result of this increased competition. Customers are in a position to demand more value-added services and greater product availability.
- **Economic challenges.** Challenging economic times have forced many distributors to reduce their material purchases. They no longer can afford to maintain unneeded inventory or "fat" in their warehouses. Every dollar invested in inventory has to work hard to generate profits.

The result: Distributors have to provide the best possible material availability as well as more services with a smaller investment in stock inventory. They have to do more with less. In order to accomplish this goal, estimates of future usage of stocked items must be as accurate as possible. In this document we will explore some ideas we have found to be effective in developing accurate demand forecasts for your stock products.

Traditional Forecasting Methods

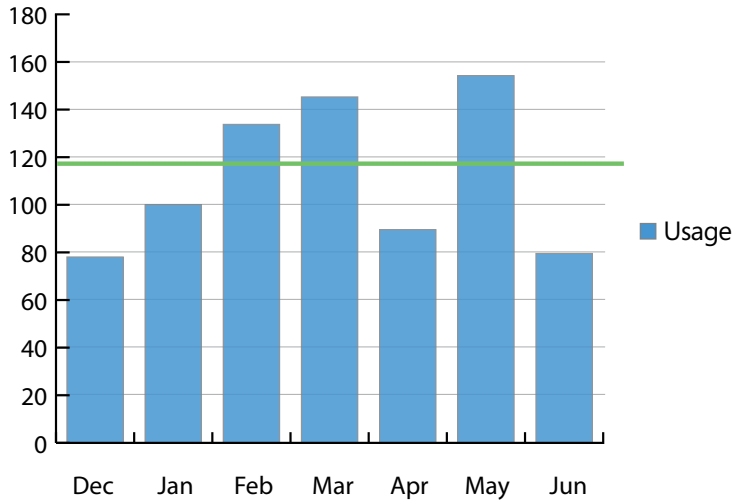
One of the most common methods distributors utilize to forecast future demand of products is to average the usage recorded during the previous several months. Consider the usage history of this product:

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Usage	78	100	133	145	90	154	80	?

To forecast demand for July, we might average the usage recorded during the previous six months:

(100 + 133 + 145 + 90 + 154 + 80) ÷ 6 = 117 pieces

As the following graph shows, a forecast of 117 pieces seems to be a reasonable estimate of July's usage (the green line reflects the forecast for July):



The Effect of Unusual Usage

But averaging past usage does not always result in an accurate forecast of future demand. If the distributor experienced unusually large sales of a product, averaging the usage in the past six months would result in an inaccurate forecast. For example, suppose the distributor experienced an unusual 1,000-piece sale of the product we examined before (that is, usage in June is 1,080 pieces instead of 80 pieces):

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Usage	78	100	133	145	90	154	1080	?

Averaging the previous six months results in a forecast for July of 284 pieces:

(100 + 133 + 145 + 90 + 154 + 1080) ÷ 6 ≈ 284 pieces

But is 284 pieces a good estimate of July's demand? Probably not. To help ensure forecast accuracy we must adjust usage history for any unusual activity that will probably not reoccur. It is a good idea to examine all instances where the demand forecast differs significantly from actual usage. Abnormally large sales are just one type of unusual activity. Consider a situation where there was no usage of the product in the month just completed:

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Usage	78	100	133	145	90	154	0	?

A forecast for July based on the usage recorded in the previous six months equals 104 pieces:

(100 + 133 + 145 + 90 + 154 + 0) ÷ 6 ≈ 104 pieces

Neither 284 nor 104 pieces appears to be a good forecast for July. To ensure the accuracy of demand forecasts, it is critical that buyers or salespeople examine possible unusual usage. A report or inquiry should list products whose usage in the month just completed is greater than "x" percent, or less than "y" percent, of the forecast. For example, some distributors will scrutinize any item whose usage is greater than 300 percent or less than 20 percent of the predicted demand. These percentages are not "cast in stone" and should be modified to meet each distributor's specific situation. There are three reasons why an item would be included on this possible unusual activity list:

1. Activity that will not reoccur. This includes abnormally large sales as well as unusually low usage that was caused by stockouts, temporary customer shutdowns, or some other reason.
2. The start of a new sales trend. There is a dramatic increase or decrease in usage that is representative of probable future usage of the product.
3. The wrong formula is being used to forecast future demand of the item.

If the possible unusual usage was caused by activity that will not reoccur, usage should be adjusted to equal what usage would have been under "normal" circumstances. If a new sales trend is detected, you might want to either adjust past usage to reflect current market conditions or override the actual forecast until an adequate history that reflects the new trend has been accumulated.

Different Patterns of Usage Require Different Forecast Formulas

It would be wonderful if we could forecast future demand of every product by averaging the usage (or adjusted usage) from the previous six months. But we have found that different patterns of usage require different forecast formulas. We've also discovered that an average of past usage is just one element of a good forecast formula. In fact, comprehensive forecasting considers five elements:

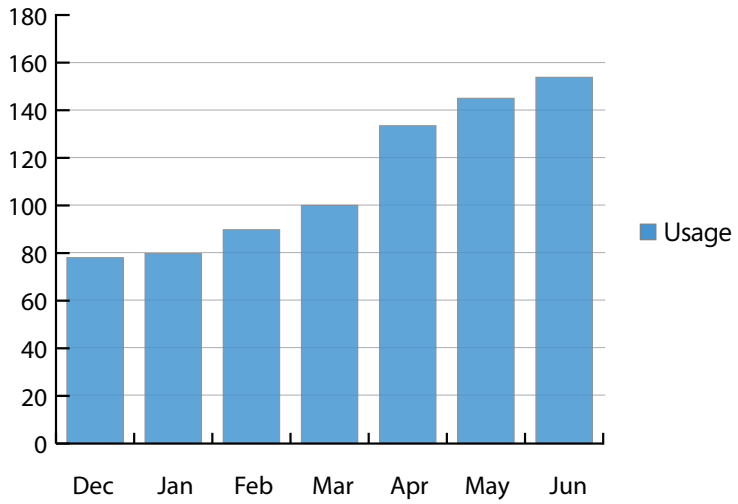
- A weighted average of past usage
- An optional trend factor
- Possible collaborative information from customers and/or salespeople
- The effect of promotions or events
- Identification of the proper time frame for the forecast, also known as the forecast horizon

Weighted Average of Past Usage

Look at this product's usage history:

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Usage	78	80	90	100	133	145	156	?

A forecast for July calculated by averaging the previous six months usage is again 117 pieces [(80 + 90 + 100 + 133 + 145 + 156) ÷ 6 ≈ 117]. But notice how usage has increased during the past several months:



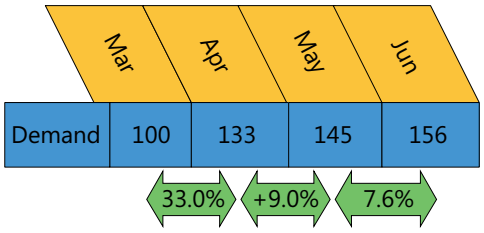
It is logical that June's usage of 156 pieces should have more of an effect on July's demand than January's usage of 80 pieces. We need to be able to emphasize the history of certain months in our forecast demand calculations. This can be accomplished by utilizing a set of weights with the average usage calculation. For this item we will place the greatest emphasis or weight on June's usage and gradually decrease the weight over the previous four months:

Month	Usage	Weight	Extension
June	156	3.0	468.0
May	145	2.5	362.5
April	133	2.0	266.0
March	100	1.5	150.0
February	90	1.0	90.0
Total		**10.0**	**1336.5**

The total extension of 1336.5 is divided by the total weight of 10 to equal a weighted average of about 134 pieces. A forecast of 134 pieces appears to be better than the previous estimate of 117 pieces, but it will probably still fall short of July's actual usage. But remember that past usage is just one element of a comprehensive forecast.

Trends

No average of past usage can result in a forecast that is greater (or less) than the largest (or smallest) usage quantity included in the calculation. If usage is either consistently increasing or decreasing over time, a "trend factor" should be applied to the results of the weighted average formula. Going back to our example, let's look at how usage has increased, month to month, during the past several months:



This item has experienced an average increase of 16.5 percent [(33.0 + 9.0 + 7.6) ÷ 3] during the previous four months. If we increase the weighted average of 134 pieces (calculated above) by 16.5 percent the result is a forecast of 156 pieces. This is probably a fairly good forecast considering that the percentage increase in usage, month to month, is gradually getting smaller.

It is important to note that a trend percentage should not be applied to every forecast calculation. After all, not every item has a consistent increase or decrease in usage over time. Applied trend percentages also may have to be adjusted to reflect changes in interest rates, general business activity, housing starts, or other economic factors.

Finding the Best Forecast Formula

Because various weights can be applied to any previous month's usage, there are literally thousands of sets of weights that can be used to forecast the future demand of products. So how do you determine what set of weights to use with each item? Though this may seem like a formidable task, it is actually not that difficult. We typically start by selecting the eight most common sets of weights. In this example we are forecasting demand for March 2010:

	Feb '10	Jan'10	Dec'09	Nov '09	Oct '09	Sep '09	Aug '09	Jul '09	Jun '09	May '09	Apr '09	Mar '09
A	3.0	2.5	2.0	1.5	1.0							
B	1.0	1.0	1.0	1.0	1.0	1.0	1.0					
C	1.0	1.0	1.0									
D	5.0	2.0	1.0									
E	1.0		1.0		1.0							
F											1.0	2.0
G										1.0	1.0	1.0
H											1.0	4.0

A computer program or process calculates the forecast for each item, using each formula (with and without a trend factor), for each of the past several months. Each forecast is compared to the actual usage (or adjusted usage) for that month with the equation:

[(The absolute value of the forecast – Actual usage) ÷ The smaller of the forecast or actual usage]

For example, if an item forecast is 100 pieces and 50 pieces were sold last month, the resulting forecast error would be 100 percent:

Absolute value of (100 – 50) ÷ 50 = 100%

We receive the same forecast error if the numbers are reversed (a forecast of 50 pieces and actual sales of 100 pieces):

Absolute value of (50 – 100) ÷ 50 = 100%

This method of calculating the forecast error realizes that being overstocked is just as bad as being under-stocked. The forecast formula that has the lowest average forecast error during the previous several months will be assigned to that product to forecast demand in the future. If none of these formulas generate an acceptably low forecast error, other sets of weights or forecasting methods will be tested.

Note that formulas F, G, and H use history for the upcoming months, last year. These formulas are appropriate for seasonal items. These are products whose usage normally fluctuates in a normal pattern throughout the year (for example, beach umbrellas, snow shovels). Trend percentages applied to seasonal forecast formulas compare usage in the last several months this year to usage in the same months of last year.

If your computer system does not allow you to place weights on the usage history in forecast calculations, try averaging the usage in the last three, four, and six months to determine what average usage calculation is most appropriate for each item.

The Effect of Promotions and Other Events

A promotion or event is something that we anticipate will have an effect on usage but does not occur at exactly the same time each year. It is important to accurately analyze the results of promotions and events, correct the usage history to remove the effect of each promotion or event, and apply the anticipated effect of a promotion or event on a future forecast when that promotion/event occurs again in the future. We accomplish this with a four-step process:

1. Hypothesize: Define those events and promotions that you think will affect usage.
2. Test: Determine if the event/promotion did affect usage.
3. Record results: When this event/promotion occurs again adjust the forecast to take into account the previous results.
4. Clean usage history: Adjust the effect of the event out of usage history. After all, the event will not occur at exactly the same time next year.

Collaborative Information

Sometimes a customer's or salesperson's estimate of future usage provides a better forecast than an average of past history. If you can obtain reliable estimates of what will be needed, this information can be included as a component in your "total" forecast calculation:

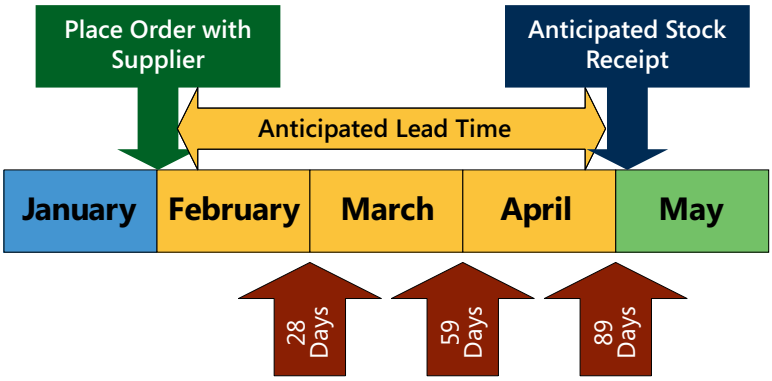
Results of the forecast formula based on past usage
+ Effects of a trend percentage
+ Anticipated effects of events/promotions
+ Collaborative forecast information

Total forecast

If a customer regularly supplies collaborative information for your forecast, make sure that you do not include shipments to that customer in your usage history. If the same customer demand is reflected in both usage history and collaborative information, the resulting forecast will reflect twice the customer's actual needs.

Forecast Horizon

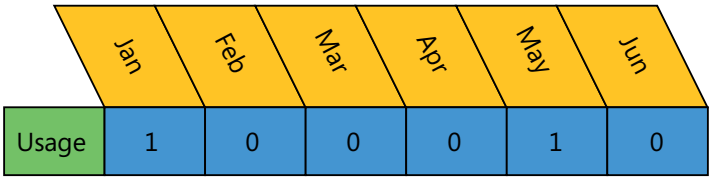
Forecasting is a lot like going to a rifle range. You have to be sure to aim at the right target. That is, you have to be sure that you are forecasting demand for the correct inventory period. For example, suppose a product has a 90-day lead time. If you are forecasting demand at the end of January, your forecast needs to reflect your anticipated usage in May:



After all, an order placed with the vendor will not arrive until late April or early May. Forecasts for February, March, and April should have no effect on your current replenishment plans.

Identify Products Whose Future Demand Cannot Be Forecast

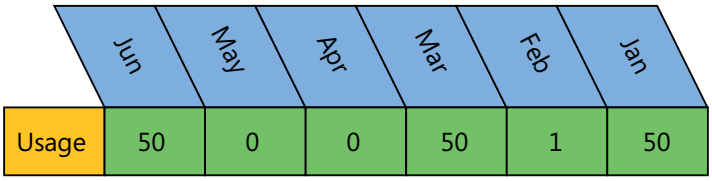
We've spent a lot of time discussing how to accurately forecast future demand of products. Unfortunately, like lottery winners, future usage of some products cannot be accurately predicted. These items tend to have sporadic or irregular usage. Here is the usage history of one of these products:



	Jan	Feb	Mar	Apr	May	Jun
Usage	1	0	0	0	1	0

There was usage of one piece in January and one piece in May. Any average of past monthly usage will result in a forecast of less than one piece. What are the chances a customer will ask for one-sixth of a unit?

Here is the history of another item with sporadic usage:



	Jun	May	Apr	Mar	Feb	Jan
Usage	50	0	0	50	1	50

It appears that customers buy 50 pieces of the product at a time. Any average of past monthly usage will result in a forecast demand of less than 50 pieces (that is, 150 pieces divided by six months equals 25 pieces per month). But even a forecast of 50 pieces per month will not be accurate. After all, the item has sporadic usage. Fifty pieces are not sold every single month!

Products with sporadic usage can usually be identified as those whose average quantity sold or used in one transaction is greater than the average monthly usage. Instead of a forecast of future demand, these products should be maintained with a target stock level. The target stock level is a multiple of the average or normal quantity used in one transaction. For example, you might want to maintain a target inventory of one normal usage quantity of the product sold 50 pieces at a time. The result would be an order up to quantity of 50 pieces. That is, when the stock level drops below the minimum of 50 pieces, enough of the product will be ordered to bring the stock level back up to 50 pieces. If the item has a long lead time or requires a very high level of customer service, you might consider maintaining a target stock level of two normal use quantities. For the item we've been discussing we'd reorder the product as soon as the available quantity dropped below 100 pieces (that is, two orders of 50 pieces).

Accurate demand forecasts are a critical factor in achieving effective inventory management. If you do not have good estimates of future usage, you are forced to overstock in order to maintain a high level of customer service. This is the equivalent of adding "fat" to your warehouse. It costs a lot of money to maintain this excess inventory, money that probably could be put to better use. In today's competitive environment you must be "lean and mean" to prosper and maximize your company's profitability. You need to develop the most accurate forecast of future demand possible for every stocked product in your inventory!

About the Author

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Jon Schreibfeder is president of Effective Inventory Management, Inc., a firm dedicated to helping manufacturers, distributors, and large retailers get the most out of their investment in stock inventory. For over 20 years, Jon has helped over two thousand firms improve their productivity and profitability through better inventory management. Jon has designed several inventory management computer systems and has also served as a distribution industry "troubleshooter" for two major computer companies. He is the author of numerous articles and a series of books on effective inventory management, including the recently published *Achieving Effective Inventory Management (5th edition)* and the *National Association of Wholesale Distributors' Guess Right – Best Practices in Demand Forecasting for Distributors*.

A featured speaker at seminars and conventions throughout North America, Latin America, Europe, Asia, and the Pacific Rim, Jon has been awarded the title "Subject Matter Expert" in inventory management by the American Productivity and Quality Center. He is an advisor and guest lecturer in the Industrial Distribution Program at Purdue University.

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