An MIT Supply Chain Exchange Symposium

Proceedings of the "Demand Management: Optimizing Supply and Demand Over Time" Symposium

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Background for the Symposium

The symposium *Demand Management: Optimizing Supply and Demand over Time* was conducted on September 12-13, 2006 as part of the launch of MIT-CTL's Demand Management research initiative in order to share ideas, case studies and learnings with its Supply Chain Exchange partners. A prior symposium, *Demand Management: Integrating Demand and Supply in Real Time*, was conducted in September of 2004 to survey sponsors on their areas of interest.

The research initiative was recently launched because of the growing influence of demand management around such industry-based concepts as "Consumer-Driven Supply Networks", "Commercializing the Supply Chain, "Demand-Driven Supply Network" and "Demand Shaping."

The Demand Management (DM) research initiative takes a broad view of DM as the business processes that bridge supply-side and demand-side management. As such, DM is defined as "matching supply and demand over time" – in the long, medium, and short-term processes. Overall, the major research question to be addressed is: What strategies, principles, and methods can be leveraged to optimally match supply and demand over time?

CTL is assembling two research groups that will focus on demand management topics. The first group, the Demand Management Research Group, is limited to Supply Chain Exchange partners only. The second group, the Demand Management Solutions Research Group, is open to solution providers, consultants, and corporate IT professionals. The second group will be focusing on what solutions need to be developed to support demand management.

The symposium addressed a portion of the full scope of the demand management research. It focused largely on the medium-term processes such as Sales and Operations Planning (S&OP), sales forecasting, and demand planning, as well as on long-term processes such as setting customer expectations through service policies and customer service segmentations.

Synthesis of the Symposium

1. The Gap between Demand and Supply

Dr. Lapide began the symposium by discussing a frequent gap between demand and supply. The gap exists because companies separate the demand and supply sides of the organization. Each side uses, and is rewarded on, very different metrics and incentives, which further exacerbates the gap.

1.1. Demand-Side Goal: More Sales, More Commissions

On the demand side, the people in functions such as sales, marketing and merchandizing work to maximize the top line of the company. They seek to grow revenue via a combination of sales, promotions, and responsive customer service. For them, high inventory and high production means they can sell more products. They see expedited orders not as extra costs but as a way to satisfy or delight customers. Their own compensation and incentives are tied to revenues, satisfied customers, and stretch goals for adding customers and orders.

1.2. Supply-Side Goal: More Efficiency, Lower Costs

On the supply side, people in functions such as operations, manufacturing and logistics work to satisfy demand while minimizing costs and inventories. To hold down costs, these functions seek efficiency. Their efficient-minded solutions include batch production, full truckload shipments, and low levels of inventory.

1.3. Result: Service Problems, Overstocks, and Lost Sales

Although the twin goals of boosting revenues and shrinking costs would seem to ensure maximal profits for the company, it doesn't. When the two sides of the equation operate independently, each side often takes steps that degrade the performance of the other. In an effort to maximize sales, the demand-side of the organization makes short lead-time promises and overestimates demand to keep production going. The result on the supply side is excess inventory and excessive transportation costs on expedited orders. To minimize costs, the supply side restricts inventory and configures production schedules and transportation plans for maximum efficiency. The result for the demand side is stock-outs, delayed orders, and lost sales.

1.4. Summary of Approaches to Bridging the Gap

The presentations and discussions at the symposium covered a wide range of methods for bridging the demand-supply gap. The first solution centered on better forecasting. Demand forecasts can be waylaid by biases in different parts of the organization. One way to improve forecasting is to understand the difference between an unbiased forecast, the business objectives for volume, and the actual volume of sales.

Second, companies shared ideas on how to combine knowledge about customers and products, such as by embedding forecasters into the sales organization. A third set of solutions focused on

creating closed-loop cycles that adjust the sales plan and operations plan on multiple timescales. For instance, several of the companies described how they do monthly S&OP (Sales & Operations Planning) as a medium-term solution to matching demand and supply. The companies also deploy long-term processes such as customer segmentation and customer service policies (e.g., prioritization) to adjust the demand profile to better match the capabilities of the supply side of the business.

The final set of solutions addressed people issues. Dr. Shalom Saar described a color-coded three-category model of people's mental styles. "Red" people insist on hard facts and the practicalities of day-to-day realities and are driven by "what is true." "Green" people operate on a optimistic flow of possibilities and are inspired by "what is new." "Blue" people operate impatiently from deep convictions and are motivated by "what is right." In general, operations people are Reds and sales people are Greens; this implies a chasm between the two that can create misunderstandings and mistrust.

2. What Contributes to the Gap

Several factors contribute to the gap or exacerbate it. First, on the demand-side, it is becoming more difficult to serve as customers that have become more exacting or change their demand patterns more frequently. Second, some companies may have little visibility onto that demand due to churn, short selling seasons, or immature demand planning by the customers. Third, supply-side issues such as long batch processes or intricate manufacturing make it hard for some companies to flex. Finally, special events such as new product introductions and M&A can exacerbate the gap.

2.1. Challenges on the Demand Side

In discussing the causes of the gaps in matching demand and supply, the speakers started with the demand-side of the equation. As P&G said, "the customer is boss." Many organizations are shifting toward a more demand-driven model. For example, Intel's plans for unit-level RFID tagging will help the company track inventory as it flows through Intel's broad network of channel partners. The result is a shift toward what P&G calls a Consumer-Driven Supply Network (CDSN) or what AMR Research calls a Demand-Driven Supply Network (DDSN).

Consumers are also becoming more demanding. Increasingly, consumers want more innovation, value, and a better in-store experience. Global customers, such as large retailers and OEMs (Original Equipment Manufacturers), want an increasingly global interface that requires standardization and coordination among business units in large supplier organizations. At the same time, customers want customization. For example, Wal-Mart is moving to six customized formats that will call for different mixes and patterns of demand to suit different demographics.

The CPG (Consumer Packaged Goods) industry is not the only industry to see shifts in the marketplace that impact demand planning. Dr. Lapide noted Dell's recent problems with a shifting PC market. In the past, the PC market was driven by business demand for commodity computers configured to meet business needs. Today, the focus of the market is shifting to a more fashion-oriented, consumer-electronics market for home computing. Supply chain models

that excelled at supplying to a business market don't seem as well suited to the rising consumer markets.

2.2. Poor Visibility Increases the Gap

Some companies lack visibility onto future demand. Without timely data on future sales, the company doesn't know how much to produce, Some companies face high levels of churn when large customers switch brands. For example, hospitals and medical products distributors often switch between interchangeable supplies, much to the detriment of forecast accuracy for companies such as Cordis.

For companies further up the supply chain, the demand plan becomes sensitive to the plans of customers and customers' customers. A company's forecast accuracy is thus sensitive to the customer's forecast accuracy. If the customer has no visibility onto demand, then that affects the company's ability to forecast.

The size and process maturity of its customers affects a company's forecast accuracy and operating efficiency. For example, Intel sells processors to tens of thousands of channel partners consisting of smaller distributors and local PC shops. These smaller companies don't have sophisticated forecasting processes and may even have poor visibility onto their own inventory and sales. Intel spoke of being whipsawed by these smaller customers when the customer gyrates between ordering huge volumes for an inaccurately perceived boom in sales to canceling orders when the customer realizes how much they've accumulated in inventory. Lack of in-transit visibility exacerbates the picture.

2.3. Challenges on the Supply Side

Constraints on the supply side of a company also contribute to the gap. That is, the flexibility, scope, and complexity of the supply side affect the gap. First, companies vary in the flexibility or scope of their manufacturing systems. Solutia's batch processes and costly changeovers between product variants (e.g., different colors or plastic resins) mean that it optimizes for very long batch runs to maximize production with its limited capacity. Long batches and long leadtimes create a gap when demand fluctuates. Other companies operate a flexible global network of locations and route work-in-process around the world. Intel has flexibility in routing wafers and chips from fabs to assembly and test sites. The point is that supply side issues can modulate how companies respond to demand.

Other companies have complex manufacturing environments that make it easy for gaps to appear and make it hard to know how to close the gaps. For example, Cordis has an extremely complex production environment in which only the most skilled production specialists understand what the factories can do. Making intricate, sophisticated medical devices under the sharp eyes of regulators implies constraints on which factories can produce what and with which labor pools.

In some cases, challenges on the demand and supply side combine to make the gap almost inevitable. For example, Monsanto's herbicide division faces an extreme type of the classic problem of matching efficient year-round production to a limited window of seasonal demand. The needs of efficiency on the supply-side clash with the short season of herbicide sales on the

demand side. In some ways, Monsanto's problem is similar to (but more extreme than) that faced by fashion-oriented product-makers, perishable goods makers, or high-tech producers of rapidly-obsolete products. Whereas fashion and technology products can be discounted at the end of the season to spur demand and recoup some of the costs of production, herbicide sales don't respond to after-the-season sales and have a finite shelf-life.

2.4. Challenges from New Product Introductions/Product Lifecycle

Several of the presenters commented on the special challenges of matching demand and supply during new product introductions (NPI). Big demand-side uncertainties, such as customer adoption of the product and competitor's response to the product (e.g., aggressive promotions or counter-products) mean very large uncertainties in the sales plan. Moreover, new products also involve uncertainties on the supply side, with issues such as low yields, debugging new production processes, ensuring supplies of new raw materials, and the general issues of ramping to volume.

Several speakers and participants spoke of tactics for handling NPI. P&G uses scenarios to envision how it might handle a +/- 50% variance in demand due to the combination of competitor and consumer response. The company also noted that NPI calls for the intelligence of a skilled forecaster. With no data on the new product, forecasting around a NPI is more of an art, especially when the demand pattern shifts during the launch. For example, the beginning of an NPI may see high sales of smaller "trial size" SKUs. The skilled forecaster will know that as the product becomes accepted in the marketplace, sales of small SKUs will fall and sales of larger "economy size" SKUs will rise.

NPI, R&D, and engineering also impact the supply side of the bridge between demand and supply. P&G noted that a formulation change can create slower batch times, implying a reduction in effective capacity and supply shortages. Cordis noted that clinical trials consume some supply. The engineering activities needed to support a new product can consume production resources during the downtime needed to changeover or reconfigure the plant and produce initial quantities to fill the channel prior to the launch.

2.5. Challenges from M&A

Mergers and acquisitions are a final exacerbation in the gap between demand and supply. As companies acquire other companies, they must merge sales-side groups and supply-side groups. For example, when P&G purchased Gillette, it found that Gillette had a different approach to customer segmentation than P&G did. This means that the combined company needed to decide whether to migrate customers to a single service policy or to maintain different policies for Gillette versus P&G products.

3. Forecasting Demand

Forecasting is both part of the problem and part of the solution to the gap between demand and supply. On one hand, some forecasting phenomena exacerbate the gap. On the other hand, a solid unbiased forecast process can help fill the gap. Although demand management is much more than forecasting, forecasting does play a major role in the cycle of planning for demand

and planning for operations to meet that demand. Most of the speakers' companies used sales forecasts as a critical starting point in the demand management process.

3.1. Visibility: Sales Knows Best, But Are They Telling?

The first challenge on the supply side is the matter of who in the organization knows the likely future demand. Sales people often have the most information on customer intentions. They have relationships with customers, they see the RFQs coming in, they can judge the optimism/pessimism of the customer, and they have their finger on the pulse of the marketplace. Yet organizations find it difficult to get that information from the sales force. Sales people would rather be out on the golf course making deals than in the office entering data about potential sales.

Lucent contended that sales people make bad forecasters despite their unprecedented proximity to the customer. Sales people tend not to be quantitative and are not well-versed in statistics; they are perpetually optimistic about the next big deal and are not interested in taking time to enter data. Dr. Saar reinforced this view by noting that most sales and marketing people are "greens" -- people with a mindset oriented toward future possibilities rather than toward the facts.

One further challenge to forecasting is the presence of the sales funnel -- the narrowing processes during which a large nebulous cloud of prospective customer orders becomes progressively firmer until it generates a sale. As the funnel progresses, the many potential orders become a generally-smaller set of actual sales. The forecaster's challenge, especially when looking further ahead in time, is to convert the large-end of the funnel into an accurate, unbiased estimate of future sales.

Other members of the audience felt that sales people can provide useful forecast information at lower levels of granularity. For instance, forecasters can use their own data to create a preliminary forecast and then go to sales people to get feedback and insights to adjust that forecast. Another tactic is to ask sales people for their insights specifically related to larger customers with whom the sales people have a closer, deeper relationship. This information about "big deals" and A-list customers can help guide forecast adjustments to the extent that larger customers reflect the broader market and total pattern of future demand.

In some companies, marketing people may have more insight into demand than salespeople because the marketing people control the promotions and marketing campaigns that can radically influence demand. Their knowledge alone is not complete, however, because they may know the timing of a promotion but not know the exact impact of the promotion on demand. The point is that organizations need to use information from sales and marketing, but getting the information can be hard and the quality of information may be low.

3.2. Barriers to Unbiased Forecasts

Many of the speakers talked of the desire for a one-number forecast -- creating a single, shared, organization-wide estimate of expected demand. If a company can't operate with a single, shared estimate of demand, it's no surprise when supply doesn't equal demand. Yet the speakers admitted that the goal of a single, shared estimate of demand was hard to achieve because different groups in the organization had reasons to believe in or want different forecasts.

Human nature and incentives affect forecasts and cause people to create their own shadow forecasts. First, human nature -- the optimism of marketing and sales versus the pessimism of operations -- pulls the forecast in different directions. Second, misaligned incentives -- sales commissions or bonuses for high sales versus operations penalties for excess inventory or logistics costs -- further pull the forecasts away from any objective value. Using Excel spreadsheets for demand and supply planning exacerbates the problem because anyone can adjust a forecast to suit their own political purposes or undocumented hunches.

The different phenomena can pull the forecast either upward or downward. Some factors push the forecast higher. Mandates and bonuses for growth, for example, motivate stretching the forecast to fit the goal regardless of the real market conditions. Desire to avoid lost sales and lost sales commissions may encourage some people to tweak the forecast upward to insure increased supply. Other factors push the forecast lower. Risk avoidance, for example, may drive the plan downward to minimize the financial risks of over-production. Some people may want to reduce the sales forecast to reduce their commitment to make sales or to supply that level of volume. Finally, capricious top-management intervention based on gut feel can override more objective forecasting and planning methodologies. All sides use the forecast as a political tool for negotiating what they want.

One downside of all the political maneuvering is shadow forecasts. When the different groups disagree and distrust each other, they may publicly agree to some "official" forecast number but then secretly use a different number for their own purposes. For example, if the operations manager thinks that the sales manager always creates a biased forecast, the operations manager might create a shadow forecast that's 10% lower than the agreed-upon forecast. These shadow forecasts can exacerbate the gap because they are hidden and not subject to oversight.

A final challenge to achieving an unbiased forecast is the difference between the properties of an unbiased forecast versus the participants' needs to show high performance in their jobs. Creating a truly unbiased forecast is hard because of what it implies in terms of the probability of hitting the forecast volume. If the true volume shipped has both upside and downside variations, then the volume sold by sales will fail to meet the sales forecast a total of 50% of the time. On the flipside, the volume produced by operations will fail to meet actual demand 50% of the time. In most domains, failing to reach a target half the time would be bad. But in the realm of forecasting, it is a sign of a good, unbiased forecast.

3.3. Three Numbers: the Estimate, the Objective, and the Actual

P&G noted that every forecast really involves three interrelated numbers. The first number is the estimate of expected sales given the company's supply plans. The second number is the business objective or target for sales as determined by the growth goals of the company. The third number is the actual sales achieved.

P&G compares each of these numbers pairwise for specific business purposes. First, comparing the estimate of sales with the objective gives P&G an idea of plan sufficiency. That is, does the company have a plan to achieve the business objective. This difference is a measure of the stretch or tension in the goal. Second, comparing the objective to the actual tells the company if it succeeded in achieving its objectives.

Third, comparing the estimate to the actual tells P&G the accuracy of its forecasting process. This drives improvements in forecasting. It also helps P&G understand risks in the sense of knowing that it may have to accommodate fluctuations in actual demand with respect to planned supply.

3.4. RFID for Enhanced Visibility

Intel discussed its plans for using RFID (Radio Frequency IDentification) at customer locations. RFID tags on Intel chips would help the company track products as they moves into and out of customer facilities. Because Intel does not recognize revenues until the sale of the chip by the customer, Intel has a vested interest in knowing exactly where the chips sit. Moreover, Intel's channel customers -- many of whom are smaller businesses -- lack sophisticated tools for matching supply and demand. The customers' own lack of forecasting prowess means Intel gets hit by whipsaw orders and financial repercussions from unknown levels of product backlog.

Thus, Intel is looking to put RFID tags on chips at the unit level and put readers in the distribution and customer network to automatically track the flow of products. Intel sees RFID as a technology that is almost at the point of widespread usability. Early RFID technology suffered from high costs, high tag mortality, and low read rates. Even today, at 22 cents a tag, Intel expects tags to represent 84% of its RFID costs.

Intel's simulations of using RFID show that RFID can help Intel improve its replenishment performance. RFID data lets Intel track actual daily demand rather than using sparse inaccurate demand estimates created by customers' batch orders. Timely demand data lets Intel simultaneously reduce inventory, increase fill rates, and virtually eliminate sales lost to stock-outs. Nearly three quarters (71%) of the anticipated benefits for RFID for Intel come from improved forecasting and replenishment. RFID reduces data latency, improves visibility, and enables accurate automatic ordering processes. A mere 9% of the benefits come from reduced labor. This calculation of benefits underestimates the total ROI because Intel only calculated the value of RFID for a few select deep-dive areas.

Unit tagging is one of many RFID-based projects at Intel. Intel has been exploring ways to use the technology for three years. During those years, teams have found that they have to take the work out of the lab to truly understand the issues. Finding RFID experts has also been a challenge. As the company grew expertise internally, it discovered that ham radio operators can make good RF engineers.

Intel has plans for a prioritized range of initiatives based on RFID. Initiatives tied to ROI include improved replenishment, agile build plans, and improved processes in distribution. These initiatives will roll out within a year. Later initiatives will include POD (Proof Of Delivery), gray market tracking, a redesigned returns process, and better daily revenue recognition. Longer-term initiatives will use RFID data to support more complex processes such as promotions, VMI, customer flow, and anti-counterfeiting.

3.5. Measuring Error: Going MAPE

Forecasting errors result in lost sales, excess inventory, and unnecessary costs. Bias in forecasting is even worse than errors because it means consistent underselling or overproduction. Several of the participants use Mean Absolute Percent Error (MAPE) as a key measure of

forecast errors. MAPE doesn't tell the entire story of error, however. Therefore, some companies also measure bias; others (P&G) also measure the range of forecast errors. P&G believes that it's better to be consistently within 10% of actual than it is to be within 5% most of the time but miss by 20% some of the time. Accurate estimates of uncertainty (knowing the likely range of error) helps the company plan for flexibility.

Most companies create accuracy targets and expect steady improvement. Reviews of prior forecasts and inaccuracies are intended to drive forecasting process improvements. For complex, multi-line, multi-regional companies, these targets are specific to each segment because some regions and some products are harder to forecast than others. Some companies, such as Solutia, provide rebates to customers who provide accurate forecasts of future sales.

3.6. Low Accuracy on the Horizon

Some of the companies mentioned specific causes of low accuracy forecasts. For example, P&G noted that the fiscal year represents a bit of a wall in terms of forecasting. Poor visibility beyond the year-end leads to conservative forecasts that underestimate demand. If the customer has not made their plans for the coming year, the salespeople see the lack of certainty as indicating a reduced likelihood of sales.

Other companies face churn from customers who bid out large contracts for interchangeable products such as medical supplies for hospitals. Companies also face a sensitivity to macroeconomic factors such as the price of oil and interest rates. For example, Michelin said that demand for tires drops as oil prices rise.

The group debated the problem of forecasting horizons. Uncertainty makes a mockery of every forecast; long-term forecasts may seem like a ludicrous exercise. Planning out 104 weeks of demand, as P&G does, seems futile in a world that doesn't know if oil will be $35/bbl or $150/bbl. Yet all of the companies face long-term investment decisions -- they must commit real dollars today if they have any hope of meeting demand in coming years.

4. Approaches to Bridging the Gap

No single solution can bridge the entire gap between demand and supply. The complexity of the problem and of global supply chains means that companies use multiple strategies to tackle the problem. First, bridging the gap between demand and supply means bringing knowledge from the two sides of the organization together – combining knowledge of the customer and the product. A second tactic focuses on reducing complexity while a third bridges timescales.

4.1. Embedded Forecasters

Bridging the gap between demand and supply requires knowledge of customers as well as products. Understanding both what customers want and what the company can cost-effectively produce helps the company maximize profits. Where companies find this knowledge and how companies bring it together varies by company. For example, very technical industries (e.g., Cordis' cardiology products) may require very specialized production plan specialists. The speakers and audience members shared various mechanisms for bringing these two categories of knowledge together.

Lucent solved the problem of combining product and customer knowledge by embedding 35 forecasters into the company's 2000-person sales organization. The forecasters come from the operations side of the business and have product knowledge. After completing a 40-hour training and certification process through a university, the forecasters are promoted to Unit Forecast Analyst (UFA) and go to the sales side of the organization. By participating in sales activities and visiting customers with the sales team, the forecasters learn about forthcoming potential sales. With the product knowledge they already have, the embedded forecasters have some insights into supply issues and order composition. For example, the forecasters know that the sale of a given communications platform usually entails sales of specific numbers of modules or components. Their product knowledge combines with the insight they gain from being with the sales team and helps them create more accurate forecasts.

Lucent still maintains a supply chain planning group in operations, although the group is now much smaller in size. The product-focused centralized group aggregates demand data from the customer-focused embedded forecasters and adds its own more intimate knowledge of the supply side to create a forecast. Whereas the forecasters do a middle-out forecast of key independent demand items, the supply chain planners do a SKU-level plan. Overall, forecast error dropped by two-thirds within a year after Lucent aligned the forecasters with the sales organization.

The embedded forecasters do more than just aid in estimating future demand. They also provide a bidirectional communications channel between the demand and supply sides of the organization. The forecasters can provide alerts to the supply side of the business about impending new orders or last-minute changes to customer orders. The supply chain planner can help the forecasters be aware of supply and production constraints so that the sales side doesn't over-promise. At the same time, the embedded forecasters provide a buffer between the supply chain planners and the sales force -- the forecaster can answer questions that previously consumed the valuable time of the sales force.

Lucent noted that the job of an embedded forecaster requires a special type of person. Lucent needed to find people who had the right mix of analytic, communication, self-discipline, technical and interpersonal skills. The flux of uncertain and conflicting data on the sales side can confound people with a very objective, fact-oriented mindset. Some operations people don't do well with the torrent of unstructured data floating around the sales environment. Dr. Saar suggested that the best pairing for a forecaster-salesperson team was a female forecaster and a male salesperson. When asked about this, Lucent admitted that the vast majority of its forecasters were women and the vast majority of the salespeople were men. Lucent pays its forecasters well and the job is considered desirable for top professionals.

Other companies have analogous positions modulated by the relative roles of sales versus marketing in managing demand. For example, General Mills, Pepsi, and Michelin spoke of the greater role of marketing in creating demand. General Mills embeds its demand planning centers of excellence in its marketing groups, as does Michelin. Others spoke of the role of large customers such Wal-Mart, club stores, or Sears in driving or providing crucial forecast data. In the event that forecasts from sales are too optimistic, Solutia uses statistical adjustments to correct for bias.

4.2. Avoid the Devil in the Details

Many of the companies spoke of having thousands, tens of thousands, or even one hundred thousand different products that need to be forecasted, inventoried, and delivered. For some companies, the point of demand requires an on-hand inventory of a wide assortment of product sizes -- surgeons don't know what size of Cordis stent they will need until the patient is on the table. Forecasting every SKU for every day or even every week of demand is hard. Companies face a complexity problem in managing the combinations of SKUs (Stock Keeping Units), time periods, and supply tactics.

Path complexity compounds SKU diversity. Intel displayed an eye chart of colored lines and boxes illustrating the multiplicity of paths that a given wafer of silicon might take in becoming a particular chip. Intel's dozens of fabs and assembly/test facilities handle the 60,000 wafer starts per week in producing 100,000 product variants for 95,000 customers.

P&G faces a similar problem in having 22 brands that sell more than a $1 billion a year. With operations in 80 countries and products ranging from detergent to potato chips to pharmaceuticals, P&G has a complex problem. P&G's different product families have different supply chains. Bulky laundry products have regional production centers whereas high-value razor products flow across a global production network. Regional variations in products and markets and a mix of regional and global manufacturing strategies have pushed P&G to create a matrix organization. P&G matches demand and supply on over 90 combinations of regions and product-line business units.

One key to managing all the complexity was to avoid too much detail. Cordis, Lucent, and P&G all argued against overly-detailed plans because such plans create problems on three levels. First, they take too long to prepare -- a rough aggregated plan delivered sooner has more value than a detailed plan delivered late. Second, overly-detailed forecasts and plans consume too many resources -- burdensome processes become overhead and create resistance to participation. Third, overly-detailed plans may be unexecutable -- the factory may not be able to supply an exact SKU mix in exact numbers on exact days depending on the needs of batching and change-overs.

Reducing Complexity

Companies such as Intel and Solutia avoid complexity by aggregating some activities, such as forecasting, to the product family level. Later activities can then split the plan to the SKU level or split a monthly level into weekly segments. Lucent argued for a more nuanced approach in which the split of segments for forecasting and planning. Rather than bottom-up detail or top-down product families, Lucent advocated a middle-out process that focuses on key uncertainties.

Solutia reduced complexity by reducing the number of SKUs. Previously, the company sold rolls of its plastic in centimeter-width increments, but that brought a very high SKU count with all the attendant problems with availability and lead-time. Now Solutia stocks a more limited set of widths. When a customer asks for a non-standard size or a size which Solutia does not have in stock, Solutia ships a larger width roll up to 10% larger than what the customer requests. The policy does mean that Solutia loses some capacity due to waste, although 80% of the scrap material is returned to Solutia where it can be re-melted and reused.

4.3. Bridging the Time Scales

Companies bridge the gap between demand and supply on multiple time-scales. On the shortest timescales, companies use a variety of tactics to fulfill demand from inventory or through flex supply activities. Inventory often fills the gap when variability of customer demand exceeds flexibility of the manufacturing systems. But inventory costs money and suffers from perishability, obsolescence, and disposal costs. Many companies seek to replace inventory with information, creating a better understanding onto future demand patterns.

Companies use Available-to-Promise and Capable-to-Promise to both make firm short-term commitments to customers and to allocate available inventory or capacity to demand. Some companies, such as Dell, actively shape short-term demand on a daily or hourly basis by dynamically changing prices, offers, and product configurations.

Extending the bridging activities means running different supply management cycles at different timescales. For example, P&G does monthly RCCP (Rough Cut Capacity Planning), weekly planning, and daily scheduling of its factories. To better match supply to demand, P&G reschedules its more responsive plants multiple times per day.

Dealing with all these timescales poses challenges. Converting monthly objectives into weekly plans and daily schedules requires a variety of skills and sensibilities. Dr. Saar and Lucent noted that people who are great at tactical execution of concrete tasks on a short-term basis may not be able to think about contingent, long-term, flexible, strategies for meeting uncertain goals.

Managing in the medium term often means joint demand-supply planning processes such as S&OP (Sales & Operations Planning). These processes consider bridging activities on the scale of months. Longer-term processes to match demand to supply include customer segmentation and customer service polices.

Time-Scales Meets Limits on Details

Intel's plan for unit-level tagging and RFID raised the issue of other companies' use of real-time data, regardless of whether the data comes from RFID or POS (Point-Of-Sale) data. Most of the participants do not routinely use POS data despite its nearly 15 years of availability. Companies have found the data to be too inaccurate or volatile to be of use.

The reasons for this discrepancy between Intel's plans for RFID for real-time demand data and other companies' disinterest in real-time demand data from POS are not clear. Perhaps one explanation is that Intel's channel customers are relatively small and immature -- they lack systems for accurate reordering and for tracking inventory. In contrast, the large retailing chains that can provide POS data also have sophisticated replenishment systems such that the supplier gets accurate reordering and aggregate demand data without needing POS data. Also, current promotional activity may obviate historical demand data.

5. Bridging the Gap in the Medium-Term: S&OP

A growing number of companies use Sales and Operations Planning (S&OP) to help close the gap between demand and supply on a medium-term basis. S&OP is typically a monthly process to coordinate demand planning and supply planning, and to communicate those plans across

functions and up the organizational ladder. Managers from the demand side, supply side, finance, IT, and others all play important roles in S&OP.

Cordis noted that S&OP creates transparency across the different functions of the organization. It exposes both the opportunities and the problems in both the demand side and supply side of the organization. It reveals any problems in biased forecasts or unmet plans. It helps the entire management team see the effects of a range of issues, from trends in the marketplace to trends on the factory floor.

S&OP is also a microcosm for both shorter-term and longer-term processes for matching demand and supply. The key is in understanding the unconstrained potential of demand, the constrained reality of supply, and the best means to leverage the resources of supply to meet the opportunities of demand.

5.1. The S&OP Cycle

Three companies described their S&OP processes. All three companies do S&OP on a monthly cycle. That cycle is synchronized to take advantage of timely data and to provide timely recommendations. In general, the cycle includes demand planning, supply planning, and executive overview.

P&G uses a 4-stage S&OP cycle. P&G is organized in a matrix structure on the basis of geographic region and business unit (BU). Given its complexity, P&G runs the S&OP process in some 90 different Region-BU matrix combinations. The S&OP process begins with demand planning, which is primarily owned by regional sales divisions. Demand planning creates a bottom-up forecast. Second, supply planning occurs at the product-focused business unit level. Third, a pre-S&OP meeting hashes out the details of the combined demand and supply plans. Fourth, a final S&OP meeting presents the competed results to upper management.

Solutia's S&OP process follows a similar path to that of P&G. A sales forecast meeting leads to a regional demand meeting. This leads to an SPI (Sales, Production & Inventory) Plan which leads to the plant supply meeting and then a global supply meeting. The last step is the S&OP meeting.

Cordis uses a monthly cycle that begins immediately after the prior month's close. Unlike the other companies, demand planning at Cordis begins in the supply chain management group with a statistical demand forecast. Cordis' SCM group takes the lead in bridging the demand and supply sides of the company. The statistical forecast is given to the sales and marketing teams, who adjust it for promotions, sales, NPI, and so forth during the first week of the cycle. During week two, the finalized demand forecast is used to do supply planning that incorporates operational constraints such as capacity, yields, leadtimes, inventory, and sourcing. Capacity allocation optimizes the various marketing, operations, finance, and supply chain trade-offs to create a feasible plan. This plan is then presented for executive review and sign-off during the third (final) week of the cycle.

5.2. Roles in S&OP

On the demand side, the key roles are marketing and sales. These two groups understand key issues related to customers, consumers, and competitors in the context of the marketplace,

promotions, and the conversion of prospects into orders. The relative role of marketing versus sales varies across companies and product lines. In some companies, such as Pepsi and General Mills, the demand driver of promotions means that marketing plays a bigger role than sales. Other companies, such as Lucent, see a much larger role for the sales force because the sales force works directly with the big telecoms that dominate Lucent's customer base.

On the operations side, key roles include manufacturing, logistics, warehouse, and supply. Finance will also play a role in managing working capital for inventory, customer credit, CapEx for capacity, and the ultimate calculation of profit. IT may play a role if they are bringing new tools, new data or new analytics to the process of matching demand and supply. In some companies, other groups may be involved in S&OP. For example at Cordis, R&D and new product teams play a role as clinical trials for new products represent a special source of demand.

The relative weight of the roles will vary in different organizations and even in different business units or regions of a given organization. For example, Cordis noted that the technical complexity of medical device manufacturing means that operations plays a strong role in bridging processes. P&G also noted that the tenure of the personnel affects the process. New personnel generally defer to more experienced personnel regardless of the general relative dominance of the roles.

5.3. Challenge: Excel-ERP Gap

None of the participants or speakers had an enterprise software system that covered all aspects of demand management and S&OP. Although the companies do have ERP systems and various systems for forecasting, demand planning and supply planning, these systems don't provide end-to-end management of the entire process. All the companies admitted that Excel spreadsheets play a major role in bridging the gap between demand and supply.

Excel was seen as a source of problems in terms of shadow forecasts, undocumented processes, untraceable numbers, and labor-intensive manual update processes. Yet others argued that it was the best tool for complex processes that need flexibility. Excel is flexible, usable, and available. Rather than wait months for IT to create a custom report or application, business users can quickly craft a spreadsheet, regroup data, prepare charts, and share the results with others in the organization. Intel even said that its customers regularly send their forecasts to Intel as Excel attachments in e-mail. For many, Excel is a necessary evil caused by hard-to-use ERP systems and unresponsive IT departments.

5.4. S&OP Roll-Out

Because a number of the audience members were in the process of implementing S&OP processes, the group discussed how companies roll-out S&OP. Cordis advocated a 6-8 month progressive roll-out of S&OP in which the first few cycles perform demand planning only, then add supply planning for a few cycles, and then add the executive review stage. Debugging each step of the cycle builds confidence during the pilot and increases buy-in for key stakeholders.

P&G started doing S&OP in the 1990s with globally scattered parallel efforts. It typically started in one business unit or country and spread from there. It was not a big-bang implementation. As S&OP spread, people realized that they were doing similar things and that P&G could benefit from standardization. One approach that has been used to create and

maintain standardization is horizontal process networks (HPNs) that enable communication, cross fertilization and global consistency within a work process such as S&OP.

5.5. S&OP Renewal and Continuous Improvement

P&G discovered that the process for S&OP must parallel the organization's structure. The company had initially implemented S&OP over a decade ago. But over the years the company changed, acquiring more businesses and new leadership. With these changes, S&OP performance had declined. The company realized that the old S&OP process did not fit the new matrix structure of the business.

Thus, the company went back to basics to craft an S&OP process that suited the diverse realities of all the regions and business units it had. The company reemphasized unbiased (50/50) forecasts, reduced cultural barriers to S&OP, increased accountability, increased collaboration with marketing, and accelerated its system capability to support S&OP. P&G has a global standard toolset for S&OP but allows variations in processes as needed by its very diverse range of business units.

To prevent S&OP performance from degrading in the future, P&G created a transparent scorecard for assessing S&OP at the more than 90 BU-region combinations in the company. A 5-level maturity model drives process and accuracy improvement activities. The model helps set expectations for improvements. Rather than emphasize the exact level of maturity or improvement, P&G focuses on the quality of the action plans that will create future performance improvements. A transparent scorecard helps the company identify outstanding performers that should be emulated and identify stragglers that should be coached to higher performance.

6. Overall Rules for Bridging the Gap

S&OP and other processes for bridging demand and supply have rules of engagement. P&G shared its S&OP principles, and other speakers and audience members agreed that certain rules help ensure that processes such as S&OP are constructive.

6.1. Future-Focused, Not Past-Obsessed

Cordis argued strongly against turning an S&OP meeting into a fight about last month's performance. At Cordis, only a short fraction of the S&OP meeting is spent on history, as a quick debrief on the prior plan's performance and implications for the future. The majority of the time goes into the forward-looking plan with an emphasis on justifying the organization's confidence in the plan. Similarly, P&G's S&OP meetings focus on the future. P&G has a visual top sheet for its S&OP meetings that includes a simple graph of historic sales plan performance for the preceding 12 months and a graph of the sales plan itself (in units) for the preceding 12 months and forthcoming 24 months. General Mills, likewise, sees the S&OP process as a means of growing the business and changing the future, not just replicating the past.

6.2. Decision-Makers, Not Delegates

Cordis argued that bridging is only possible when all key functions are present. Cordis also noted that many bridging processes, such as S&OP, require high-level participation. Managers

below these levels are unlikely to have either the knowledge or the authority to commit to the courses of action needed to bridge demand and supply.

6.3. Meeting for Incremental Value, Not for the Sake of Meeting

Cordis cautioned that not every function should be present in every meeting in a joint planning process such as S&OP. A sales manager will be bored in a meeting that drones on about factory yields and utilizations. Representatives of a given functional area should be at the meeting only if their presence provides incremental value to both the group and the individual. This rule also affects whether bridging processes should be regional or global: if the company uses regional sourcing and distribution, versus global sourcing, then the demand and supply managers in the EU don't need to participate in bridging processes in the U.S., and vice versa.

6.4. Data and Systems

Bridging the gap means acquiring needed data that gives insights to decision makers on the evolving nature of both demand and supply. To be useful, the data must be vetted, timely, and shared. Data plays a major part in filling the gap between demand and supply. Companies that can replace inventory with information can fulfill demand more effectively with lower costs.

Data alone isn't sufficient. General Mills noted that the company has copious volumes of data, but it doesn't have the systems to process and make use of all that data. This was another reason why many companies eschew POS data -- the problem isn't a shortage of data, but a shortage processes and systems to make use of the existing data.

Many of the companies at the symposium have implemented SAP across the company, but they find that even SAP can't cover all the myriad details required to bridge the gap between demand and supply. This pushes individuals to use Excel spreadsheets for easier manipulation of the data, but that creates shadow forecasts. To minimize this, companies like P&G have created globally standard toolkits and processes to help ensure that differences in organization don't create additional gaps. Having documented data, well-understood tools, and well-designed processes helps serve the ultimate goal of confidence in the data, forecasts, and plans.

6.5. Building Confidence to Bridge the Gap

In many ways, bridging the gap between demand and supply involves selling the parties involved on the process, the forecasts, and the plans. Lucent noted the need for forecasters to sell their estimates. P&G noted the need for confidence in the process to avoid shadow forecasts and second-guessing by top management. Lucent and General Mills stressed the importance of softer people skills in bridging the gap. Creating respect for the process also means showing respect to all the participants in the process.

6.6. R-E-S-P-E-C-T Spells Success

One of P&G's principles for S&OP insists on trusting all individuals and organizations to execute their elements of the S&OP process without bias or politics. Solutia suggested the need for respect for the process. In addition to respect for the function is the need to respect people. As Dr. Saar pointed out, the people from sales and from operations have very different mindsets, but they need to respect each other because the forecast's accuracy depends on both sides' inputs.

Each group makes valid suggestions for the joint plan. Sales needs to respect the operational constraints of the supply chain, operations needs to respect the goals of the sales force in serving the customer, and all parties need to respect the financial and strategic imperatives of the company.

6.7. Leadership

Dr. Saar stressed that the real key, at the end of the day, is leadership. There are no good, bad, or tired supply chains, there are only good, bad, or tired leaders. Leadership creates the commitment for change, improvement, growth, and competitive advantage. Anyone can copy a supply chain strategy, but copying leadership is both harder and more rewarding. If companies really want to use their supply chain as a competitive weapon, they will need leadership to motive and coordinate their troops in battle.

7. Bridging the Gap in the Long-Term

Long-term initiatives and changes can also help bridge demand and supply. Companies can change how they treat their customers by segmenting them into groups and treating those groups differently. Long-term initiatives can also help bring together the very different types of people on the different ends of the demand and supply ends of the organization. Changing people and changing incentive structures takes time.

7.1. Customer Segmentation

One approach to bridging supply and demand is customer segmentation, in which the company offers different levels of customer service, service levels, and guarantees of demand fulfillment to the different customer segments. Customer segmentation provides a natural means of prioritization when demand outstrips supply. A recent MIT-CTL survey showed that 73% of companies do segment their customers. Except in the interesting case of Solutia, bigger customers generally receive better service.

Segmenting Strategic vs. Tactical Customers

At the 2004 MIT conference on demand management, Gillette discussed its segmentation of strategic and standard customer segments. Gillette provided customized, integrated services (e.g., VMI, CPFR, data synchronization, etc.) to its largest, most sophisticated customers. The company offered a more standardized set of services to smaller retailers. Gillette's acquirer, P&G, does not segment customers.

Solutia described its 3-level segmentation for its main business, which is a plastic resin used to reinforce automotive and architectural glass. Solutia uses an ABC set of customer levels. A-level customers are the global OEMs. B-level customers are regional users of Solutia's products. C-level customers are the smallest local shops that use Solutia's materials.

For apparel maker and retailer Limited Brands, the segmentation opportunity is with respect to internal customers -- the 4000 stores in its retail chain. Currently, the company segments based on store format and distinguishes between core and flagship stores. Limited Brands also sees a significant opportunity in segmenting based on store size and velocity. The frequency and

timeliness of delivery would be different for a store in Butte, Montana rather than a store in New York City.

Natural Segments

Several of the participants have natural segments among their customers. Intel sells to both very large OEMs that buy processors by the $40,000 tray and smaller channel customers that buy by the unit. Michelin sells tires to OEMs as well as to the after-market. Solutia sells glass-reinforcing plastics to both the automotive and architectural product industries. These very different segments can support different bundles of customer service policies tailored to each group.

Legal Issues: Self-Segmentation

When asked about customer segmentation, some of the symposium participants said that they do not explicitly segment customer due to legal "class-of-trade" issues. For example, neither General Mills, Pepsi, nor P&G segments customers. Intel, especially, said they can do nothing that might raise antitrust issues given the company's prominent role in the PC chip market.

Yet antitrust issues do not stop the companies from creating self-segmentation. The companies know that some customers will participate in some types of programs, so the companies offer programs to all customers knowing that only some of them will participate. For example, both Intel and Cardinal know that some of their customers are totally price-driven, whereas others value innovation and collaboration. Offering different product and service bundles lets customers self-select.

7.2. Customer Service Policies: When Bigger Isn't Better

Many of the companies bias their activities toward their largest "A-list" customers. When a big customer speaks, they listen. In many ways this is a rational strategy, because these customers represent such a large volume of business and because it is more efficient to provide special services whose costs are amortized over a large volume of business with a large customer. But the "bigger gets better service" mantra has important exceptions.

Solutia described its customer service policies for its three customer segments. The twist is that Solutia prefers its medium-sized B customers to its giant A customers because the A customers only care about driving down the price, which hurts Solutia's margin. Thus, Solutia provides better service to B customers. For example, Solutia offers a wide range of value-added technical assistance and collaborative services to the mid-size B group and expects to enjoy increasing prices, margin, and growth with these companies. In contrast, Solutia will only do a logistics program with an A-segment customer if there is a shared benefit to Solutia as well.

Some service policies transcend all segments. Solutia offers a rebate for Full-Truck-Load to all three levels of customer. Other services, such as rebates for forecast accuracy, consigned stock, VMI, and returnable packaging, go to the A and B segments. Solutia uses a spreadsheet of terms to help enforce and communicate these service policies. The document delineates size limits, product substitution policies, and firm order requirements for each product formulation for both regular and preferred customers.

Customer service policies can create a risk of gaming; that is, some customers may discover a way to gain some unexpected benefits at the expense of the company. For example, the audience discussed whether Solutia's roll-size policy could be gamed. If customers know that 95 cm is the standard stock roll width and that they can get a 95 cm roll by ordering (and paying for) a smaller 90 cm width, they might do this. Solutia did not think that this was likely to occur, however, because the stock sizes are set and periodically reset by Solutia. If customers start ordering small rolls, Solutia would shift its standard roll sizes to provide the small size exactly. The point is that customers have no guarantee of getting a 95 cm roll when they order 90 cm, so ordering a small roll in hopes of getting a bigger one is risky for the customer.

Solutia's new customer service policies achieved many of the company's goals. The policies reduced SKUs and increased stock rotation (turns). They also increased the percentage of orders converted from MTO (make-to-order) to MTS (make-to-stock). So-called "lost" volume did increase as Solutia shipped stock-sized rolls wider than that needed by the customer, but the amount was within the company's targets. The company continues to look at further improvements. For example, Solutia plans to reduce the complexity of customer service through Customer Relationship Management (CRM) and by reducing variability in customer demand.

7.3. Curing a Colorful Root Cause: Conflicting Mindsets

Sales people and operations people seem to have a natural distrust of each other, and that creates a barrier to long-term success. Dr. Saar asked the audience to consider how the two groups might describe each other. The sales people seem fun, outgoing, and optimistic, but they also seem too loud, too ungrounded, and not able to commit. The operations people seem logical and focused but also seem too pessimistic and rigid. These qualities, which make the two groups mutually incompatible, also make them good at their respective jobs.

Other companies have noticed this difference among different functional groups. Beginning in 1977, Jerry Rhodes and team at Philips Electronics studied the thinking styles of people and found that people's minds have a combination of some 220 different mind frames. Rhodes then distilled these 220 mindframes down to three overall thinking styles and color-coded them red, green, and blue. Each of the three groups has its own characteristics and motto.

Red: "What is True"

People who are "reds" are driven by facts, numbers, and analyses. They're good at spreadsheets, at getting their ducks in row, and doing their homework. Reds often focus on the present. People in operations tend to be reds or have strong red thinking style tendencies.

Green: "What is New"

People that have the green thinking style are imaginative, out-of-the-box thinkers. They focus on the future and the new, not the facts and the present. People in marketing and sales tend to be greens. The gulf between the green's world of future possibilities and the red's world of present-day facts creates frustration in the relationship between sales and operations.

Blue: "What is Right"

People who are blue are decisive, judgmental, and impatient. They are propelled by values and don't need data or facts to back that up. The blue thinking style wants action. Often, executives

exhibit the blue thinking style. People with a blue thinking style can be frustrated by the plodding analyses of the reds and ungrounded fantasies of the greens.

Bridging Between People

Although people of different thinking styles can clash, an organization needs all three thinking styles to succeed. Dr. Saar recommended that groups can explicitly use the different styles to create innovative solutions to tough problems. For example, BP convened a group of greens to think about deep water drilling, passed the results to a group of reds for analysis, and then gave the best solution to the blues for execution. The green style can create innovative new solutions, the red style can analyze the problem and possible solutions, and the blue style can reliably execute action plans.

Blending the Colors

The red-green-blue color categories aren't black and white in the sense that people only belong to one or another of the categories. Most people display a mix of styles with a concentration in one. Dr. Saar provided a quick self-test to the participants to help them see their own mix of colors. Nor are the styles immutable -- people can learn other styles or at least become effective at working with people who have other styles.

Translation into Three Languages

The issue of conflicting mindsets among different functions extends to language. Cordis noted that bridging the gap means translating across the languages of the different functions. Each group needs to express its concerns and plans in terms that others understand. A sweeping demand plan from sales needs to be made detailed and specific for the plant to know which product to make when.

Translating for the C-suite (CFO, CEO, etc.) is the most important step to creating buy-in for plans. This means converting from unit plans into discussions of dollars and showing the relationship between quantitative operation metrics and qualitative strategic goals (e.g., adding inventory to serve high-margin last-minute customers).

7.4. Aligned Incentives

During Dr. Saar's session on bridging across mindsets, breakout groups discussed key challenges and made recommendations for helping bridge the gap between operations and sales. Several of the groups advocated aligning incentives as a means of drawing sales, operations, and management together. Misaligned incentives exacerbate natural differences in how different function groups think.

For example, sales commissions could be adjusted to reward sales of what is available in inventory or on the schedule for production. Other shared incentives might focus on improving forecast accuracy. Sales people need a motivation to help the company create more accurate forecasts and plans.

Realigned incentives could do more than change sales force habits. Incentives on the operations side could change, too. Operations needs incentives for responsiveness and flexibility so that the

supply chain can serve shifting customer demand. Both parties need incentives that align them to long-term performance rather than short-term.

7.5. Future Research

Research also plays a long-term role in bridging the gap between demand and supply. Future research at MIT will delve into demand management in greater detail. Two research groups, one for MIT Supply Chain Exchange sponsors and one for solution providers and corporate IT professionals will address a range of research questions.

The work will cover a range of time scales. Research on short-term time scales might consider customer prioritization, order promising, and real-time information-driven strategies for redirecting activities (e.g., using RFID for redirect goods in transit). Research on medium-term timescales might further explore S&OP and merchandise planning and allocation. Research on longer-term aspects of demand management could examine customer segmentation and service policy differentiation. Research that cuts across timescales would examine how visibility, reporting, and data feeds into systems which then support decisions at multiple levels on both the demand-side and supply-side of the organization. Overall, the research will look at demand management process integration to consider how global S&OP, customer service policies, and order promising combine to affect and optimize organizational performance.