Real-Time Profit Optimization:

Coordinating Demand and

Supply Chain Management

An Overview

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— An Overview —

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Most businesses could immediately cut costs and increase profits by improving their supply chain coordination and connecting it more closely to their marketing. Yet the difficulties many companies experienced recently in adjusting rapidly enough to the economic slowdown showed that this is more of a challenge than many had thought. To help businesses move on to a new level of supply and demand coordination, Cisco Systems and Tuck's Center for Digital Strategies recently convened the first in a series of thought leadership summits. This day-long roundtable discussion brought together top business thinkers not only from Cisco and Tuck, but from other top business schools and a wide variety of corporations known for their best practices in supply chain management, product configuration, pricing, and forecasting. The result is a new picture of how supply chain decisions and marketing decisions can function together.

Supply chain coordination has recently become a much higher stakes game. Globalization and leaner production have been dramatically reducing supply costs. Companies' differing abilities to master these new supply chain realities are having a huge impact on their ability to compete. Meanwhile, these same realities have been dramatically *increasing* the costs of getting supply numbers wrong.

In many cases, the new efficiencies in supply chain management have been accompanied by new fragilities. James Figura and Rick Spann offer vivid examples of how these changes have been affecting Colgate-Palmolive. Colgate's gel toothpaste is made in England, and its toothbrushes, in China. Roughly a third of its sales are to Wal-Mart, which regards "on time and complete" as a condition of doing business. Hence, if Colgate-Palmolive runs short on a product in America, it might have to pay for emergency air freight across the Atlantic or even halfway around the world to meet its contractual obligations.

Other companies are feeling the effects of these supply chain realities even more than Colgate-Palmolive. Eric Johnson of the Tuck School describes the unnerving conditions in the garment industry, where a decade of falling margins have made tiny differences in supply chain efficiencies a make-or-break issue for nearly every clothing company. Often the design and production of a single piece of clothing will involve several partners in several countries, all of whom need to be closely coordinated on a schedule where a few days can make the difference between whether a new product catches a new fashion or is beaten out by a competitor.

In an increasing range of industries, the same technologies that allow faster responses to changes in demand and supply also put tremendous pressure on companies to keep up with their competitors where those technologies are concerned. John Chambers notes that all of Cisco's less nimble competitors from as recently as the mid-nineties have now dropped out of the game. He cites supply chain coordination as one of the key factors in this development. Barry Smith of Sabre points out that all the airlines that were late adopters of the new pricing and supply chain technologies have already gone bankrupt.

Meanwhile, the competitive advantage brought by better supply chain coordination has been less of an advantage to the total economy than many had expected. Despite all the dramatic progress, the current supply chain procedures, even among the leading companies, were not as successful as people had hoped when it came to coping with the recent abrupt changes in business conditions. A study done by Tuck's Center for Digital Strategies shows that, while inventories were reduced rapidly in response to the slowdown, sales dropped even faster. Hence, the relationship between inventories and shipments was not nearly as good as it had been before the showdown. Chambers concedes that even Cisco, which responded with extraordinary speed to the changes in customer demand, didn't adjust its orders fast enough. Other supply chain wizards, such as Dell, were also caught off guard with excess inventory.

In practice, the problem has been even worse than the statistics indicate, because many companies have recently been writing off inventories at an accelerated rate. This has made the inventories on their books lower, without reducing them in a material way. The inescapable conclusion is that there is a discontinuity between what supply chain coordination can accomplish in principle and what it is accomplishing in practice. Where, exactly, are we failing to make the necessary connections? What can we do differently to realize the potential gains?

Making More of the Supply Chain Visible

One of the big lessons from the recent changes in business conditions is that businesses need to share information with companies further away in the supply chain. In other words, they need to communicate directly with their suppliers' suppliers, their customers' customers, and other businesses even more removed from theirs. Professors in business schools have been

preaching the value of this kind of information sharing for roughly a decade. Yet getting companies to share information that they worry could benefit their competitors continues to prove difficult. David Pyke reports that when a laptop sells at Best Buy, Corning, who makes the glass that goes into the monitor that goes into the laptop, isn't able to find out about the sale until two months later. Even then, the information has been filtered through two intervening businesses.

Often it is only the dominant company in an industry that has enough bargaining power and other resources to put an efficient cross-company information system in place. To accomplish this, it is first of all necessary to induce all the companies involved to collect the relevant data in a direct enough way and to supply it in a compatible form. Then it is necessary to install a system that compiles this data into a sufficiently usable interface. Carl Redfield of Cisco, in collaboration with Greg Owens of Manugistics, has recently been able to accomplish this for Cisco's own supply chain. According to Hau Lee of the Stanford Graduate School of Business, the goal of any such system must be to make the entire supply chain totally visible.

The physical technology for tracking materials through an entire supply chain is now quite remarkable. Lisa Smith describes how new equipment from Deere & Company makes it possible to monitor a supply chain all the way back to the component raw materials. These raw materials might include the individual trees from which wood products are made, or in the case of agriculture, the very seeds from which the crop is grown. It is literally possible to track which tree went into which piece of furniture, or which cup of grain went into which loaf of bread. Such awesome supply tracking is possible because Deere is putting sophisticated sensors, wireless communication, and geo-positioning devices in the tractors and other equipment that handles the raw materials.

Even after a company is collecting extensive numerical data on its supply chain, it will often need to supplement this data with other kinds of information. Where customer demand is concerned, for example, mere point-of-sale numbers usually aren't enough. Businesses need to gain an understanding of the context that creates those numbers. This means learning more about the customer's intentions, plans, and the relevant contingencies. It also means understanding the role the product plays in relation to other products. What inventory mix does a given customer actually want, for example? How will the customer's activities in other areas affect its need for the product? Reuben Slone says that Whirlpool coordinates twenty-three different capabilities with its major customers in order to make sure it has a constant, in-depth understanding of their changing needs and the supply chain can be effectively coordinated. Companies as different as Cisco and Colgate-Palmolive have found that more extensive, person-to-person communication with trading partners also remains essential.
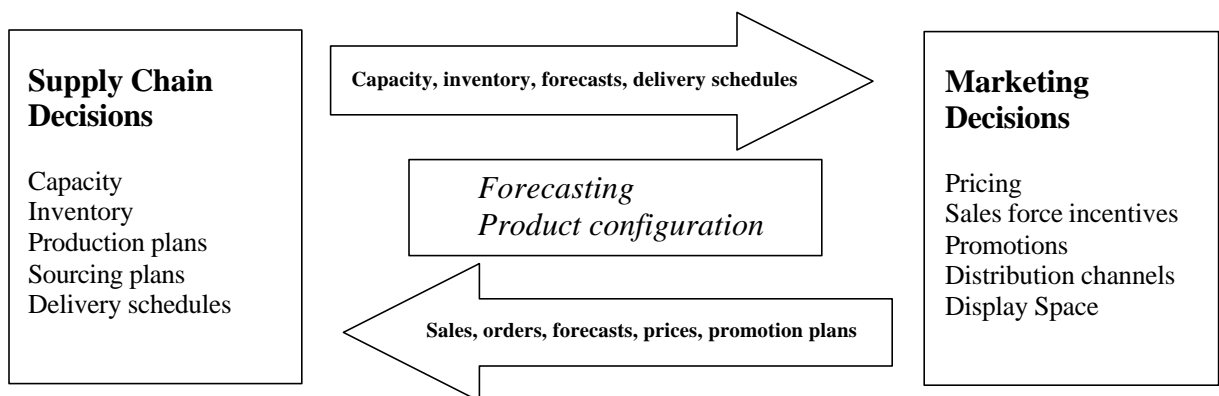
Once a company is receiving the relevant demand and supply information, there needs to be a specific person or procedure that makes sure the information is disseminated throughout all

the relevant parts of the business. Then there needs to be a concerted effort to make sure each business component is taking account of this information in their plans and objectives. David Pyke points out that when it comes to making sure people adjust their behavior in response to new information, there still seems to be no substitute for person-to-person meetings.

The more these meetings span the entire supply chain, from procurement people to sales people, the more they can reduce waste and prevent missed opportunities. James Figura and Rick Spann report that Colgate-Palmolive has recently instituted regular bi-weekly supply chain meetings for accomplishing these things. The meetings focus on inventories that have gotten too high or too low, possible sales promotions that need to be started or cancelled, and measures that might be taken to adjust production levels. Colgate-Palmolive reinforces the effects of these meetings with people who are responsible for communicating the needs and projections of the marketing people to the relevant production people, and who warn marketing people about possible supply problems. John Alexander and Reuben Slone report that the comparable meetings instituted recently at Whirlpool are weekly and can run as long as five hours. John Chambers, Larry Carter, and Carl Redfield participate in similar, but less frequent meetings at Cisco.

The number of areas where companies need to coordinate their supply chain and their marketing can make the whole problem seem intimidatingly complex. But each of these areas is also an opportunity to create more value by cutting costs or increasing revenues. This is why companies like DemandTec, Profit Logic, i2, Greg Owens' Manugistics, and others have been energetically developing software components that will make it easier to connect supply chain decisions with marketing decisions.

The Supply Chain – Marketing Interface

Supply Chain Decisions Capacity Inventory Production plans Sourcing plans Delivery schedules	**Capacity, inventory, forecasts, delivery schedules** → *Forecasting* *Product configuration* ← **Sales, orders, forecasts, prices, promotion plans**	**Marketing Decisions** Pricing Sales force incentives Promotions Distribution channels Display Space

Although many of the systems cited here as examples have been fully operational only for a matter of months, there is no doubt about the value they deliver. Available data suggests that earlier, more limited efforts to coordinate supply chains were one of the major sources of the

productivity gains during the economic boom of the nineties. The earlier phase of the ongoing revolution in supply chain coordination gave us lean manufacturing, just-in-time deliveries, drastically reduced inventories, and a host of increases in processing efficiency. Given the quantity of promising supply chain innovations that are yet to be fully implemented, the next phase of the supply chain revolution should produce even greater benefits.

Paying Suppliers with Supply Chain Information

The enormous value of the information that can be used to coordinate supply chains has important strategic implications. Many companies, for example, will increasingly have the option of paying their suppliers in information or receiving payment from their customers in the form of information. This means that a business deciding on policies for the sharing of information will need to take account of: a) the extent to which the information sharing can result in lower supply costs for the entire supply chain, and b) the ability of the company providing the information to capture a share of these gains.

There are at least three options for a company, like Wal-Mart, that is in a position to provide its trading partners with valuable supply chain information. Sometimes the company providing the information will want to negotiate a payment or price adjustment that takes account of the information's value. This is one of the things Wal-Mart does when it's negotiating prices with its suppliers. Other times, the best way to capture a share of the information's value is to receive more reliable deliveries on shorter lead times. This is what Wal-Mart is doing when it insists that its shipments from suppliers always be first in priority, on time, and complete. Still other times, the company with the supply chain information will want to use this information to become more vertically integrated, producing its own products or services at other levels in the supply chain. This is what Wal-Mart has been increasingly doing during recent months, as it introduces and promotes larger numbers of house brands. The same calculations that make it possible to estimate the productivity increases due to supply chain coordination also make it possible to estimate the value that a company like Wal-Mart can claim in exchange for its supply chain information.

For companies that have to deal with a "voracious data hoarder," this approach to the sharing of information can seem as though it's running counter to the whole cooperative spirit that originally engendered supply chain coordination. Wal-Mart, for example, is currently re-evaluating its information sharing policies to see whether it can obtain more value in exchange for the sales information it is constantly collecting. This is interfering with some of the supply chain efficiencies that until recently had been achieved through Wal-Mart's information sharing. But companies negotiating with a data hoarder often underestimate the value of the data that they themselves are in a position to introduce or withhold. Like other resources, supply chain information will ultimately produce the most value for its compiler

by being applied where it will create the greatest overall value. Ultimately, this will benefit the whole of the value-creating network.

Pricing in Relation to Changing Opportunity Costs

One of the biggest neglected opportunities in most industries is the possibility of using data on a company's changing opportunity costs to shape the company's promotion and pricing policies. For the last few years, the emphasis in both theory and practice has been overwhelmingly on making the supply chain more responsive to customer demand. Comparatively little effort has been directed at using pricing and other promotions to make customer demand more responsive to the supply chain. Yet studies by Hau Lee of the Stanford Graduate School of Business, by Scott Borg, and by David Pyke, Praveen Kopalle, and Joseph Hall of the Tuck School, demonstrate that the gains from paying closer attention to the supply chain's opportunity costs in pricing decisions are at least as great as the gains from paying closer attention to customers' willingness-to-pay.

The key to using opportunity costs in pricing decisions is being able to track them as they change with the quantities of product supplied and also over time. Certain industries, such as airlines, hotels, cruise ships, and car rental companies, have a special need to track these costs, because the opportunity cost for a given unit of their product can change so drastically and rapidly. Adding capacity, by putting on an extra flight, for example, can be hugely expensive in these industries. But once the capacity has been added, the marginal cost of a product unit, such as an individual seat on the flight, is very small, and the average unit cost drops off rapidly. The opportunity cost (or indifference point) for selling an existing unit of capacity, such as an airline seat, depends on the price someone else might be willing to pay for the unit if it hasn't been sold. Hence, the opportunity cost will rise as the flight becomes more fully booked and the supply becomes limited, only to fall off sharply as the departure time approaches and the probability of a unit going unsold increases. Industries that experience these dramatic changes in opportunity costs literally *cannot tell* whether a given price represents a favorable deal for their company unless they are tracking their opportunity costs almost from moment to moment. Furthermore, unless they can adjust their prices rapidly and often, these companies will be operating much of the time with pricing policies that go against their own interests.

Other industries that think they don't need to pay as much attention to changes in opportunity costs should think again. Their opportunity costs might not change as rapidly or as drastically as the opportunity costs of airline tickets, but an analysis carried out by Scott Borg and David Pyke shows that the longer-term impact of changes in their opportunity costs is much the same. Furthermore, the analogies between airlines and other kinds of industries are more extensive than most managers realize. Underutilized physical capacity and underutilized employees are like unused airplane seats. Their value eventually plummets with the passage of time. As companies move toward a build-to-order model, a slot moving

through a production line will sometimes be worth holding in reserve for the possibility of a more lucrative order, much like a seat on a plane. Even completed inventory can have opportunity costs that behave somewhat like those of airline tickets, when technical innovations in product systems make products suddenly scarce or plentiful, and then obsolete. All these fluctuations in opportunity costs can be dealt with, to a large extent, by changes in pricing and therefore in the quantity sold that price changes can produce.

Not surprisingly, the leaders in using the opportunity cost data to adjust prices have been the airlines. Because their pricing techniques are probably the most sophisticated, other businesses may wish to consider what they might learn from the airlines' experiences. Barry Smith of Sabre, who is one of the architects of their pricing system, says that the key to making air ticket pricing work is being able to switch whole distribution channels on and off. That way, the average ticket price for a given flight can be changed without changing the price of the tickets within a given channel. Lowering the average price is accomplished by making more seats available through the lower priced channels; raising the price is accomplished by switching off availability through those channels. Customers with a higher willingness-to-pay have powerful incentives to use the higher priced channels, because the tickets sold through those channels are given particular characteristics those customers need, such as ability to book only a few days ahead, to get instant confirmation of the reservation, to reschedule without advance notice, and so on. The overall mix of tickets being sold can literally be adjusted from minute to minute. Any business that can find a way to introduce an analogous pricing system could reap considerable rewards.

Product Differentiation in Relation to Pricing and Supply Chains

To charge different prices over an extended period, it's necessary to provide different products. Most problems with dynamic pricing and personalized pricing can be solved if companies can differentiate their products at a level that corresponds to the breaks between price points. Airlines can charge different ticket prices, because they are differentiating their products through different lead times, different degrees of certainty regarding availability, different rescheduling and ticket return policies. Dell can customize computer prices, because it is also customizing its computers, making each a different collection of components. Cemex is even able to customize cement prices, because it customizes its cement. Raul Prieto of Cemex explains that his company's cement is never actually a commodity. Using reference CDs, phones, and now a website, customers can specify the tensile strength, brittleness, elasticity, texture, color, resistance to molds and fungus, delivery location, delivery time, delivery rate, and a host of other qualities vitally important in using ready-mix cement. Each of these specifications is then taken into account when it comes to calculating price.

When companies get into trouble trying to introduce different prices, it is almost invariably because the products in question weren't sufficiently differentiated. Amazon discovered the

importance of this principle when its one-day experiment with personalized pricing ended amid a storm of internet protest and an almost instantaneous customer boycott. Jim Miller, now of Cisco, was present at the Amazon meetings that dealt with this experiment and was able to confirm the details. The chief reason Amazon *wasn't* able to charge different prices to different customers was that the products it was trying to supply at different prices—books and CDs—were the same. Amazon was actually providing *another* product that *was* customized—its customized recommendations—but it was providing that product for free.

Product differentiation, of course, creates its own supply chain problems. Every time a company adds another unique product, it is gaining in its ability to segment the market and to set a more favorable price. But it is simultaneously increasing the complexity of its operations and adding to its unit costs. John Alexander of Whirlpool describes the long-term result as a "binge and diet cycle" in which a company like his will first fatten its product lists, to serve more market segments more effectively, then trim its product lists, to get unit costs down—then start the cycle all over again.

Fortunately, it is possible to avoid much of the trade-off between lowering unit costs and increasing product differentiation by increasing modularity in product design. If this is done well, a relatively limited list of components can be used to produce a vast number of product variations. The master of this is Dell Computer. It is also possible to differentiate products at a relatively low cost if the components and processes that differentiate the product are introduced relatively late in the production process. Rick Spann describes how Colgate-Palmolive has applied this idea to things like liquid detergents, adding fragrances, colors, and different labels at the very end of the manufacturing process.

To employ these production techniques wisely, it is more necessary than ever to work out the implications for every step in the supply chain, from raw materials all the way through to the end user. Otherwise it is all too easy to design a production system that delivers options which *seem* low in cost, but aren't worth their expense in the eyes of the customer.

The opportunities for creating highly differentiated products that deliver more value to the customer are greatly expanded when these products are systems of goods and services assembled from the output of several companies. Chuck Stucki of Cisco argues that this is, in fact, one of the greatest opportunities to be seized by companies today. Rather than having one company design and assemble the final product, he envisions a group of companies working collectively to meet a customer's needs in a more dynamic way. Praveen Kopalle points out that to make this vision into a reality, there needs to be a "solution-centric" approach underlying the activities of each contributor. That way the whole, if not all the parts, can truly be built to order—and, better still, built to need.

Forecasting in an Increasingly Build-to-Order World

No matter how close a company comes to making its production a direct response to demand, there is always a need to buy or build certain things in advance. A company might be getting real time information on customer needs, and it might be able to reconfigure itself rapidly in response to this information. But it will still need to make bets on what resources it will need to have available. Forecasting of some kind is thus an unavoidable part of business life.

Yet forecasting in a world where companies are constantly making new products is a challenging problem. Extrapolating trends from the past is of limited value when new factors are constantly being introduced. The moves the company is contemplating making will themselves change its business environment in complex ways. Even if a linear extrapolation proves accurate for a time, Peter Fader of Pennsylvania's Wharton Business School points out, the business using it will gain no deeper insights into the underlying causes generating the trend. Without these deeper insights, the business will never know when its extrapolations are about to go awry or what to do about it when they do.

The difficulties of forecasting in this increasingly build-to-order world have caused some farsighted companies to tackle the forecasting problem in a completely new way. Kurt Doelling has helped create an approach to forecasting at Sun Microsystems, for example, that is truly state-of-the-art, despite, or perhaps *because*, he is in many ways a forecasting skeptic. Instead of trying to predict a future state of affairs by extrapolating trends from the present, this approach starts with the state of affairs the company is trying to create and then works backward, asking what conditions would be necessary for that state of affairs to come into being. This process quickly reveals whether the goal is an appropriate one or needs to be adjusted. It also forces the forecasters to think through all the relationships and contingencies that could produce outcomes different from the intended one. As a picture of the future begins to take shape, it is then possible to adjust the bets the company is making on different outcomes, so that the costs of getting the bets wrong are minimized and the profits from getting them right are maximized. That way, instead of betting everything on the most probable outcome, the company will be positioning itself to take best advantage of a range of outcomes.

Because forecasting is still so problematic, it elicits a wide range of attitudes. Carl Redfield of Cisco believes that maintaining a greater degree of flexibility in manufacturing is usually more important than achieving a greater degree of accuracy in forecasting. But Barry Smith of Sabre points out that forecasting is nearly always an area where a small increase in accuracy can result in large reductions in cost or large increases in revenue. Smith agrees with Redfield that complex forecasting systems need to be regarded with considerable skepticism. In fact, Smith says, until a couple of years ago, the forecasting systems that were used most successfully by the airlines were fundamentally "dirt simple." But Smith reports that some of the more complex systems have recently reached the point where they are

clearly proving their worth. Companies will increasingly need to adopt these forecasting systems if they don't want to be left behind.

As more ingenuity is expended on forecasting, it might seem relevant to ask whether we might already be approaching its practical limits. The effects on the airlines and other industries of the September terrorist attacks, for example, seem to demonstrate how easily unpredictable events can make even the best forecasts of demand and supply irrelevant. Hans Brechbühl of the Tuck School argues convincingly, however, that forecasting *possibilities* should be regarded as just as much a part of the forecasting process as forecasting *probabilities*. For every event that catches businesses completely by surprise, there is a kind of forecasting that would, at minimum, have lessened the shock, and likely increased the ability to deal with the consequences.

Reducing Variability as an Overall Organizational Policy

A more pro-active approach to future supply and demand is not to predict them, but to make them more predictable. This is another area of great potential where supply chains are concerned. Variations in levels of output are very expensive, and unexpected variations, especially so. Take almost any plant, process, or business operation. Run it well above or well below its optimum capacity, and the result of the variation in either direction will be soaring costs per unit of output. If variations are predictable, as with seasonal variations in demand, there are ways to adjust for them that make them considerably less costly. But if the variations are something a company hasn't prepared for, they can completely erase the profits from otherwise successful operations.

One would think from this that policies resulting in more uniform operation levels would be part of the regular practices of almost every company. Larry Carter of Cisco argues that "achieving linearity" should be one of the guiding principles in all business decisions. He argues that the opposite of linearity is "excess capacity, excess inventory, excess cost, excess people, lower quality, lower customer satisfaction, and more likelihood of a surprise." He compares "non-linearity" to "a cancer that can spread through a whole company," destroying profitability everywhere it reaches.

Yet many companies do not make any systematic or thoroughgoing effort to reduce variability. Indeed, many companies constantly use incentive systems that *increase* variability. Stretch goals, monthly or quarterly targets, and any other policies that result in big end-of-term sales pushes are especially to blame. Customers learn to wait for the better terms they will be able to get during the big sales pushes. Increased sales during the big sales pushes will lead to decreased sales immediately after. Responses by competitors can magnify the effect further. Every oscillation in demand or supply will lead to additional oscillations up the line. Sometimes these oscillations will pile up, leading to further highs or lows that might have no significant cause, apart from sales policies.

What can be done to stop this? First of all, Carter argues, reducing variability needs to be made a conscious goal at every level from the CEO on down. Public statements about projected company earnings will need to be tempered by recognition that reducing variability is enormously important. Sales people and the workers processing each order need to be told that "the first week of orders is just as important as the last week." Rewards to sales people always need to be based on products shipped, not on products sold. Product promotions need to be focused on reducing variability, not increasing it. With a culture of steadiness operating throughout a company, numerous variations can be eliminated that businesses had previously accepted without question.

Transferring the Lessons of One Industry to Other Industries

The extent to which extremely different businesses share the same supply chain problems comes as a surprise to almost everyone comparing notes across industries. The participants in the thought leadership summit uncovered astounding parallels between the supply chains for washing machines, ready-mix cement, minicomputers, toothpaste, networking equipment, airlines, software, tractors, and other diverse products.

The value of these parallels for supply chain managers comes from the fact that these various industries have each made different issues the focus of their attention. A company like Cisco is a leader in collecting data from companies further away on the supply chain; Deere is a leader in remote, automatic data collection; Manugistics is a leader in software for coordinating and optimizing complex sets of processes; Colgate-Palmolive is a leader on managing its supply chain globally; Whirlpool is a leader in achieving coordination with its large-scale customers on many dimensions; Sun Microsystems is a leader in certain kinds of forecasting; Sabre is a leader in pricing; Cemex is a leader in efficient product differentiation. When it comes to the "thought leadership supply chain," each industry is able to supply different collections of insights that the other industries need.

Putting these insights together, Donna Soave of Cisco reminds us, allows businesses to deliver the three basics that everyone ultimately depends on: productivity, profitability, and cash flow. Coordinating supply chain management and marketing is essential to all of these. If businesses can use the new insights to achieve a tighter connection between each phase of their supply chain management and their marketing, the benefits should be enormous for everyone involved.

**Nine Questions to Help Determine Where Your Coordination of
Supply Chain and Marketing Is State-of-the-Art
(and Where It Might Not Be)**

1) Are you sharing information, not just with your suppliers and customers, but also with your suppliers' suppliers, your customers' customers, and other businesses further away on the supply chain?

2) Is your information on the changing availability of supplies and the changing quantities of demand arriving as fast as you can adjust for it?

3) Do you have an adequate system for making sure all the relevant operations within your business actually take account of the supply chain information your company is receiving?

4) Have you figured out how to receive appropriate value for the supply chain information you are able to collect and provide to your trading partners?

5) Are you taking sufficient account of the constant changes in your opportunity costs when making pricing and product promotion decisions?

6) Are you moving simultaneously toward more differentiated products and more differentiated prices?

7) Are you controlling the costs of more differentiated products by increasing the modularity of their designs and differentiating them as late as possible in the production process?

8) Is your forecasting aimed at genuinely positioning your company for future possibilities, rather than simply extrapolating past trends?

9) Have you made reducing variability a basic feature of your company policies at every level?

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