Massachusetts Institute of Technology

Demand Management: Integrating Demand and Supply in Real Time

A Symposium by the
MIT Center for Transportation & Logistics

Cambridge, Massachusetts
September 22-23, 2004

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Background

Recent studies show that average perfect order fill rates vary drastically and are as low as 80% or less in some industries. What explains the wide range of perfect order fulfillment? And why can't companies achieve perfect fulfillment by making a promise they can keep 100% of the time?

* *Are expectations set too high by the marketing/sales organizations?*
* *Are the marketing/sales promises based on unrealistic supply plans for fulfilling orders?*
* *Are there glitches in supply chain and logistics during order fulfillment?*
* *Are demand and supply organizations just not communicating well enough?*

Increasing complexity and uncertainty in supply chains partially explain the root causes of these significant challenges to supply chains, but the environment alone does not explain all of the challenges.

The "Demand Management: Integrating Demand and Supply in Real Time" symposium was conducted to address these important questions and the core disconnects between the traditional supply chain management activities and the demand generation and management processes by looking at integrated demand management processes. These involve matching supply and demand in planning, as well as during the promising and fulfillment of customer orders.

The first day of the symposium exposed state-of-the-art practices for integrating supply and demand, and the second day focused on what was possible and the obstacles to attaining the potential. As is the MIT tradition, the session entailed a series of presentations from practitioners and researchers and in-depth facilitated exchanges and discussions to reveal new insights and wisdom that would be useful and timely for attendees. In addition, this symposium was conducted to uncover research opportunities that can help address what companies need to do to improve the performance of their supply chains.

This event, conducted on September 22-23, 2004 at the Cambridge Residence Inn hotel, was part of an ongoing series of symposiums offered by the MIT Center for Transportation & Logistics (CTL) for its Supply Chain Exchange sponsors and the MIT community.

Executive Summary

The integration between supply and demand is like a dance by Fred Astaire and Ginger Rogers. When it works well, it is a thing of beauty. For most companies, demand is like Fred Astaire in leading the dance. Customers and sales drive supply-side activities. Thus supply, represented by Ginger Rogers, must perform all the complicated steps -- with the added challenge of performing them backwards and in high heels. One key for companies is to bridge supply management (that includes Supply Chain, Operations, and Logistics), and demand management (that includes Marketing, Sales, and Customer Service). Bridging helps avoid stock-outs, excess inventory, poor profit margins, and low customer loyalty.

Several companies presented their experiences with various facets of bridging supply and demand. Gillette discussed its customer-facing programs, while Campbell Soup and Enterasys described their Sales and Operations Planning (S&OP) processes -- contrasting two very different industries of consumer packaged goods and discrete complex manufacturing, respectively. P&G presented its work on using real-time metrics to drive decision making. Intel and Prof. Malone of MIT presented new innovations on using internal markets to both match supply and demand and to help forecast demand. Other company representatives in the audience contributed insights and additional examples of the process of bridging supply and demand.

Key points of the symposium included:

* *The high value of integrating supply and demand:* Major companies see opportunities worth hundreds of millions of dollars in added sales or reduced costs if they can better match supply with demand.
* *Revision of S&OP processes:* Companies are revisiting and revising their S&OP process, recognizing its importance in achieving perfect order fulfillment.
* *Move to the future:* companies are shifting to future-focused, exception-based S&OP processes to replace old-style, history-obsessed, blame-game, and dog-and-pony show processes.
* *Old habits die hard:* Incentives, accountability, and participation remain major challenges for supply-demand integration efforts.
* *One size does not fit all:* seasonality, the immediacy of demand, and the scope and scale of the customer all affect how companies match supply with demand.
* *An alternative to centrally-planned companies:* In the future, companies might more efficiently allocate supply to demand and help forecast demand by creating internal markets that leverage the intelligence of the entire organization.

Themes

1. The Gap between Supply and Demand

The gap between supply and demand has many guises. In an ideal world, supply would always deliver the right product to the right place at the right time for the right price. Many companies look at perfect order rates: the percentage of filled orders that have no errors and reach the customer on time. A typical value for the perfect order rate may be about 80% to 90%. Although that sounds like a high number, it means that the company breaks its promise to its customers 10% to 20% of the time.

Out of Stock

Insufficient supply is the first type of gap between supply and demand. At Gillette, a 10% out-of-stock rate would cost the company an estimated $1 billion per year. For a discrete manufacturer like Enterasys, a related problem is the failure to meet lead-time promises: not having the product in the hands of the customer when the customers wanted it. Out-of-stocks become a customer service nightmare and can lead to costly expediting.

Overstocks

An opposing type of supply-demand mismatch is oversupply, often in the form of slow moving, obsolete inventory. Any company can satisfy demand by overproducing -- guaranteeing high fill rates by holding mountains of inventory. Companies can end up with million of dollars in slow and obsolete inventory. This inventory results in lost profits during promotions as well as extra costs for returns and disposal. Gillette has worked to reduce slow and obsolete inventory (SLOB), from $170 million in 1999 to $33 million in 2003. For companies such as Lucent and Enterasys, the analog to SLOB is excess and obsolete (E&O) charges from the contract manufacturers that they use. Over-estimates of demand or a mismatch between the manufacturer's lead-time and the customer's delivery-time demands can lead to oversupply.

Low Margins

Gaps between supply and demand can be more than simply product quantity gaps such as under- or over-supply. Mismatched prices for supply and demand can create low or negative profit margins when a company attempts to match a low-price customer to a high-cost supply. This gap represents a bigger issue than the differential of the sales price to the raw materials price. Gillette noted that the cost-to-serve is an increasing consideration, especially in serving larger versus smaller retailers. Offering shorter delivery cycles, carrying higher just-in-case inventories, and forcing factories through more frequent changeovers often adds costs to the system and worsens the price mismatch even as it improves the match for supply-demand quantities.

2. Causes of the Gap

Several factors that contribute to the various types of gaps between supply and demand were discussed at the symposium. For example, lack of information flows between the supply and demand sides of the organization foster a lack of coordination. Oftentimes, supply management does not have accurate information about likely upcoming sales. Promotions, in particular, are a challenge for supply when unexpected demand appears. Similarly, the sales function is often unaware of capacity constraints, raw materials inventories, factory schedules, and supplier lead-times. In other cases, the information disconnect is with the customer and the distinction between what the customer says they need versus what the customer really needs.

Biased and Rogue Forecasts

Several of the participants decried the tendency to ignore methodically-created forecasts. Campbell Soup noted that in the past, the company used eight independent forecasts -- seven created by functional heads and an eighth created when top management decided to ignore all the other seven inputs. Regardless of the official consensus forecast, some functional heads create their own forecasts, adding their own optimistic or pessimistic bias factors to the official estimate.

Rogue forecasting reduces forecast accuracy and leads to a lack of coordination. P&G noted that the challenge of managing to a target is in picking which target: the MRP II target, the sales target or the financial targets of the company. Before working on improvements, Campbell Soup's forecast error was 35% MAPE (Mean Absolute Percentage Error) by item/DC/month. The fact that sales managers, factory planners, and top executives all tend to create their own forecasts for their own purposes exacerbates the gap between supply and demand.

An Incentive to Cause Problems

Incentive structures both create and sustain the gap between supply and demand at many companies. For example, at Gillette, sales incentives encourage incremental dollar revenues regardless of costs, leading to reduced margins. The sales bonus structure at many companies encourages the sales force to lowball the forecast and thus make it easier to gain a bigger bonus. On the supply side, incentives or job performance factors that are tied to availability, fill rate, asset utilization, or stock-outs can drive these managers to over-produce stock "just in case." But if the company penalizes for excess inventory, then factory and warehouse managers may go to the opposite extreme and hold too little stock to handle demand variations. Incentive-related disconnects can occur between marketing, sales, manufacturing, warehousing, and transportation. Related to the problem of incentives is accountability. In many organizations, the incentive structure does not enforce accountability on issues such as forecast accuracy, schedule compliance, or violations of consensus plans.

Process Gaps

Sometimes the processes employed by a company do not mesh well with those of its customers. In any supplier-customer relationship, assumptions about who can do what and who wants what can lead to suboptimal results. Gillette found large opportunities for improvement with what it calls customer service opportunity assessments. Gillette works with selected customers to

understand and improve how products get from Gillette into retailer's back rooms and then how the products travel the last 100 yards to the shelf. Process gaps also occur inside the company when the customer deals with different departments on different issues. Gillette uses one-face-to-the-customer to minimize these externally-visible internal gaps.

Barriers to Improvement

Related to the problem of incentives is the siloed structure of many companies. For example, at Gillette, the supply chain organization owned supply planning, warehousing, and transportation, whereas Commercial Operations handled demand planning and account planning. This structure created a disconnect in the planning process. When the CEO realized that he was the only person responsible for customer service, it was time to reorganize the company. To help bridge supply and demand, Gillette reorganized around a horizontal, integrated value chain structure. Forward-facing supply chain operations such as warehousing and transportation were moved into customer support. Planning, which had been fragmented into supply and demand components, was integrated into a planning function that included customer teams.

3. Data Sources

The first bridge between supply and demand is an information bridge: data provides needed signals about demand and supply. Companies have more data than they realize, as the speaker from Campbell Soup pointed out. Moreover, as P&G put it, most managers can foresee 80-90% of the surprises by watching a dozen or so critical business variables. The key is using the right data and doing statistical analyses to understand how the data you have can help estimate the data you need.

Getting Data from the Point of Consumption

Data from the point-of-consumption is the Holy Grail for many companies. Getting that data is not easy. Retailers, especially, are loathe to share point-of sale (POS) data with vendors. For example, Wal-Mart strictly regulates access to POS data -- only specific people at vendor companies can have limited access to the data for specific purposes. Wal-Mart, and other retailers, fear leakage of crucial competitive data to other retailers. P&G noted that when Wal-Mart cut off access to scanner data, P&G went from 81% visibility onto demand to only 58% visibility. Nonetheless, several stories illustrated how different companies do have access to downstream data and can use that data to advantage.

Pringles is one of P&G's billion-dollar brands. Although Frito-Lay makes Stax, a competing stackable potato chip, P&G has enjoyed superior market share based on better taste. When Frito launched an aggressive ad campaign assailing Pringles on taste, P&G worried about the potential impact on sales and the need to respond. Fortunately, all it took was a quick look at POS data from Wal-Mart over the opening weekend of Frito Lay's promotion. To P&G's surprise and delight, Frito's ad campaign of a direct comparison to Pringles was boosting sales of Pringles, too. Thus, the company used the data to avoid a costly counter-campaign or promotional blitz.

Another example of data from the point of consumption is Monsanto, which has remote monitoring equipment on its tanks of herbicides at 8000 retail locations. Each day, the tanks

automatically "phone home" with data on the level of remaining stocks. The data flows into Monsanto's IT systems, and managers receive exception reports. The company can even catch instances of a tank's inventory increasing without a corresponding Monsanto delivery, meaning that the tank was replenished with a non-Monsanto product.

McDonald's is working on techniques that give it data on the point before consumption. The fast-food maker operates in a narrow window of supply-demand mismatch. On the one end, McDonald's knows that customers won't wait for the food to be prepared -- McDonald's must deliver the food fast in the fast-food business. At the same time, the company cannot pre-cook too much, too far in advance, for freshness and wastage reasons. Therefore, the company is starting to use a roof-top camera on its drive-through lanes. The technology gives the company a peek into likely future demand: both the numbers and the types of vehicles entering the queue provide insight before the vehicle reaches the order point. McDonald's historical profile data indicates which types of vehicles correlate with which types of product orders. For example, the presence of three SUVs in a queue almost guarantees the sale of a Big Mac, so the kitchen can start cooking a Big Mac just ahead of the actual order.

In another example, Budweiser's delivery drivers act as field intelligence agents when they go into retail locations. The driver does an in-store shelf check to gain data on competitor's shelf space, relative square footage, promotions, etc. An electronic data pad relays the information back to Bud at the end of the day.

The Budweiser example highlights the role of field technicians and sales people in gathering intelligence. When CSX implemented a self-service online ordering system, the company reduced costs but also lost a valuable insight into customers. Other companies recognize the value of forward-facing personnel. One company mandates that its sales force communicate any customer changes (such as changes in SKUs) to the appropriate people inside the company.

Challenge: Latency

Delays in the data exacerbate some of the gap between supply and demand -- if managers do not know the latest levels of demand and available capacity, they cannot make sound decisions about execution, order promising, demand forecasting, capacity planning, and so on. P&G described its reliance on Nielson panel data to understand changes in consumption and market share. Unfortunately, this data is six weeks old by the time the company sees it.

Challenge: Executive Overreaction

P&G raised the cultural issue of executive overreaction to real-time data. Short-cycle data is inevitably statistically noisier. Managers, accustomed to smooth operations and infrequent news of variances between plan and execution, may act too aggressively when exposed to volatile data that shows the day-to-day variations in orders, shipments, and business performance. CSX described the gridlock this caused as managers delved into "why were shipments down 30% yesterday?"

Several companies recommended schemes to limit management overreaction. P&G recommended the use of control charts to help distinguish problems from normal statistical fluctuations. P&G also suggested regulating the timescales of data -- sometimes a longer data cycle is better for management purposes because it smooths out the volatility of real-time

variability. Control charts, appropriate data aggregation and exception rules help regulate what is reaction-worthy and what is not. Managers should only react when there is a reason to react, and that requires distinguishing between normal and abnormal variations.

4. Bridging Supply and Demand

Data provides material for the supply-demand bridge, but data needs processing in order to support meaningful management action. Some of this activity is handled by software, such as the demand planning and real-time forecasting software used by many companies. Such systems improve visibility onto demand and enhance estimates of future demand. For example, previously, Campbell Soup forecast demand at the distribution center (DC) level. Now, the company forecasts at the customer level.

P&G described its system for steering its business in real-time. Using data on shipments, Nielson panel data, adjustment factors, and scanner data, P&G calculates consumption at retail outlets. These outputs are then fed to the dashboards of P&G managers who can make faster decisions about execution and planning. P&G continues to improve its system, looking for better sources of data and new supply chain statistical models to help enhance the company's estimates of current and future consumption. Overall, P&G expects real-time steering to add a 3% to 5% improvement to its business.

The power of timely data and prompt management reaction was illustrated by a story about Wal-Mart. Immediately after the 9/11 terrorist attacks, Americans bought flags to show their patriotism. With real-time POS data, Wal-Mart noticed the spike and quickly bought up all the American flags it could find to meet the surge in demand. By the time other, slower, retailers noticed they were out of flags, Wal-Mart had captured the supply and the market.

Sales & Operations Planning (S&OP)

Beyond data and software, companies are implementing or revising management processes that connect supply and demand at the management level. Sales & Operations Planning (S&OP) is a process of bringing upper-level managers from all sides together to plan upcoming sales and supply activities. At Campbell Soup, S&OP is a monthly meeting for senior managers from across the value chain of activities. Many of the companies represented in the symposium (both as presenters and in the audience) use S&OP.

Exceptions are the Rule

Campbell Soup's new approach to S&OP shifts managers' attention to exceptions. Campbell Soup described how the old approach failed to live up to the "planning" side of S&OP. In the past, S&OP meetings where more like dog-and-pony shows with everyone saying how they were "on track, on budget, good to go." The meetings did not address pressing issues or opportunities that could affect the mismatch between supply and demand. The new approach at Campbell Soup focuses on exceptions -- managing the unusual issues rather than having a feel-good, no-problems session.

From Rearview Mirror to Front Windshield

Both Campbell Soup and P&G noted the need to change the focus of management from the past to the future. More timely data and less arguments over why the previous forecasts were wrong would help companies shift to a future-oriented view on management. For example, Campbell Soup tries to limit S&OP meeting discussions about the previous month to 5 minutes and focus instead on the coming 18 to 24 months. In fact, Campbell Soup does not even focus on the next month because that has already been pre-sold. Rather, managers look further ahead to the future factors which they can influence. The intent is to emphasize decisions that can improve future business operations rather than cast blame for inevitable problems with forecasting or from execution errors.

S&OP Pre-Meetings

Both Campbell Soup and Lucent use a pre-S&OP meeting at a more junior-staff level to help maximize the effectiveness of the senior management S&OP meeting. The key is to focus the senior managers on making future-focused decisions which will make a difference to future performance. The process involves winnowing the topics of the meeting to emphasize exceptions that require cross-organization coordination. Routine issues that can be handled within a department or at a lower level of management need not be surfaced in the senior-level S&OP meeting.

The ABCs of Bridging

Several companies mentioned the use of Activity Based Costing (ABC) as a crucial prerequisite for bridging supply and demand. ABC means accounting for the costs of business activities on a fine-grained scale -- understanding the labor, materials, and vendor inputs required for each task, each product, each customer, etc. If a company does not understand the cost-to-serve a customer, the cost to changeover a factory, the cost to expedite, or other such costs, it can easily make unprofitable promises to customers.

Challenge: Participation

While S&OP dates back to the 1980s, many of the companies at the symposium described ongoing challenges for adopting S&OP. Campbell Soup noted that they were on their eighth S&OP implementation. Monsanto, Enterasys, and Campbell Soup all mentioned the challenge of encouraging participation. Monsanto described the recent implosion of S&OP when the sales and marketing groups became reluctant to participate. Campbell Soup described a previous S&OP process that only consisted of a group of junior-level people meeting in the cafeteria. Without clout, accountability, and a mandate to adhere to S&OP meeting decisions, the process cannot work. The problem with S&OP, as Campbell Soup found out, was that the initiative delves into every process in the company. Between busy schedules, a fear of losing control, and the fear of being forced to agree to extra commitments, many executives approached S&OP warily.

Demand Steering

Companies that have a direct connection to customers and a substitutability among their products can adjust demand to suit supply. Dell, for example, has a "sell what you can make" policy that helps bridge supply and demand by shaping the demand side of the equation. Dell -- by making daily changes in price points, base configurations, and promotion of available add-ons -- steers on-line PC buyers to the computer configurations that Dell has in stock or can make. Enterasys also uses a similar approach to shape demand for networking equipment. Although Consumer Packaged Goods (CPG) companies don't have the same direct-sell relationship to influence demand in real-time, they can steer demand on longer timescales through adjustments in promotions. The company can add or remove SKUs from promotions, such as coupons, in order to match demand to capacity. Lucent joked that it had a "sell what you have" initiative when the dot-com crash left the company with billions in excess inventory.

5. Different Industries, Different Problems

Throughout the symposium, the presenters and the audience described differences between various industries. Contextual factors affect either the nature of the gap between supply and demand or the methods that can be used to bridge it.

Stock the Shelf or Lose the Sale

For CPG and many retail-consumer companies, shelf availability is the key. P&G calls this the first moment of truth. If the product is not on the shelf when the consumer walks by, the manufacturer (and often the retailer) loses the sale. For high-value brands such as Gillette's Mach3 razor, out-of-stocks represent a large revenue loss. The challenge for bridging supply and demand is that the manufacturer usually does not control replenishment (VMI being an exception). Gillette's work with its customers has helped bridge the last 100 yards between supply in the back room and demand on the shelf.

Supply Constraints and Phantom Orders

Some companies, such as Intel, face the problem of phantom orders during times of constrained supply. If demand for a hot new chip runs above capacity, Intel must allocate available supplies across the demand, and many customers receive less than what they ordered. Knowing that they will receive less than they order, customers try to game the allocation process by ordering more than they actually need -- e.g., ordering double what they need knowing they will receive half of what they order. Phantom orders distort the demand signal and lead to excess inventories when customers cancel their phantom orders as supply outstrips actual demand.

Seasonality

Companies such as Monsanto and Campbell Soup face seasonality on matching supply and demand. Strongly seasonal demand patterns, such as Monsanto's seed-selling season or Campbell Soup's winter soup sales season, place special demands on the supply side. These companies produce year-round in order to efficiently supply the in-season surge in demand.

To the outside observer or financial analyst, prestocking creates some bad numbers with high inventories and low turns. Because the company may be producing goods months in advance, the issue of forecast accuracy is a concern. Monsanto, for example, tries to prebuild for the 80% demand about which it is confident. The agricultural company then reserves its near-season and in-season capacity for last-minute, less-predictable demand.

Seasonality also changes the nature of management coordination efforts such as S&OP. At Campbell Soup, S&OP meetings vary in tenor and depth during the year. For the eight out-of-season months, the meeting is merely a quick review of future plans and status. During the in-season meetings, the S&OP becomes a critical update process and is much more reactive.

Product Transitions

Intel suggested that the transition between old and new products is one of the toughest times to bridge supply and demand. Managing the product ramp (technology adoption) means understanding both the ultimate level of sales and the rate of adoption of the new product while simultaneously phasing out production of the old products. In many instances, a product transition for Intel means a product transition for its PC-making customers -- the customers will be changing the design of their PCs to take advantage of the newly available features or the power of a just-introduced Intel processor or chipset.

Large & Complex vs. Small & Independent Customers

As companies create more sophisticated customized product, delivery, and service offerings, the sophistication and scale of the customer becomes an issue. A company such as Gillette, Campbell Soup, or P&G can implement more sophisticated programs with a Wal-Mart then with a mom-and-pop convenience store. Gillette charted the difference between the two ends of the retailer spectrum to describe the distinctions between selling to independent operators versus working with the major retailing chains. For independent operators, Gillette offers basic support on a tactical partnership level. Small customers receive standardized supply chain services, less differentiation, and a functional interface to Gillette. For the larger chains, Gillette offers highly-differentiated customer segments of one, seamless value chain services, and an integrated, process-driven interface.

These differences are driven both by the cost to serve and the ability of the customer to handle a more complex relationship with the supplier. Sophisticated supplier-customer integration efforts are not cost effective if the customer is below a certain volume of business.

Outsourced Manufacturing

For Enterasys and Lucent, the use of outsourced manufacturing brings special challenges for integrating supply and demand. When a company does not make its own products, it relinquishes some control of the supply-side lever. Smaller companies, especially, have the least control over their contract manufacturers. Moreover, if the company over-estimates demand, it then must pay the contract manufacturer E&O (excess and obsolete) charges for the unneeded inventory.

Project-Oriented Supply Chains

For engineer-to-order companies, the definition of a perfect order may be extremely complex. For example, Lucent provides complex telecommunications network installations with mind-boggling numbers of components for a single order. One Lucent order, from a cell phone service provider in India, consisted of 250,000 items on a single purchase order. A "perfect order" not only includes delivery of the big switchgear cabinets and modules, but also includes appropriate quantities of the "as needed" materials such as the cabling that Lucent technicians will use when installing the system. All of these items had to be delivered to sites across India, assembled, configured, and tested.

6. Future Alternative: Internal Markets

Although business celebrates capitalism, most companies have management structures that bear a strong resemblance to socialist central planning, Prof. Malone pointed out. Yet capitalism and free markets offer an alternative to central planning, offering companies a decentralized approach to making complex decisions -- especially decisions involving allocating a scarce resource across a multitude of competing needs.

Internal Markets for Bridging Supply and Demand

The allocation of supply to demand was the original reason for markets. The buying and selling of goods and materials on open, free, external markets allows any buyer to find any seller without the need of a central authority. All that needs happen is for the buyer and seller to find each other and agree on the price and terms. The power of the market comes from its distributed nature -- the most knowledgeable people (the buyers who know the value of the trade and the sellers who know the cost of the trade) automatically participate with mutual self-interest. Markets automatically find a price at which the market clears -- the price at which supply and demand exactly balance. With the Internet, the costs of buyers and sellers finding and transacting business with each other drop even further.

Companies can emulate this process by matching internal buyers (sales people and accounts) to internal sellers (factories and warehouses). Consider Intel and its need to decide which chips to make at which factories. Intel faces a triple challenge in matching supply to demand. First, capacity is extremely costly -- each factory costs billions of dollars. Second, inventory is extremely costly -- price deflation on high-tech chips can run 4% per month because nobody wants last year's chips. Third, frequent product transitions make forecasting very difficult.

To deal with this, Intel invests in a complex array of road-mapping, planning, and scheduling processes on the sales side as well as the manufacturing side. Yet the current system is deemed both inefficient and inflexible. One alternative, currently under study, is an internal market that would have the plant managers selling futures contracts for capacity slots and sales managers buying contracts to get capacity for anticipated customer needs. The prices for these contracts would fluctuate as new information about demand and supply became available. When the contracts come due, the holder of the contract would gain the contractually-defined capacity or products. Monsanto suggested that such internal markets could turn a manufacturing plant into a

profit center rather than a cost center as the plant sold its capacity to the highest bidder amongst the sales orders and customer accounts.

The key to markets is price transparency -- both the supply and demand sides inside a company can see the going price and take action accordingly. If a salesperson has a very valuable new client, the salesperson should be willing to bid high for capacity -- outbidding other salespeople with less profitable clients. Less valuable uses of the firm's assets would then drop down in priority. If manufacturing costs rise, the asking price will rise. If customers or salespeople refuse to pay the asking price, the likely reason is that the transaction would be unprofitable. And if prices rise sufficiently high on a sufficiently long forward contract date, it signals the potential value of additional capacity.

Internal Markets for Corporate Directives and Goals

Internal markets can also handle the tough job of allocating corporate directives (e.g., cost-cutting directives or hiring freezes) across multiple divisions without infighting. British Petroleum's sustainability goals called for a 10% reduction in greenhouse gas emissions over a 12-year period. BP could enforce this corporate goal in three ways. First, BP could use a simplistic allocation scheme in which all divisions would have to adhere to the directive equally. This scheme may be fair, but it ignores crucial differences between divisions, such as the ease of reducing emissions, the relative growth rates of different divisions, or the economic value of allowing emissions at its most profitable divisions. Second, BP could use central planning and have top management study the problem, perform a trade-off analysis, and allocate steeper reductions in some divisions and permit continued emissions in other divisions. This would devolve into political infighting and procrastination, especially by those divisions selected for heavy reductions and by fast-growing divisions who need to emit more.

BP adopted a third way. Instead of pan-corporate fiat or decision-by-central-committee, BP created an online internal market by giving all the divisions emissions permits (with the built-in 10% decline) that could be traded. Rather than require top management effort, analysis, and approval, any division could then trade emissions permits for payment from any other division. If a division could easily reduce emissions, it could offset the cost or even turn a profit by selling its unneeded emissions permits. If another division was experiencing high, profitable growth, it could buy that right to emit. The internal market set the fair price. The asking price for the permit reflects the seller's cost of reducing emissions while the bid price reflects the buyer's value for the emissions. With its internal market, BP reached its 12-year goal nine years early.

Prediction Markets

Most traditional markets involve the trading of a tangible resource, such as raw materials and other goods. Internal markets might trade internal resources such as available inventory, factory capacity, or employee's time. But the traded object in the market could be an intangible, such as a prediction of who might win the next presidential election. Prof. Malone described the Iowa Election Markets, in which the payoff on the futures contracts depends on who wins the election or how many votes they get. The market price is thus determined by people's aggregate predictions of the election outcome.

Prof. Malone then described an internal market equivalent for this trading of intangibles. HP created an internal "idea futures" market with the goal of predicting printer sales. Futures contracts in this market specified a prediction for a specific range of sales in a specific time period (e.g., "between 1,500,001 units and 1,600,000 units will sell in September"). If the prediction contract buyer is correct, the contract seller must give them $1; otherwise the buyer gets nothing. As with real-world future contracts, anyone can write and sell a futures contract if they think the contract price (and thus the sales prediction) is too high. Anyone can buy a prediction futures contract if they believe that the price/prediction is too low. With participants across HP, this market outperformed the official consensus forecast in 15 out of 16 cases.

Speculators

Speculators buy and sell marketable commodities or prediction contracts with no intention of taking or making delivery of the commodity or exercising the contract at its expiration date. Rather, they seek pure short-term profits inherent in the buying and selling process. Speculators serve a valuable role by providing liquidity to the market, ensuring that buyers and sellers are always present. In an internal market, corporate planners are effectively speculators -- they have no interest in handling the physical goods, only in predicting or speculating about future supply and demand. Speculators also become adept at finding and reducing inefficiencies. For example, they might notice that the price difference between Asian and European factory capacity contracts exceeds the cost of transportation between the two regions.

Internal Markets as Data Sources

Internal markets provide a valuable source of data, according to Prof. Malone. For example, prediction markets can create more accurate forecasts. Moreover, if properly structured, prediction markets provide not only a point forecast, but also information on uncertainties or the range of possible outcomes. But an internal market does not have to be a prediction market to provide information. Data on market prices, trading volume, open interest, amounts on bid or ask, and the trading habits of individual participants provide a wealth of data for the company.

Consider what companies might learn from studying trading patterns -- assessing who trades, how they trade, and how profitable they are. Highly-profitable traders point to potential data sources. Traders who can consistently profit in an internal market are those with the most knowledge of the subject of the trade, regardless of their official standing in the corporate hierarchy. Intel suggested that such analyses of traders and their trading patterns could also help reveal that person's estimation or forecasting biases. If a person consistently underbids or overbids a futures contract on a forecast estimate, it suggests that they are biased. Other data, such as trading volume and open interest, can reveal the confidence of participants' confidence in future conditions.

Markets and prices may even tell companies things that they did not know. For example, the audience debated the problem of unutilized capacity which is under a threat of potential disruption, such as during a hurricane watch. If the company is faced with a forecast of a possible hurricane strike, the salespeople might decide to bid low or not bid at all for the threatened capacity. Some audience members saw this is as a failure of the market, that the factory could go unutilized even if the hurricane never struck. Yet others saw this as appropriate given the uncertainty, because it signaled the importance of guaranteed delivery. Basically the

sales force would rather delay or forgo the order than promise a delivery that could be disrupted. Thus, the market tells the company about the relative worthlessness of potentially unreliable capacity.

The Downsides of Markets

Internal markets, much like the stock market, face potential unfair trading practices and manipulation. For internal markets, insider information seems an unavoidable risk -- the VP of sales probably knows more about next month's demand than does the transportation manager. But in the context of an internal market, insider information can be a good thing. Although the insider gains an unfair advantage over less informed participants, the company benefits by having that insider information come into the market.

What is potentially more destructive is market manipulation. In one experimental internal market, a factory manager refused to issue supply contracts, created artificial scarcity, and drove up the price of future capacity contract. Other manipulations could include a salesperson cornering the market for a good needed by a rival salesperson; or, a high-level salesperson might delay a deal to make their own prediction of sales the right one. As with real external markets, internal markets could suffer from bubbles and crashes if they are not regulated.

Perfection?

Prof. Malone emphasized that whereas internal markets are not perfect, they should not be compared to perfection. Instead, they should be compared to the very imperfect process of existing central planning approaches that served the Soviets so poorly and remain entrenched in the management structures of otherwise capitalist companies. Effort spent on regulation will be far less than the effort required to centrally plan all the decisions that a market can make. Central planning suffers from the same or worse manipulations when managers use political means to further their self-interests. But even with the cost of regulation, an internal market is more efficient because it naturally leverages the distributed resources of the organization.

This brings us full circle -- back to the elusive quest for the perfect order, the perfectly full shelf, and the perfect answer to every customer's needs. The challenge is that supply and demand are not so much like the fleet feet of Ginger Rogers and Fred Astaire. Whereas manufacturing and distribution can function most efficiently when everything is known well in advance, sales provides the best performance when it can flexibly accommodate every last-minute gyration of customer demand. Matching slow supply to fast demand remains a challenge.

Demand Management Research Opportunities

Summarizing, the symposium delved deeply into three broad demand-supply topics:

* *Setting customer expectations by aligning supply chain capabilities to customer service programs*
* *Planning supply capacity by leveraging a Sales and Operations Planning (S&OP) process*

* *Executing to demand in real-time using dashboard-based performance metrics, optimized customer order promising, and instituting internal markets to match demand and supply.*

Throughout the event there was a lot of discussion around the three topics, demonstrating their importance when targeting perfect customer order fulfillment, in a profitable fashion. The following five areas of fertile research were identified:

* *How to best understand customer-level profitability and other information needed to support tailored service programs that match supply with demands from a range of customer segments.*
* *What industry- and company-specific elements need to be incorporated into S&OP processes to get beyond largely "cookie-cutter" implementations? What optimization and risk management techniques can help S&OP processes deal with highly uncertain demand and supply? What role will the S&OP process need to play in the context of real-time decision making?*
* *What profit optimization and decision-making techniques dealing with uncertainty can be used in order promising that will support a company as it makes a promise it can keep?*
* *What dashboards are needed to help steer businesses in real-time, including using downstream data such as POS, as well as the potential tidal wave of information that will come into a company as RFID tag and other auto-identification usage becomes more prevalent over time?*
* *How can one tap the enormous potential of market mechanisms to help match supply and demand inside a company, in real time?*

Answers to these questions will go a long way towards integrating demand and supply in real time and achieving 100% perfect customer order fulfillment --- thereby helping a company keep all the promises it makes to its customers.

Appendix: Presentation Summaries

1. Introduction, Dr. Larry Lapide, Research Director, CTL, MIT

Larry Lapide began the meeting with a video clip of Fred Astaire and Ginger Rogers dancing, and he asked the audience, "Who leads?" "Who's the better dancer?" In analogy to the supply chain, Fred leads the dance in the way that demand that drives the supply chain. Ginger, (the supply side), must be the better dancer because she has to do the same moves as Fred, but in response to him, backwards and in high heels. The key message is that it's all about coordination, and both enhance partners each other. Demand management, the theme for the symposium, requires integrating demand and supply in real time. Demand management is not just about forecasting and demand management; it includes order promising and management, production scheduling and aligning demand with supply.

2. Achieving Perfect Retail, Bill O'Connor, Director, Center of Expertise, The Gillette Co.

Gillette is a company known for its brand excellence, with brands like the Mach3 razor, which has greater market share than all of its competitors put together. Gillette is now working to create perfect retail, to match its strengths in high-volume precision manufacturing with an organization that gets the right product to the right place at the right time in optimal quantity for retail. This initiative is not unique to Gillette -- P&G calls it "moment of truth #1," to get have the product on the shelf when the customer wants it. ("Moment of truth #2" is exceeding the customers' expectations after they buy the product.)

Avoiding stockouts brings a big gain to companies. Gillette is a $10 billion company, so a 10% stockout rate could cost the company up to $1 billion. The opportunity afforded by higher fill rates, even when discounted 50, 60 or 90%, could still be worth $100 million.

Key Performance Indicators

The key performance indicators which Gillette uses are forecast accuracy and case fill rates. The company is looking to stamp out "SLOB" -- slow and obsolete inventory-- and reduce the days-on-hand inventory. Gillette has made improvements in reducing days-on-hand inventory from 148 in 1999 to 100 in 2004. When benchmarking other companies, however, Gillette found that the best in class have 60 with a goal of 30 in five years. Gillette knows it still has a large opportunity for improvement to reach best in class. Gillette has also made significant improvements in forecast accuracy (from 40% in 2001 to 65% in 2003) and case fill rate (from 80% in 2001 to 96% in 2003).

Global Value Chain

To continue to drive these improvements further, Gillette restructured its organization to improve the bridge between supply and demand. Gillette created an integrated, horizontal value chain, combining previous supply chain and commercial operations under one management point with a principal focus on the customer. Gillette then linked supply planning to its new customer-focused organization. This new organizational structure obviates some problems of the past, such as when account planning promised order shipments without considering the cost of transportation. By combining and aligning parts of the supply chain together with a focus on the customer, Gillette created a point of ownership for promises made to the customer.

Next, Gillette identified 11 key elements which it had to improve in order to improve overall value chain performance (i.e., to increase service levels, reduce inventory, and improve costs). One such element was to reduce promotion complexity. Gillette's promotions, such as off-shelf displays and advertising, were creating excessive complexity for the customer, but analysis showed that the promotions were not truly driving sales. Another element which Gillette identified was organization: Gillette's factories were run in a silo, resulting in extra inventory. By creating an end-to-end value chain process, Gillette gained a more complete understanding of the whole process and created one face to the customer.

Connecting to the Customer

Gillette created team-based selling as part of its Customer Value Chain strategy. The cross-functional teams create alignment from the functions inside Gillette to the corresponding ones inside the customer's organization. Thus, sales matches to the buyer; Gillette's category management connects to customer's category management; senior managers connect to each other, and so on. The aligned teams support the company's mission to strengthen key customer relationships through an effective, collaborative, improvement-oriented process.

Collaborating with customers is a key element of Gillette approach and includes initiatives such as Collaborative Planning, Forecasting, and Replenishment (CPFR), data synchronization (UCCNET) and Auto ID. Gillette also works with customers to map processes across company boundaries to avoid a gap between Gillette's processes and the customer's processes. The company has found numerous opportunities to improve issues such as shrinkage, shelf replenishment, packaging, and display design. Gillette worries about customers' performance issues because when the retailer loses the sale, Gillette loses the sale, too.

Gillette is differentiating its customer strategy by customer size. More complex, sophisticated retail chains will receive more differentiated and integrated service based on Gillette's value chain structure. Smaller, independent operators will receive a standardized set of supply chain services. Both the cost-to-serve and the sophistication of the customer drive this distinction. Thus, Gillette only does CPFR and Vendor Managed Inventories (VMI) with its largest accounts.

Developing Expertise

Finally, Gillette created a Center of Expertise to pursue further value chain enhancements. These enhancements include standardizing the company's approach to forecasting across regions,

customer-based forecasting for promotions, and redesigning some parts of the company's warehouse and transportation strategy to improve transit time to customers. All of this activity to restructure and enhance how Gillette connects supply to its customers are part of the company's quest for perfect retail.

3. The S&OP Journey: A Relentless Pursuit of the Truth, Mike Mastroianni, VP, North America Planning & Operations, Campbell Soup Company

Sales and Operations Planning (S&OP) is challenging for companies because it forces them to look under the hood of every business process. The S&OP process drives considerable change throughout an organization.

Campbell's launched an S&OP redesign in July 2003. Prior to that time, the company's S&OP process was informal, relying on "cafeteria meetings" with junior-level people discussing forecasts. The company had tried to implement S&OP before. Under the old system, Mike discovered that eight different, independent forecasts were being used at the company, and forecast error was 35% MAPE (mean absolute percentage error) by item/DC/month. Supply planning was decentralized and order fill rates were poor.

Improved forecast accuracy and S&OP would bring Campbell's a number benefits. First, its customers could see improvements in "perfect order" metrics such as case fill, line fill, order fill and on-time rates. These improvements would bring improved sales revenue by reducing out-of-stocks and improved promotional execution. All of these activities would make it easier for customers to work with Campbell's because they wouldn't have to spend time reworking invoices or rescheduling deliveries.

In turn, Campbell's would see increased revenues, better manufacturing efficiency and fewer unplanned changeovers. Its employees would have better tools and would spend less time re-planning and dealing with "noise" about forecast issues.

S&OP Initiatives

When launching its "Class A" S&OP process, Campbell's had to re-implement its Manugistics demand planning tool. The company had used Manugistics before, but for forecasting into the distribution center. Now, with visibility at the customer level, Campbell's needed to change to forecast at the customer level.

S&OP at Campbell's is a process led by senior management that evaluates projections monthly. The purpose is to make decisions, not just to present numbers. Campbell's goal is to get consensus across the organization on a single operation plan that will run the organization. The horizon for planning is not simply to analyze last month's figures (that historical discussion now takes only about five minutes of time in the meeting) but to do a rolling 18-24 month forecast.

S&OP Behaviors

Implementing S&OP requires some cultural change and the encouragement of new behaviors. For example, people need to create valid plans (not promising more than they can deliver) and give bad news early so that adjustments can be made. Mindsets also have to change from an

annual-planning mindset to one of continuous replanning. Perhaps the biggest change for Campbell's was the drive toward agreement on *one* set of operational numbers -- "the truth" with a high side and a low side.

The nature of S&OP meetings also changed. In the past, the meetings were held over two business days, 4 hours each, and they were more of a dog-and-pony presentation-style meetings with difficult issues not being raised. With the Class A S&OP initiative, Campbell's instituted a root-cause analysis to dig into issues like budget overruns and why they occurred. The new meetings now focus on exception-based reporting and discuss only the plans that didn't work. The new meetings are only 2 hours long because they focus on decision-making issues. After the meetings, plans may be re-prioritized based on the exceptions that were discussed.

Common Misconceptions about S&OP

One of the misconceptions associated with S&OP is that anything that goes wrong is the fault of S&OP. For example, Campbell's doesn't typically sell much soup in Florida during August and September, but in 2004 it was selling ten times the normal amount because of the hurricanes. The discrepancy between forecasted demand and actual demand is not the fault of the S&OP process.

Another common misconception about S&OP is that it is simply a logistics and planning process. In actuality, the S&OP function sits immediately below Strategic Planning and above many processes, including the New Product Planning, Aggregate Demand Planning, Financial Planning and Supply Planning.

Five Steps of the S&OP Process

The first step in the S&OP process is a new process for Campbell's, namely a "new initiatives review." The review looks at the full pipeline of new initiatives 24 months out, examining the key milestones, volume changes and impact on financial plans. The second step is the "demand review," and the biggest challenge of this step is how to build consensus in the forecast across the company. The demand review takes into account a staggering number of factors, including customer plans, sales forecasts, market intelligence, statistical projections, distribution chain inventory plans, product management and summaries of assumptions, vulnerabilities and opportunities. The third step, the supply review, looks at the ability to support the plan, evaluating different alternatives and assessing risks, opportunities and costs. The fourth step -- alignment and reconciliation -- is the easiest step for Campbell's. Finally, the management business review rounds out the last step in the S&OP process. In this step, general managers make decisions based on the alternatives. In the past, this was a finance-dominated meeting that involved 70 pages of numbers. Now, Campbell's is using technology to make those numbers more manageable and to focus on the key issues.

Conclusions

The focus of the S&OP process should be the future horizon, not talking about history. Companies can't influence last month’s demand and can’t even affect next month's demand very much -- at companies like Campbell's, next month's demand has typically been pre-sold and the

shelves have been preset; therefore, it makes sense to think further out into the future, where the company has greater influence over demand.

The biggest win to date for Campbell's with the new S&OP process has been to gain insight into previously broken processes. Adding technology and real-time forecasting has enabled Campbell's to reduce forecasting error from 45% to 23% (MAPE by item/DC/week). The improvement is widespread, with 603 out of 645 items forecasted more accurately and 99.4% of item volume being forecasted more accurately. All weeks and all locations are forecasted more accurately.

Looking to the future, Campbell's will work on collaborating more closely with customers as the next step of its continuous improvement process.

4. Reducing Complexity and Creating Value via Sales and Operations Planning, Seema Phull, Director, Process & Technology, Enterasys Networks

Enterasys is a $414 million builder of secure enterprise networks, serving 25,000 customers globally. One of Enterasys' biggest challenges in the S&OP process is that it works with contract manufacturers rather than having its own manufacturing plants. Enterasys also has a two-tier distribution process, selling its products through 10 major distributors as well as through a direct sales force which is involved in most sales activities. This two-tier system adds complexity and puts communication with partners at a premium. As a result, Enterasys is focusing on collaboration: collaborative forecasting and collaborative procurement.

Collaborative forecasting and demand planning (CFDP) is a month-long process which focuses on minimizing demand uncertainty. Alongside CFDP is the Collaborative Procurement Planning Project (CPPP) which seeks to minimize supply uncertainty. Together, these two processes culminate in the S&OP process, which strategically aligns supply and demand with the net result of improving customer service while reducing costs.

In 2003, Enterasys' planning process was not company-wide in either structure or discipline. The process was biased to the supply side and key stakeholders such as finance people did not show up for the quarterly meetings. The prior focus was on short-term tactics and fire-fighting (not strategic), and there was no penalty for not meeting the forecast. This situation is not atypical for companies the size of Enterasys, but the problem is that such a process does not help the company grow and succeed.

Re-engineering the S&OP Process

To improve demand management, Enterasys created an enterprise-wide, closed-loop process to replace the disconnected manual process of the past. The new S&OP process focuses on performance management with shared processes, assumptions and ownership across the enterprise. The company set up an audit trail and measured results on a monthly basis. Accountability improved through the creation of a CFDP champion who reports to the supply chain but has dotted-line responsibility to the Chief Operating Officer. By creating a position which was responsible for the entire S&OP process, Enterasys drove accountability and coordination across the organization.

In creating its new S&OP process, Enterasys focused on laying out the business processes first and doing the technology piece last. Enterasys' rationale was that technology is a no-brainer given enough time and money, but if the company didn't have process ownership and the process was not correct, then the technology would be of limited value. Therefore, Enterasys spent 4-6 months designing business processes, identifying disconnects from a policy standpoint, assigning roles and responsibilities, and making sure it had cross-functional teams in place to foster consistency and collaboration. The company also identified critical business information that needed to be communicated and defined critical reports and metrics so that the information would be shared on a timely basis.

Collaborative Forecasting and Demand Planning

The objective of CFDP is to develop the right forecast to enable decision-making. Although people want accuracy, accuracy is difficult to reach; therefore, it may make more sense to strive for demand predictability rather than accuracy. Enterasys gets most of its orders during the last two weeks of each quarter, which creates a hockey-stick demand curve. The question Enterasys faces is how to learn of demand as far in advance as possible. At present, Enterasys never misses a shipment, but in order to do that it holds a lot of inventory, which leads to excess costs and obsolete inventory. The company needs to change the mindset that the hockey-stick requires large inventory and that expediting orders is acceptable. Instead, by aligning supply and demand, Enterasys will be able to reduce expediting costs.

Results of the New CFDP Process

With the new process, S&OP meetings now focus not on "are we making the numbers?" but on more strategic-level issues like "Where is our business going? Who else is coming into the marketplace? Where do we see constraints? Where are we building obsolete products?" This new strategic focus, and discussion of end-of-life products, is new for Enterasys. What's more, S&OP meetings are now attended by executives such as the CFO, because the meetings are now strategic enough to warrant executive attention.

In terms of technology, Enterasys is now bringing data into one central place -- the operational data store -- where it runs the analytics so as not to bog down the production systems. People are now spending more time analyzing information and taking action rather than simply trying to gather the needed data. The management team is able to get critical business information such as gross margins, inventory exposure, and revenue tracking.

Finally, Enterasys now has a "demand steering" champion. In the past, the company simply "let revenue happen." But for a company that wants to grow beyond half a billion dollars, the company needs to *make* revenue happen. Therefore, the S&OP champion now holds a weekly meeting to look at demand and steer it in response to market and sales conditions. Enterasys has highly configurable products but does not know the mix of products until shortly before the order, so having this step in the process helps steer demand and takes a proactive approach to revenue management.

5. Recap of the Day, Dr. Larry Lapide, Research Director, CTL, MIT

Perfect order fulfillment depends on making promises that you can keep, profitably. This makes promising extremely important, to make sure that the company both stays profitable and meets customer demand.

Manufacturing lead times, at many companies, are a "big lie" in the sense that the lead times are averages -- sometimes the company can do it faster, sometimes it takes longer. Order promising, therefore, needs to address several questions:

* Should we fill the customer's order right now? If not now, when?
* Should we fill it using available or planned inventories? Should we fill it using available or future production? (because the biggest customer order may be coming tomorrow and the company wants to be able to fill that order immediately).
* Is the current customer's order more important than another future order?
* Is the customer order more important than a warehouse or plant replenishment order? (Counter to popular belief, if a replenishment order is one that fills a key customer's needs, then heeding the replenishment order may take precedence).
* If we take the order, at what price should we take it? (Customer profitability needs to be calculated, as companies like Gillette discussed.)

In short, many factors go into the promise date; making the order promise decision requires knowing customer and warehouse demand. Customer-level planning helps in this decision -- knowing the current and future supply (inventory, production capacity, and materials), and conducting activity-based costing and customer profitability analyses.

The order-promising decision is even further complicated because demand is not certain. Plans are not certain; neither are future inventories and future production capacities. Thus, while a company can promise against future inventory, it is making that decision under uncertainty.

6. Symphony – Steering the Business Real-Time, Tony Saldanha, Manager, Global Business Services, The Procter & Gamble Company

Real-time (RT) decision-making can improve the profits of a company 3-5%, Tony Saldanha said. P&G estimated that applying the principles of real-time to general management can bring them a $200-400 million incremental profit per year.

The goal of RT is to prevent surprises and seize potential opportunities. It's a concept that Wall Street likes as well -- by avoiding surprises, company executives don't have to go in front of analysts and explain why there's a difference between promised results and delivered results.

RT is more possible now than in the past given the improvement of data, forecasting and communication techniques. For example, the worst national disaster in the US was the hurricane that hit Galveston, Texas in 1908. Thousands of people lost their lives because the day before -- even hours before -- the hurricane hit, experts predicted that the hurricane would pose no problem. Today, hurricanes are tracked right from when they begin forming off the coast of Africa. Predictions for 2004 identified 10 hurricanes would hit the Atlantic coast and supplied

the approximate dates and strengths of each. These predictions make life easier and safer, yet they don't require massive amounts of data. The hurricane predictions are based on two datapoints: West African rainfall and North American wind patterns.

RT also helps companies seize opportunities. For example, the day after 9/11, Wal-Mart saw sales of American flags spike. So Wal-Mart bought all the flags they could. By the time K-Mart identified the trend, the supply of flags was gone.

P&G used RT when its Pringles brand of potato chips came under intense competition from Frito-Lay. Frito-Lay began a direct attack on the brand, claiming taste superiority over Pringles. Taste was the foundation of Pringles, and management felt strong pressure to react. P&G's CEO carefully watched daily point-of-sale data from some retailers and saw that while Frito-Lay sales were going up, sales of Pringles were going up as well. The direct-comparison ads were driving sales of Pringles up, reminding people of the brand. Thus P&G determined that there was no need to hold blind taste-test counter-campaigns or to unleash its own barrage of ads -- it could sit back and watch sales of Pringles go up. The RT data let P&G make a sound decision that saved it millions of dollars.

With RT data, companies don't have to do "rear-view mirror" driving, (i.e., looking at last quarter's data to explain what happened). Instead, they can do front-windshield driving, seeing and managing events as they occur.

P&G is now applying RT principles to decisions related to management across all of P&G. Through its Symphony strategy, P&G is asking managers in each category and geography what decisions they cannot currently make and what would help them make those decisions. The Symphony strategy is being applied in the supply chain and sales organization now and will eventually be applied to R&D as well.

The Symphony strategy involves two steps. The first step is to identify the business drivers that decision-makers need to know. Most have 6 to 12 indicators which they watch to foresee 80 to 90% of potential surprises. By identifying those crucial indicators, the Symphony team can get the needed data to the managers.

The second step is streamlining processes so that data can be shared across P&G more easily. Most industries use dashboards as a way to bring in information, to show deviations from control, and to give managers the data they need without overwhelming them. P&G currently gives a daily intelligence report to its top 100 executives that covers all of P&G's products globally. The report is understandably very thick and isn't as easy for managers to use as it could be. The Symphony team is looking to use intelligent agents -- be they control charts, mathematical models, etc. -- to help executives know on which information they should focus. P&G will start with weekly RT buckets of data. Leaders currently get daily shipments data and up-to-the-minute plant line uptime. The expected end state is to aggregate all this data and use the intelligent agents to help managers quickly find the most important information they need to make their decisions.

Lessons Learned when Applying Real-Time Principles

Along the way of applying RT principles, P&G uncovered some issues. For example, when discussing the comparison of sales numbers and targets for use on dashboards, managers ran into

a dilemma: which targets should be used? There are MRP II targets, sales targets that the sales force has given, and targets that finance uses. RT makes it clear that people may not be trusting each other when sharing data. The sales force may set higher targets, for example, than finance is given, but the transparency of the RT processes exposes this fact.

As companies work to apply RT principles, the first step is to identify the surprises that drive the business. For example, in P&G's pharmaceutical business where it has billion-dollar brands, the manufacturing costs are next to nothing -- all the costs were in R&D. So for that industry, watching upstream competition and regulation is key. By contrast in the diaper or tissue business, the focus is all about costs, down to the pennies; managers watch costs daily. Every business unit needs to identify the business drivers critical to their unit and apply appropriate statistical models.

Another lesson is that companies can't restrict themselves to using only internal RT data. For example, K-Mart may have thought that it was doing well selling flags post-9/11, but the number of flags being sold by Wal-Mart was dwarfing the number sold by K-Mart.

Cultural Issues

Using RT data brings a fear that upper-level managers may overreact upon seeing the data, calling lower-level managers and demanding action too quickly. Lower-level managers may not want their bosses looking over their shoulders and telling them how to run their businesses. Thus, applying RT principles requires careful navigation. P&G has learned to start the process and then let managers learn way through it: the Symphony team builds a prototype and lets a business try it out. The entire Symphony project is run using 90-day product cycles. That is, the team delivers a product (such as a dashboard) in 90 days -- the dashboard is nowhere near perfect in this first iteration, but after several 90-day cycles it is better.

Other Companies' Use of RT

Monsanto, in its agricultural herbicide businesses, monitors the daily use of all its retail tanks (in 8000 locations) and uses that data to see how the company is doing relative to the competition. Managers get exception reports and can take action when they see anomalies. For example, if a tank increases in volume but Monsanto did not make a delivery to that tank, Monsanto knows that a competitor provided that product. The manager gives that information to the salesperson who can then contact the retailer.

McDonald's uses RT data to run its kitchen operations. The company's reputation depends on fresh products and speed -- the products must be available quickly, without making customers wait, but at the same time the food can't be prepared too far ahead of time and compromise the freshness. For example, French Fries can't be cooked too far ahead of time (resulting in waste), but long lines drive people way. So McDonald's is testing technology that takes pictures in real time of cars coming into the drive-through or parking lot. Based on previous data and history, McDonald's knows that seeing an SUV enter the parking lot increases the chances of an order for a Big Mac. The company has created profiles of cars and the corresponding order patterns. Seeing three SUVs pull into the parking lot means there's almost a 100% chance of a Big Mac order in the next three minutes.

7. Bringing the Market Inside, Tom Malone, Patrick J. McGovern Professor of Management, MIT Sloan School of Management

Companies are beginning to experiment with bringing market mechanisms inside the company, according to Prof. Malone. If markets are the best way to match buyers and sellers in the outside world, as most capitalist companies believe, then markets might be useful for matching buyers and seller inside a company as well.

BP

Consider BP's company-wide goal to reduce emissions by 10% over 12 years. The goal immediately raises the question of how the different divisions of BP should contribute to the goal and how BP might allocate the relative emission reductions at each division. Traditional top-down management would use the corporate hierarchy to analyze, decide, and direct each division's reduction in emissions. Unfortunately, hierarchies are contentious and can create results that arise more from political machinations than from rational optimization. Hierarchies also suffer from bottlenecks as information moves up and down the chain of command and is sometimes stalled by people with a vested interest in delaying the process.

Thus, BP chose an alternative approach: creating an internal market for emissions permits. Each division was granted the right to a declining schedule of emissions and the right to buy and sell those permits with other BP divisions. If one division could easily reduce emissions, it could do so and then sell the unused permits at a profit. If fast, profitable growth in another division made the permits valuable enough to buy rather than to invest in their own reductions, those other divisions could buy permits from the divisions which had reduced their emissions. An online market space let the divisions connect directly to each other without any intervening chain of command. The result: BP achieved its 12-year goal for emission reductions in only three years.

Idea Futures

Companies can also create internal markets for forecasting. HP created an experimental "idea futures" market for predicting printer sales. Market participants bought and sold contracts for sales volume predictions (e.g., "HP will sell between 1,500,000 and 1,600,000 printers next September"). If the contract holder was right about the prediction, he or she received $1; otherwise they got nothing. The market outperformed the official consensus forecast 15 out of 16 times.

Prof. Malone also discussed other uses of internal markets. For example, Intel is researching market alternatives for allocating production slots at its highly expensive fabrication plants. In another example, HP created VC Café, a quasi-market for letting engineers bid their time on new R&D projects. Both markets help connect supply to demand.

Strengths and Weaknesses

Markets outperform traditional central planning because they encourage more unbiased participation and thus incorporate more unbiased information. Rather than filter information through the time-delayed funnel of the hierarchy, markets let anyone contribute instantly to the process. As soon as anyone hears of an earthquake, or when a salesperson learns of a big sale,

the market can react immediately rather than waiting for a cycle of weekly staff meetings. Markets might also provide better quality information. Whereas hierarchical forecasting methods encourage people to say what they wish would be true or what they think their boss wants to hear, internal markets encourage greater honesty because the payoff is tied to the actual outcome.

Internal markets do have some weaknesses. First, one general weakness concerns incentives, in which the costs and benefits of the trade do not fully accrue to the participants. For example, a factory manager might be willing to sell a capacity slot that creates costly demands on the company's transportation network. Or, a supply manager might artificially withhold capacity to drive up the price.

To counter this first weakness, corporate markets can be regulated to guide outcomes and reduce abuse. For example, risk averseness or short-term greed in company personnel could lead to undesirable trading outcomes. If nobody bids on a high-risk, long-term R&D project, it might never be done. Thus, managers might subsidize certain outcomes by adding a bonus to the trade or by creating price supports. Another issue might be cost structure complexities that aren't found in simple commodity futures contracts. In this case, the structure of the factory capacity contracts could incorporate penalties for factory changeovers, expediting, or other cost-adding factors to reflect the fact that factory production slots are not as interchangeable as bushels of wheat. Regulation and oversight can forestall abusive or suboptimal behavior.

The second weakness which markets have is the cost of communication: buyers and sellers must find each other and negotiate agreements. Here, continuing improvements in information technology help lower communications costs.

The Move to Markets

Internal markets for corporate applications are in their infancy. Under a market for matching people and projects, such as HP's VC Cafe, company structure might evolve to have project managers and people managers to support the two sides of the internal market. Corporate planners and schedulers might become speculators in the market, buying and selling capacity in the short-term whenever they see inefficiency. Automated software might add liquidity to thinly-traded internal markets. Companies might experiment with various trading allowances, bonuses, and links between trading profits (or losses) and real compensation.

Markets are not perfect, but they have proven to be better than central planning for many applications. Markets provide efficiency, visibility, and real-time flexibility. Ongoing improvements in IT make it less and less expensive for anyone in a company to connect and trade in real time in an internal market. Prof. Malone suggested that companies might want to think about leveraging the power of internal markets in the future.

8. Internal Markets Research, Jay Hopman, Researcher & Strategic Analyst, Intel Corporation

Intel is researching the application of internal markets to a wide range of corporate allocation, planning, and forecasting problems.

Forecasting in a faced-paced industry such as semiconductors is inherently challenging. Each month, forecasters create a forecast that inevitably turns out to be wrong. The forecasters then explain why they were right when they made the wrong forecast, what changed and made the forecast wrong, and how the new forecast will be right.

Intel sees markets on a 2-dimensional space. On one axis is the time between the negotiation of the contract versus consummation of the deal. At the one end of this axis -- spot markets -- the buyer and seller set the price and immediately exchange goods for money. With increasing delay between negotiation and consummation come forward contracts (i.e., trades to lock-in next month's purchases or sales) to futures markets (trades to hedge longer-term price risks).

The second axis spans the gamut from markets for physical products (e.g., commodity markets) to markets for notional outcomes (e.g., prediction markets). This axis can also be defined in terms of the percentage of trades that consummated with physical delivery of some product. Futures markets, even those dedicated to physical commodities, can be considered prediction markets because of the high level of speculator activity in these markets. Because speculators never intend to take or make delivery of the underlying physical commodity, the contracts they trade act more like predictions of future price rather than contracts for consummating trades.

Production Capacity Futures

Given the high cost of semiconductor fabs, the high cost of obsolete chips, and the challenges of ongoing new product introductions, Intel is looking for new ways to match supply to demand. Experiments have already shown that internal markets can allocate capacity efficiently. Merchandising markets seem quite complex because of the numerous details involved with each transaction, such as delivery dates, transportation requirements, storage costs, and the large number of SKUs involved.

Potential Benefits and Risks of Internal Markets

Intel considers prediction markets as a potential entry point for internal markets at the company. A prediction market could improve forecasting without requiring changes to existing well-honed processes for planning, scheduling, and execution. Prediction markets would allow Intel to create a less-biased forecast on a real-time basis that taps into a wide range of up-to-the-minute knowledge at the company. Prediction markets can be potentially sophisticated, with multiple layers of forecasts (e.g., global sales, product family sales, product mix). Intel might also use conditional futures such as "will Q4 sales exceed 3.5 million units without a price move?" If properly structured, the prediction markets could help estimate forecast uncertainties or ranges instead of just creating a point forecast.

Internal markets and the data that they create offer opportunities to learn about the developing pattern of supply and demand. Beyond the share prices themselves, Intel is looking at two categories of supplementary data. First, other aggregate market data such a trading volume and open interest might reflect the level of turbulence in the environment or the level of confidence of participants. Second, tracking trades by individuals or region might reveal useful patterns of knowledge or identify the sources of shifts in supply and demand.

Intel does have some concerns about internal markets, especially about who participates in the market and how they behave. For example, sales-force incentives may cause salespeople to bias

their trades in a prediction market in favor of lower forecasts that lead to higher sales bonuses. Biased trading might lead to under-allocation on capacity and lost sales. Excessive numbers of speculators or internally-focused traders could lead to prediction prices that have too little to do with external data and market response. Excessively powerful or unfairly knowledgeable traders might also abuse the market -- perhaps the VP of Sales shouldn't be allowed trade. Intel also suggested tracking all the activity by trading individuals as part of regulatory oversight.

Next Steps

Intel is continuing its research on the use of internal markets. One promising area for internal markets is during major product transitions. This is a time of high uncertainty, high importance to the company, and extremely distributed information. Internal markets might help gather all the widely-dispersed information on likely new product adoption into a more accurate forecast. One key is to ensure that market participants understand all the contextual factors (strategy, uncertainty, and contingency plans) that could affect supply and demand. Thus, Intel might use a blended solution that would combine Intel's Product Transition Index methodology for organizing information on some 65 factors about product transitions with internal markets for creating a consensus prediction of outcomes.

9. Demand Management Research Opportunities, Dr. Larry Lapide

In the wrap-up discussion, participants discussed issues for future research:

* What are the conditions under which internal markets work well? (a follow-on to Prof. Malone's research on internal markets)
* Can we incorporate external markets into an internal one?
* What is the impact of future technologies such as RFID on S&OP and integration between planning and execution? (S&OP and order promising tend to blur with demand management)
* Many S&OP initiatives are not working, which means that "one size does not fit all" -- what needs to change about S&OP so that companies can make it work?
* How can we align accountability and incentives (particularly with the sales force). The sales force may be motivated to forecast low and then exceed the targets -- that's not bad if the company makes profits, but it wreaks havoc for manufacturing planning.
* How can we bring external information into the S&OP process in order to make the whole supply chain more efficient, not just an individual company?
* What external information should be brought into the company? How can technology help to gather this information in real time and integrate it? What are other companies doing in this area?
* When RFID becomes widely implemented and generates terabytes of information, how can companies absorb that information? When we get smart objects and know where they are, what will we do with that information?
* Is the S&OP process different in different industries? What information should companies collect and how should they match supply and demand to optimally allocate supply to meet demand?