

TOP-DOWN & BOTTOM-UP FORECASTING IN S&OP

By Larry Lapide

(This is an ongoing column in The Journal, which is intended to give a brief view on a potential topic of interest to practitioners of business forecasting. Suggestions on topics that you would like to see covered should be sent via email to llapide@mit.edu).

This May I was invited by my colleagues at the University of Tennessee to give a presentation on the importance of Top-Down & Bottom-Up forecasting in the Sales and Operations Planning (S&OP) process. The last time I had covered this type of forecasting in one of my columns was eight years ago in the Summer 1998 issue of *The Journal of Business Forecasting* (JBF). Its title was "A Simple View of Top-Down Versus Bottom-Up Forecasting." When I wrote that piece, I felt I had given the topic the coverage it needed for a very long time. However, having to prepare for this year's presentation opened my eyes to the fact that, since I wrote that article eight years ago, much has changed. The topic of Top-Down & Bottom-Up forecasting has become even more important.

The expanding globalization of business, the continuing move from push to pull manufacturing, and the rise in consumer-oriented economies, have led to a much more complex forecasting and planning world. Forecasters and planners are being asked to create plans for expanding geographies, increased numbers of sales channels, and broader, more diverse, and shorter life cycle product lines. This complexity means that markets are more dynamic and

quantitatively based statistical forecast methods are becoming less effective in capturing all that is happening in today's

rapidly changing business environment. More market intelligence now needs to be incorporated during the development of forecasts.



LARRY LAPIDE

Dr. Lapide is a Research Director at MIT's Center for Transportation & Logistics where he manages its Supply Chain 2020 Project focused on supply chain management of the future and its demand management research initiatives. He has extensive business experience in industry, consulting, and research, and has a broad range of forecasting experiences. He was a forecaster in industry for many years, has led forecasting-related consulting projects for clients across a variety of industries, and has taught forecasting in a college setting. In addition, for seven years he was a leading market analyst in the research of forecasting and supply chain software.

This means that effective collaborative environments are necessary to solicit input from a wider group of people within a company who have some understanding of where a business might be going. This has led to greater adoption and interest in the use of S&OP (a process that I have recently found myself discussing and writing more about). This is a cross-functional process that brings together teams of individuals on a routine basis to plan for where businesses are going on a tactical basis. Each team member brings to the process a specific perspective during the development of supply and demand plans/forecasts.

In this regard, each S&OP team member may have to generate, review, and revise demand forecasts that reflect the aspects of a business with which they are most familiar. This requires leveraging Top-Down & Bottom-Up forecasting in the process more than that required eight years ago. The remainder of this article discusses Top-Down & Bottom-Up forecasting in terms of what it is, how it supports accountability and commitment in the S&OP process, and the use of forecasting hierarchies as enablers.

WHAT IS TOP-DOWN & BOTTOM-UP FORECASTING?

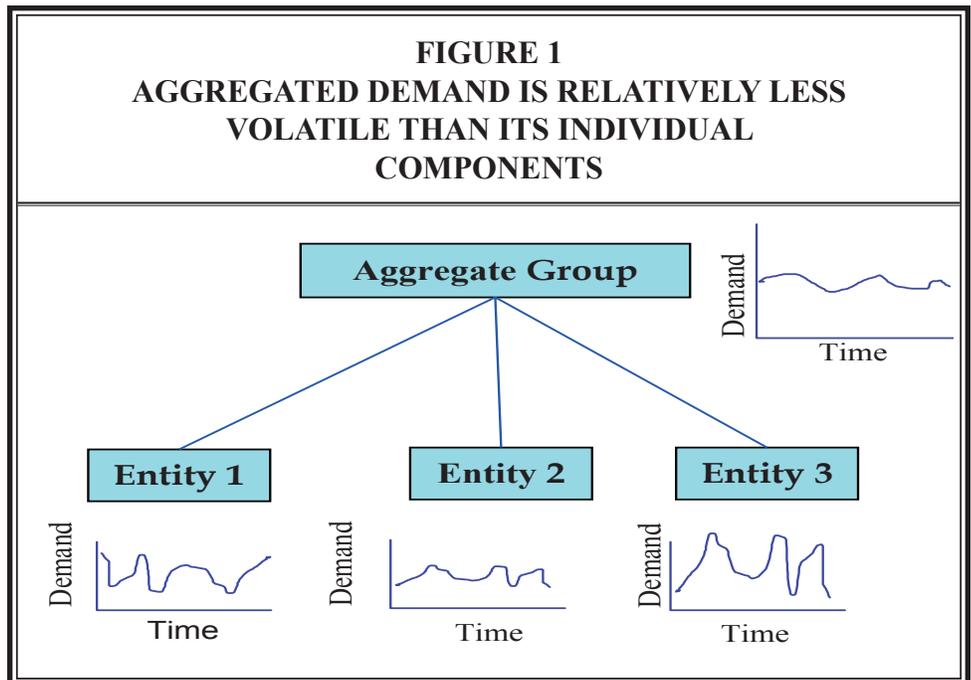
Top-down forecasting is extremely useful for improving the accuracy of detailed forecasts. As depicted in Figure

1, aggregated demand is less volatile than its individual components, so on a relative basis a forecast of the aggregate is more accurate than the forecasts of its individual components. This is due to the phenomenon of compensating errors where random errors and variations tend to cancel each other out. This is the principle behind the concept of Top-Down forecasting where, rather than forecasting each component separately, it is better to first forecast the aggregated group and then disaggregate the resulting forecast to derive the forecasts of the individual components. The good news is that this principle can be leveraged for any type of aggregation, such as aggregations across products, sales channels (e.g., stores), geographies, and even time itself.

However, as discussed in my Summer 1998 JBF column, one of the things to be careful about is that Top-Down forecasting only makes sense when a top-level aggregated group is made up of components that have similar patterns of variation. That is because component forecasts are frequently derived by breaking down the top-level forecast using the proportions that the individual components represent of the total. When this is done, the pattern of variation of the aggregated group would be assumed for the individual components—and this may not always hold.

The use of Bottom-Up forecasting is better for situations where the individual components have different patterns of variation. Under the concept of Bottom-Up forecasting, one forecasts the individual components separately and then adds the forecasts up to get the forecast for the aggregated group.

Generally, Top-Down or Bottom-Up used on an exclusive basis is not the best way to forecast. Often the aggregate group's Bottom-Up forecast can be improved by replacing it with a Top-Down forecast. The individual Bottom-Up component forecasts can be then improved by adjusting each using correction factors derived from looking at the aggregated group's Bottom-Up versus its Top-Down forecast. (For example, if the Bottom-Up forecast predicts aggregate



sales to remain flat, while the Top-Down forecast predicts it to grow by 10%, then the correction factor to apply to the bottom-level forecasts would be 1.1). Thus, Top-Down in conjunction with Bottom-Up, and even Middle-Out is recommended.

THEIR USE IN THE S&OP PROCESS

There are two ways in which Top-Down & Bottom-Up forecasting is useful during S&OP, a process that is predicated on developing consensus-based demand and supply plans. Cross-function teams comprised of members from the supply chain, operations, marketing, sales, and finance organizations meet to discuss their plans for generating and satisfying customer demand. The process is driven by a baseline demand forecast that reflects the demand expected from the marketing and sales plans, which in turn drives the supply plans reflecting the future activities of the operations, manufacturing, logistics, and procurement organizations. Thus, the first (obvious) way in which Top-Down & Bottom-Up forecasting is useful in the S&OP process is during the development of the baseline forecast, in order to take advantage

of the accuracy that can be achieved from using both types in conjunction with each other. For example, brand-level forecasts may be most accurately generated at the brand level, and SKU-level forecasts might best be derived from disaggregating the brand-level forecasts using Top-Down forecasting. In turn, product group forecasts might best be derived by aggregating the brand-level forecasts using Bottom-Up forecasting.

The S&OP process also involves refining the supply and demand plans, as well as the baseline-demand forecast. The resulting consensus-based supply and demand plans developed during the process require accountability and commitment from each of the stakeholder organizations involved to ensure each will execute as close as possible to what is embodied in the plans. In order to get this type of buy-in and increase forecast accuracy, each organization needs to participate in the development of the forecasts in terms of reviewing and revising them as necessary.

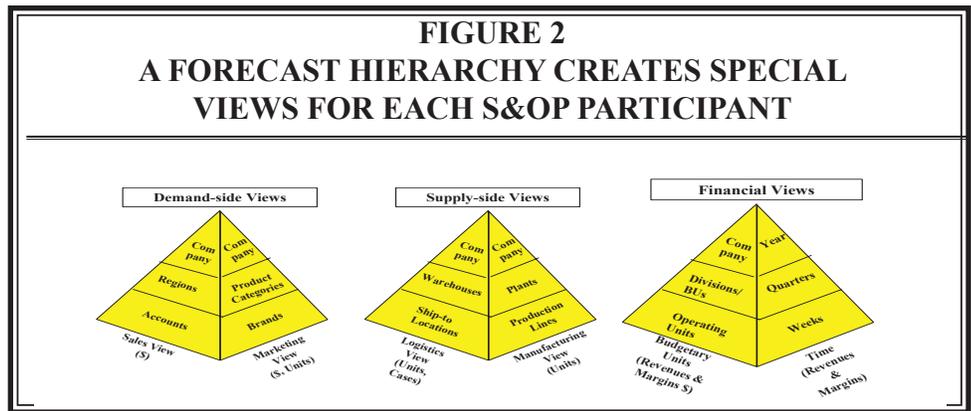
This is best accomplished by translating and representing the demand forecasts in a form in which each organization is used to dealing with. If marketing's approach to

planning, for example, focuses on revenues generated by product groups and brands rather than by unit-based Stock-Keeping-Units (SKUs), then any unit-based SKU demand forecasts needs to be aggregated to these product levels on a dollar basis before Marketing could effectively review and revise the forecasts. Meanwhile, if Sales is most familiar with dealing with sales (in dollars) by customer accounts and/or sales districts and channels, then demand forecasts needs to be aggregated, disaggregated, and translated into these account groupings before Sales can usefully play its role in the S&OP process. Similarly, Supply Chain managers are most comfortable dealing with forecasts that reflect unit-based SKU and case-level demand, for example; while Finance relates best to forecasts that are aggregated into budgetary units in terms of revenues, costs, and margins.

Thus to get the requisite accountability and commitment from all the organizations involved in the S&OP process requires that forecasts be aggregated and disaggregated (and possibly translated) to various levels to be reviewed and revised by each one, in terms they best understand. This represents another way in which Top-Down & Bottom Up forecasting is useful to the S&OP process. For example, if an organization revises a demand forecast at an aggregated level, then the revision needs to percolate up and down, using Top-Down, Bottom-Up, and Middle-Out forecasting methods.

HIERARCHY AS AN S&OP ENABLER

A forecasting hierarchy is an important element of the S&OP process that is often overlooked in its design, yet it is needed for effective leveraging of Top-Down & Bottom-Up forecasting. As discussed earlier, forecasts need to be generated, reviewed, and revised at various levels of aggregation and disaggregation. To do this, a pre-established and formal set of relationships embodied within a forecast hierarchy is required. The hierarchy maps and translates all the levels among themselves to the highest, the lowest, and the most detailed



forecasting levels. Also embedded in the hierarchy are the rules used to aggregate and disaggregate the numbers needed when generating various views of the forecasts.

I've often referred to the technology needed to support a forecasting hierarchy as a "slicer and dicer" engine because it has to aggregate and break-down numbers in any number of ways, while at the same time keeping them consistent and synchronized. A forecast revised by Sales for a very large national account, for example, can percolate up and down to all SKU-level, brand-level, channel-level, warehouse-level, and plant-level forecasts, and the resulting changes to them need to be as consistent as possible with revisions made to them by other organizations.

Figure 2 depicts an example of a forecast hierarchy that creates special views for each S&OP participant. It has two supply and two demand-side aggregated views, as well as a financial roll-up view. As can be seen from it, Marketing, Sales, Logistics, Manufacturing, and Finance need to generate, review, and revise forecasts in very different ways, as represented on the faces of the pyramids. All views on the faces need to be consistent with the lowest, most detailed forecasts, as well as be consistent among each other.

SUMMARY

In summary, Top-Down & Bottom-Up forecasting is extremely useful to improve the accuracy of forecasts and plans when

leveraged within an S&OP process. The improvement is due to three underlying principles: 1) aggregated entities experience lower relative volatility than their individual components, 2) marketing intelligence can be incorporated more effectively, which improves accuracy and 3) this results in greater accountability and commitment to consensus-based plans. All these can be achieved only if all the participants in the S&OP process collaborate during the development of demand forecasts. However, much of the potential for improvement with Top-Down & Bottom-Up forecasting cannot be fully achieved unless a formal forecast hierarchy is being leveraged to support the S&OP process.

And these are points I never recognized or discussed in my first column on the topic eight years ago—yet they are extremely important in planning for today's more uncertain and dynamic markets. ■