

WHICH E-BUSINESS IS RIGHT FOR YOUR SUPPLY CHAIN?

by Sunil Chopra and Jan A. Van Mieghem
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The Internet is revolutionizing the way companies conduct business. Or is it? We argue that the value of the Internet for a firm is strongly dependent on the firm's industry and on the strategy it pursues. A survey of firms with an online presence displays wide disparities in performance. While Dell has successfully used the Internet to boost revenues and earnings, Amazon lost \$585 million on revenues of \$1.6 billion in 1999. Firms that fully exploit the revenue enhancements and cost reduction opportunities offered by the Internet and optimally integrate e-business with existing channels are likely to be the big winners in the Internet age.

The Role of E-business in a Supply Chain

E-business involves the execution of business transactions over the Internet. Companies conducting e-business perform some or all of the following activities over the Internet across the supply chain:

- Providing product and other information
- Negotiating prices and contracts
- Placing and receiving orders
- Tracking orders
- Filling and delivering orders
- Paying and receiving payment.

All these activities have been conducted in the past using existing "channels" such as retail stores, sales people, and catalogs. For example, companies like Lands End and W.W. Grainger have used catalogs to provide product information to customers.

Companies have used the Internet in a variety of ways to enhance supply chain performance. Dell uses the Internet to display all its product options to customers. Companies like Solectron and Ford have used the Internet to increase collaboration in product design. UPS and Federal Express have used the Internet to allow customers to track their packages.

Our goal is to characterize how different firms can best use the strengths of the Internet to enhance the performance of their supply chains. We argue that the answer is industry and strategy specific and propose a simple framework that managers can use make this decision.

A Strategic Framework to Evaluate Supply Chain Opportunities from E-business

The framework starts from the premise that supply chain decisions must be evaluated in a strategic context based on the answers to the following three questions:

1. What is your firm's desired strategic position?
2. Given your the firm's strategic position, what supply chain capabilities are needed to support the strategy?
3. Given the desired supply chain capabilities, how should the supply chain be structured?

The goal is to create fit between the desired strategic position of the firm and the capabilities of supply chain processes used to satisfy customer needs (Porter 1996). The desired strategic position may be articulated in terms of a clear priority ranking on the needs of the customer segments that are targeted by the firm. Typical dimensions of customer needs that may be targeted by a supply chain include timeliness, accessibility, availability, customizability, quality of service, and price. There is a tradeoff between the level at which a set of customer needs is targeted and the cost incurred by the supply chain in meeting these needs.

The *efficient frontier* represents the lowest cost of delivering a given level of a customer need using the best available supply chain processes. Each point on the frontier corresponds to a particular supply chain structure, employing the best available technologies, managerial policies, and inputs to deliver the desired level of a customer need at lowest cost. As such, the efficient frontier constitutes the state of best practices at a given point in time (Porter 1996). It also shows the inherent trade-offs that a firm must consider when selecting its strategic position given limitations in *process* technology and policies.

With the Internet come new associated technologies and managerial policies that shift the frontier outward. An outward shift represents either a decrease in cost for a given level of performance along a customer need or a higher level of performance at a given cost. The shift in the efficient frontier on adding the Internet to available channels will vary by industry. In

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some instances, the Internet may shift the frontier by significantly decreasing the cost for existing levels of performance. For example, at industrial supplier W.W. Grainger, e-business does not change any of the underlying processes but makes them cheaper to execute. This would mean that the main advantage from e-business would be to increase efficiency by automating previous activities (i.e., substituting labor for capital). In other instances, such as the online grocer Peapod.com, the Internet primarily enhances convenience without significantly reducing costs. (Later on we will argue that costs may actually increase.) In that case, the main advantage of the e-business would be to offer higher value along a given customer need. Sometimes, e-business may shift the frontier out along both dimensions simultaneously, as is the case for Dell Computers that is able to deliver both higher customer value in terms of customization and responsiveness, and lower process cost.

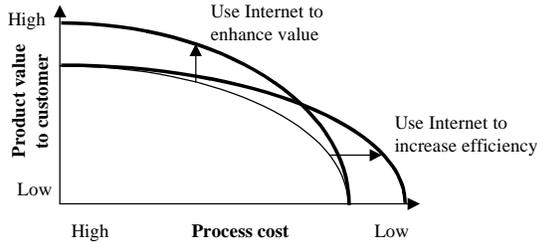


Figure 1: The Impact of the Internet on the Efficient Frontier

We are interested in characterizing the conditions under which e-business is most likely to *increase cost efficiency* or to *enhance value* in terms of some non-price factors like responsiveness, variety or quality. Firms can use such a characterization to decide how e-business can best be positioned to support the strategic position.

The Impact of E-business on Supply Chain Performance

Setting up an e-business affects both revenues and costs for a firm. Next we will elaborate on both aspects.

Revenue Impact of E-business

E-business allows firms to enhance revenues by *direct sales* to customers. Manufacturers and other members of the supply chain that do not have direct contact with customers in traditional retail channels can use the Internet to shrink the supply chain by bypassing retailers and selling direct to customers. For example, Dell Computers sells PCs online direct to customers. As a result, Dell can enjoy higher margins than traditional PC manufacturers that must share some margin with retailers. Clearly, retailers are in a weaker position to exploit this opportunity from e-business than other members of the

supply chain. For example, going online would benefit an airline more than a travel agent.

Providing on-line product and other information across the supply chain allows *flexibility on price, product portfolio and promotions*. The Internet makes information located at a central source (the seller's web server) available to anyone with Internet access, so that a change in price, product portfolio or promotions only requires one database entry. A traditional mail order company would need to mail new catalogs to all customers to change prices or products. Using its e-business, however, L.L. Bean only needs to update the price on its website. This allows dynamic "revenue management" where prices reflect actual demand and inventory positions, very much like airline yield management. For example, Dell uses the Internet to change prices and delivery times for different PC configurations regularly, based on demand and component availability.

On-line product information allows a much *faster time to market* as a product can be "introduced" as soon as a first unit is available. This is particularly valuable in industries with short product life cycles, where e-business provides an advantage over a "physical" product information model. A new product introduction in a traditional model requires a substantial volume of new product to be manufactured and transported to fill the physical channels. This is evident again in the computer industry where Dell often introduces new products earlier than its competitors.

The Internet allows *information aggregation* and offering a *wider product portfolio* from many sources to enhance revenues. For example, Yahoo! Shopping provides product information from a large number of retailers and enhances revenues for all by attracting customers because they are likely to find the product they are seeking. Physical retail store chains could aggregate product availability information across all stores on the Internet to satisfy customers by directing them to the appropriate location. In contrast to direct sales and "eliminating the middle man," it has become popular to create "hubs" or "portals" to link customers to other companies and their products. This improves shopping and fulfillment through "one-stop" and the hosting firm can receive revenues through commission fees and advertising. Recently, Amazon announced that it was renting some of its web-site to other e-tailers for \$606.5 million in cash.

Negotiating prices and contracts with customers and suppliers on-line allows *price and service customization*. By accommodating individual requests, the product/service may be customized and priced accordingly. Keeping customer profiles and having them "log-in" facilitates such price and service discrimination by allowing subsequent class or customer specific routing. Individualizing the purchasing experience for each customer is difficult in a physical store where the store layout cannot be changed for each individual customer. After logging in at Schwab, clients with a substantial investment portfolio have access to additional "Signature Services." Aside from such *service discrimination*, an e-business could *price discriminate* and alter prices based on the buying power of individual

customers to enhance revenues. Auctions sites like eBay and exchanges like Commerce One allow people to bid for goods and services with different people potentially paying different prices. Other e-businesses offer customers a menu of services at different prices, allowing them to select the desired level of service. For example, Amazon.com provides a customer ordering multiple books with shipping times for each book. Some titles may be available for next day shipping while others involve a weeklong lead-time. Customers can choose to receive one order after a week at a lower price, or separate shipments in order of availability at a higher price.

Global *access at any time from any place* in terms of order placement allows an e-business to enhance revenues by attracting customers who may not be able to place orders during regular business hours. For example, customers can place orders at industrial supplier Grainger.com, even when the Grainger stores where they will pick up their orders are closed. Grainger has observed a surge in online orders after their stores close. (Similar access convenience may be important in Europe, where many supermarkets are closed in the evenings, exactly the time when many customers that work could place their orders.) An e-business also allows a small specialty store with one location near Chicago to reach customers worldwide.

E-business can enhance revenues by speeding up collection of funds. An example of speeding up collection comes from the 2000 presidential campaign of John McCain. Within 48 hours of his primary victory in New Hampshire, Mr. McCain's campaign collected \$1 million over his website. Receiving \$1 million in checks would require much more time and effort to process and collect them!

Cost Impact of E-business

In *Designing and Managing Supply Chain Flows*, it is argued that the impact of e-business on supply chain costs is better understood by considering the four drivers of supply chain performance.

Facility costs include both site and processing costs. E-businesses are able to centralize facilities because online sales allow the *separation of order placement and order fulfillment*. Site costs may decrease as direct customer-manufacturer contact and geographical centralization eliminates or reduces retail sites. For example, Amazon supplies its customers from a few warehouses, while Borders and Barnes and Noble must incur facility costs for all their retail stores. In addition, bookstores have a higher space cost per square foot and lower asset utilization compared to warehouses.

An e-business can decrease processing cost if they can increase the amount of customer participation. For example, customers purchasing online from L.L. Bean do all the work of selecting the product, placing and order, and paying. This is in contrast to a call center where an employee is involved in the order process. In some instances, e-businesses may face higher processing costs because they have to perform tasks currently performed by the customer at a retail store. By

separating fulfillment from order placement, an e-business can smooth the order fulfillment rate. This reduces the peak load for order fulfillment and thus resource requirements and costs. Finally, a direct-sales manufacturer can reduce handling costs because fewer supply chain stages are involved in the product flow to the customer.

Inventory costs: Many e-businesses can centralize inventories because they do not have to carry inventory close to the customer. This geographical centralization reduces required inventory levels because of increased economies of scale in the supply and reduced aggregated variability in the demand. In some instances, given the time lag between when an online order is placed and filled, e-businesses can reduce inventories by postponing product differentiation until after the customer order has been placed. Postponing assembly or product differentiation allows a firm to "assemble to order" customized products from common components. Conceptually, postponement decreases the supply processes that are operated in "push" mode (i.e., in anticipation of a customer order, as shown in Figure 2) while it increases the processes that operate in "pull" mode (i.e., after a particular customer order arrives). A major advantage of e-business is that, by separating ordering from fulfillment, increased flexibility in operations is gained to implement postponement. (It is somehow ironic that by "going on Internet time," supply chains may actually buy themselves time compared to traditional brick-and-mortar retailing where ordering and fulfillment tend to coincide.)

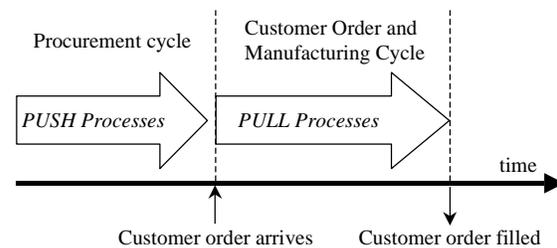


Figure 2: Push and Pull Processes

Transportation costs. One should differentiate inbound from outbound transportation: a firm incurs inbound transportation costs to bring a replenishment order in from a supplier while it incurs outbound transportation costs to deliver the product to the customer. Typically, replenishment orders enjoy lower unit transportation costs than customer orders because of scale economies. Physical centralization increases the distance traveled by a customer order, while decreasing the distance traveled by a replenishment order. Thus, compared to a business with several physical outlets, an e-business will tend to have higher transportation costs per unit. Clearly, transportation costs are eliminated for downloadable information goods.

Information sharing improves supply chain coordination. An e-business can easily share demand and other information (such as inventory positions) across the supply chain to dampen the bullwhip effect

Revenue Opportunities	Cost Opportunities
<ul style="list-style-type: none"> • Direct sales <ul style="list-style-type: none"> <input type="checkbox"/> Increased margin from eliminating intermediaries • Product information: <ul style="list-style-type: none"> <input type="checkbox"/> Flexibility on price and promotions <input type="checkbox"/> Wider product portfolio offering <input type="checkbox"/> Faster time to market • Negotiating prices and contract terms: <ul style="list-style-type: none"> <input type="checkbox"/> Price and service customization <input type="checkbox"/> Downward price pressure due to increase competition • Order placement and tracking: <ul style="list-style-type: none"> <input type="checkbox"/> Access at anytime from any place • Fulfillment: <ul style="list-style-type: none"> <input type="checkbox"/> Increased availability by aggregating information <input type="checkbox"/> Shorter response time <input type="checkbox"/> Increased choice of delivery options • Payment: <ul style="list-style-type: none"> <input type="checkbox"/> Efficient funds transfer may improve cash flow 	<ul style="list-style-type: none"> • Facility costs: <ul style="list-style-type: none"> <input type="checkbox"/> Site costs: eliminate intermediaries or retail and distribution sites <input type="checkbox"/> Processing costs: customer participation, smoothed capacity requirements • Inventory costs: <ul style="list-style-type: none"> <input type="checkbox"/> Reduce cycle stock (geographic centralization) <input type="checkbox"/> Reduce safety stock (statistical aggregation) <input type="checkbox"/> Postponing product differentiation to after order placement • Transportation costs: <ul style="list-style-type: none"> <input type="checkbox"/> Inbound <input type="checkbox"/> Outbound • Information sharing improves supply chain coordination: <ul style="list-style-type: none"> <input type="checkbox"/> Reduce bullwhip effect <input type="checkbox"/> Shared planning and forecasting

Figure 3: A (example) scorecard for e-business in the supply chain

and improve coordination. Sharing planning and forecasting information further improves coordination and reduces overall supply chain costs while better matching demand with supply. Information processing costs also tend to be lower for an e-business if it has successfully integrated systems across the supply chain.

A scorecard for e-business evaluation in the supply chain

The different factors influenced by e-business are summarized in a scorecard, as shown in Figure 3. By evaluating the impact on the various factors, one gains insight in how e-business impacts a particular supply chain and whether this value can most easily be captured by existing players or by new entrants. For example, if opportunities mostly accrue on the revenue side of the scorecard, the e-channel may be best positioned as a value enhancement of the product offering. If, on the other hand, the e-channel mostly improves cost, a focus on efficiency may be more appropriate.

At the danger of over simplification, the scorecard does suggest some key conditions for the supply chain to exploit the maximum benefit of going on-line:

- The supply chain is able to exploit all potential revenue enhancing opportunities of e-business
- Centralization significantly reduces facility costs.
- Going on-line reduces processing costs.
- Centralization yields significant inventory benefits. This is most likely if there are considerable economies of scale, or for new products or low-volume high-variety products, which have high demand uncertainty and benefit most from statistical aggregation.
- The supply chain can move processes to after a customer has placed an online order.
- The supply chain can postpone product differentiation.

- Outbound transportation to the customer is a small fraction of total product cost.

Notice that all these conditions are satisfied by downloadable information goods: Facility costs are minimal as physical storage and personnel (handling & management) requirements are minimal. Inventory requirements vanish as one copy of the file on the server is sufficient. With a sufficient, non-depletable inventory position of one, pull and postponement have no incremental value and become irrelevant. Finally, outbound transportation costs are minimal over the Internet. For example, it is much faster and less costly to let customers download the prospectus of a mutual fund than to mail or fax it. In addition, downloadable products also can exploit all the revenue opportunities. Thus, downloadable information goods are the perfect fit to the e-business channel. For them, the Internet moves the frontier out along both dimensions, increasing simultaneously efficiency and value. This, however, is the exception to the "rule:" for non-downloadable products, most supply chains should make a clear choice on the positioning of the e-channel. We illustrate this with four examples: two of which are supply chains catering the consumer (business-to-consumer, or B2C), while the other two are business-to-business (B2B) supply chains.

B2C in the Computer Industry: Dell Computer on-line

The success story of how Michael Dell started selling computers directly to the consumer in 1984 has become a classic introduction to the *direct business model*, as it is called. Recently, the Internet has become a logical extension of Dell's direct model. This becomes apparent by analyzing the scorecard of e-business in Dell's supply chain, as summarized in Figure 4.

On the revenue side, the e-business channel continues Dell's direct sales model with increased margins compared to a traditional computer manufacturer with resellers. The ability to change prices and delivery

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<ul style="list-style-type: none"> • Direct sales <ul style="list-style-type: none"> \$\$ Increased margin from eliminating intermediaries • Product information: <ul style="list-style-type: none"> \$\$ Flexibility on price and promotions \$\$ Wider product portfolio offering \$\$ Faster time to market • Negotiating prices and contract terms: <ul style="list-style-type: none"> \$ Price and service customization -\$ Downward price pressure due to increase competition • Order placement and tracking: <ul style="list-style-type: none"> \$\$ Access at anytime from any place • Fulfillment: <ul style="list-style-type: none"> 0 Increased availability by aggregating information -\$ Shorter response time 0 Increased choice of delivery options • Payment: <ul style="list-style-type: none"> \$ Efficient funds transfer may improve cash flow 	<ul style="list-style-type: none"> • Facility costs: <ul style="list-style-type: none"> \$\$ Site costs: eliminate intermediaries or retail and distribution warehouses \$\$ Processing costs: customer participation, smoothed capacity requirements • Inventory costs: <ul style="list-style-type: none"> \$ Reduce cycle stock (geographic centralization) \$\$ Reduce safety stock (statistical aggregation) \$\$ Postponing product differentiation to after order placement • Transportation costs: <ul style="list-style-type: none"> 0 Inbound -\$ Outbound • Information sharing improves supply chain coordination: <ul style="list-style-type: none"> \$ Reduce bullwhip effect \$ Shared planning and forecasting

Scale: -\$\$, -\$, 0, \$, \$\$ is from very negative impact, marginal to very positive.

Figure 4: The scorecard for e-business in Dell's supply chain.

times on the fly has been used effectively by Dell to manage demand based on component availability. Related, the faster time to market for new product introductions is a considerable benefit when product life cycles are measured in months. Having direct customer contact allows Dell to provide customization and large selection on their customer-specific Premier web pages. It may allow customer-dependent service, such as pre-installed software images and priority routing, with accompanied customer-negotiated pricing. Moreover, through continuously updated "recommended configurations," Dell can steer customers towards products that are in ample supply. Similarly, by sharing dynamic inventory information with suppliers, Dell can work both on the input and output ends of the supply chain to match demand with supply. Customers have the convenience of ordering anytime and anywhere, while Dell may track all corporate-wide purchases. As such, it becomes a virtual IT department in addition to just being a corporation's PC vendor. Finally, by tracking and managing cash flow very tightly, a negative cash-conversion cycle of a few weeks is gained: Dell gets paid before it pays its supplier, exploiting direct payment with postponed delivery. Increased response time is perhaps the only negative revenue potential that Dell has compared to traditional brick-and-mortar retailers.

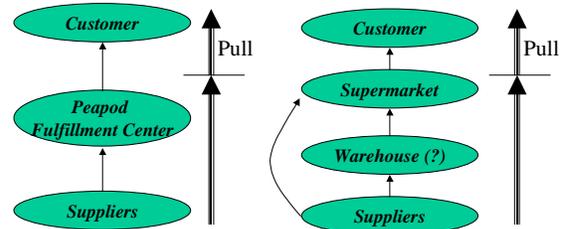
On the cost side, the direct model eliminates intermediaries. In addition, long-term relationship with high-reliability suppliers such as Sony allow Dell to ship monitors directly from the supplier to the customer, eliminating costly warehousing costs and the delays in additional inventories. Not only are warehousing decreased, ordering personnel costs are transferred onto the customer!

The greatest inventory benefits accrue from a fast, well-coordinated supply chain that enables the separation of procurement cycle from customer order and manufacturing cycle. While procurement is initiated in *anticipation* of demand, manufacturing and fulfillment is only started when an order arrives. This is possible by adopting common platforms and components for various products. While finished goods inventory is eliminated

(or already paid for), the input inventory is greatly reduced by exploiting economies of scale and statistical aggregation over the common components.

Similarly, high volumes of a relatively limited set of common inputs may reduce inbound transportation costs, or even eliminate them if the supplier is co-located. Perhaps the only negative cost impact of the e-channel is the increased outbound transportation costs to customers. Those, however, are relatively small when focusing on higher-end computers and on high-volume corporate accounts.

Thus, the opportunities of the e-business are significant in the computer industry. To exploit them well, the supply chain must move product customization to the pull phase and hold inventories as common components during the push phase. The opportunities are most significant for new, hard to forecast products, where aggregation offers the greatest benefit in terms of inventory reduction. Nevertheless, self-reliant ordering assumes a somewhat experienced customer who requires less handholding. As such, the e-channel may complement the strength of existing retail channels with focus on service and educating consumers to choose low cost computers.



Peapod Supply Chain Supermarket Supply Chain

Figure 5: Peapod and a typical supermarket supply chain

B2C in the Grocery Industry: Peapod.com

Peapod.com is one of the oldest online grocers. The company started in Chicago in a collaborative arrangement with the supermarket chain Jewel where

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Scale: -\$\$, -\$, 0, \$, \$\$: from very negative impact (-\$\$), over marginal (0), to very positive (+\$\$).

Figure 6: The scorecard for on-line grocer Peapod.com.

Peapod’s pickers would fill an order before delivering it. Peapod has now moved to supplying orders from centralized fulfillment centers in areas that the company serves. Each fulfillment center is much larger than a supermarket and is comparable to a warehouse. The Peapod and supermarket supply chains are comparable except that some supermarket products are supplied directly from suppliers (Fig. 5).

On-line grocers allow order placement anytime and from anywhere. They can attract customers who do not like to go to a supermarket (who does?). They have flexibility on pricing and promotions. They could provide a large variety of goods, including specialty items, such as ethnic foods, although Peapod does not offer significantly more variety than a typical supermarket. In addition, they can bundle menus and recommended ingredients with specialty items, based on tracked online shopping behavior and histories. Unlike a supermarket store, which has no knowledge of what has been purchased until a customer checks out or of the substitution patterns for goods that were stocked out, Peapod can guide online shopping behavior with real-time suggestions. Peapod can use its data for targeted interactive advertising and discounts. This revenue boost is significant to the extent that most e-grocers at this stage have lost money in the actual sale of groceries but made money on the sale of consumer choice data to suppliers. On the cost side, the virtual store reduces facility costs by eliminating retail sites and checkout clerks. Inventories are reduced due to centralization; although savings would accrue primarily to slow moving, specialty items.

E-grocers also have several disadvantages compared to their brick-and-mortar counterparts: increased response times and additional outbound transportation costs to cover the last mile to the customer. We argue that e-grocers have a negligible opportunity to compete on cost, except perhaps for specialized low-volume, dry items. The e-grocer incurs *additional* activities in picking, packing and handling that are not incurred by a traditional supermarket where customers do pick and pack; and handling is done in high volume (pallet based). The inventory savings due to

centralization are marginal because supermarkets already achieve sufficient forecast accuracy thanks to their large size. (If, however, online grocers focused primarily on specialty items, as EthnicGrocer.com, inventory benefits from aggregation would be larger.) Online grocers incur significantly higher transportation costs than a supermarket because of home delivery. Indeed, groceries have a low value to weight or volume ratio. They require a specialized delivery fleet whose cost will necessarily be rather high as a fraction of the value. This precludes centralization on a large national or even regional scale; indeed, most e-grocers have warehouses in each metropolitan area that they serve. In addition, depositing the groceries at the customer is much less flexible than putting a book in the mailbox: with fresh goods, consumers need to be home to take delivery, which creates significant peak demands early morning and after 5pm. Finally, while delivery density in cities may be sufficiently high, achieving an acceptable number of delivery stops per hour in a spread-out suburban area will be difficult. (Many e-grocers strive for gaining market share to improve delivery density and may extend into general home delivery of other goods. Yet it is questionable that even such strategy can ever compete with parcel companies like UPS or FedEx, who not only deliver, but also pick up; resulting in double efficiencies.)

This scorecard analysis, summarized in Figure 6, suggests that e-grocers have negligible opportunity to compete on cost in general grocery items, especially fresh food. Indeed, all key conditions listed earlier to exploit cost benefits are violated. Competition, therefore, must be on convenience or some other form of value added. For example, opportunities do exist for specialty or ethnic segments. Also, convenience can be added by automating the repeat purchasing activities that most households go through each week. Once a weekly basket is set up on the web, repetitive ordering is greatly sped up. In addition, the supply chain may exploit recurrent patterns by smoothing and leveling the load provided a solution is found for the delivery so that customer presence is not needed. (Competitor Streamline.com allows unattended delivery by installing fridge and

storage boxes with keypad access system at their customers.)

The greatest opportunity of an e-channel, however, may be for incumbent supermarket chains, which already own the regional distribution centers. They can set up the additional e-channel as a focused "plant-within-a-plant" to expand the value offering. In addition to picking themselves, customers could choose to have supermarket personnel pick the order from the shelf but the customer provides outbound transport, or, the supermarket could provide home delivery at the highest price. Among supermarket chains, Albertson's has taken the lead at combining e-business with traditional supermarkets. Part of the store is a fulfillment center for online orders, while the other part is a supermarket. This allows the firm economies of scale on inbound transport while keeping delivery distances to customers short on outbound. Our analysis would suggest that such dual-pronged approach is the most effective positioning of e-business in mass-market groceries where pure online grocers are likely to be less effective.

B2B in the Parts Supply Industry: W.W. Grainger

W.W. Grainger is a business-to-business distributor of maintenance, repairs and operating (MRO) supplies, ranging from consumables like machine lubricants to hardware items like nuts and bolts for repairs. Grainger is famous for their 4-inch thick catalogs with thousands of parts that customers could order over the phone or buy at one of the 380 branches in the U.S., which are similar to a large retail store. In 1995, it set up Grainger.com, allowing customers to place orders on its website that offers over 200,000 products.

Going on-line provides considerable revenue opportunities: 24-hour access for order placement with a very large selection available through easy electronic search. Product information is updated easily, allowing price and promotion flexibility. New products can be added to the "virtual catalog" immediately, drastically improving time to market. Allowing industrial customers to place order anytime is a considerable convenience for night shifts, who no longer have to notify day purchasing to place orders, but now can do it immediately, drastically reducing their response time. Not only can delivery times be estimated for each order using up-to-date inventory status, the customer also can be alerted automatically (through email) regarding order status. A downside of on-line ordering is increased ease of comparison shopping, which is expected to drive down prices and margins. Yet Grainger realized that it is better to cannibalize its own brick and mortar channel than to let others do it.

Considerable cost opportunities exist compared to the phone or mail order channel: order taking costs reduce as the customer participates. More importantly, errors are greatly reduced as duplication of data entry is eliminated. Catalog-printing costs reduce significantly. Inventory and transportation costs are marginally impacted, as the fulfillment system remains largely unchanged. By integrating the suppliers, synchronization

over the entire supply chain can be improved as customer orders automatically trigger supply orders when inventories need replenishment. Inventory and facility costs at Grainger will not change significantly by going online unless it decides to close some of its branches.

Online sales by Grainger also offer a significant cost reduction opportunity for buyers. Ordering costs drop significantly and buyers can allow end users to order directly, improving response time and decreasing errors.

The sale of MRO supplies is an example where the Internet is ideally suited to eliminating the weaknesses of the current system. The basic supply chain remains unchanged but going online allows both buyers and sellers to decrease the transaction cost of placing and fulfilling orders and increase the product portfolio. The use of the Internet to replace existing channels of order placement is likely to grow at a significant pace in the B2B arena.

B2B Auctions in Procurement: Internet Exchanges

Internet exchanges create electronic markets and communities where firms can obtain information and buy and sell products. Not only do they act as on-line auctioneer, they may also inspect and 'approve' (certify) bidders or suppliers along various non-price factors.

At first glance, the greatest benefit of an Internet exchange is to buyers who have the ability to search across multiple suppliers when looking to procure an item. By substantially lowering barriers to entry in the bidding process, Internet auctions drive down supply prices. Lower prices are the cost of wider demand markets to suppliers. This seems to imply that all buyers of commodity products may benefit from purchasing at auction exchanges. There are, however, considerable downsides to this approach if it is implemented indiscriminately. Purchase of all products using auctions may lower the purchase price but will tend to increase the total cost of purchase for a firm. The ability to lower supply chain costs requires long-term relationships within the supply chain. Indeed, the movement towards lean operations, as exemplified by Dell, heavily depends on a few suppliers who become "long term partners." In the auto industry, the last two decades of the twentieth century focused on improving supply chain relationships so that suppliers and auto manufacturers could work closely to improve the way products were designed, manufactured, and delivered. Chrysler significantly improved its performance by getting suppliers involved in the design phase of a new product. This level of supplier involvement is only possible given a long-term relationship between suppliers and manufacturers.

Thus, core products that a buyer requires in significant and steady quantities should not be handled through a bid or auction process hosted by an intermediary. Direct e-business between the buyer and seller should be used in this setting to reduce transaction costs of order placement and fulfillment and improved information exchange during order fulfillment as well as product design. A good example of this approach is Dell and its use of e-business when dealing with its suppliers.

Dell does not use the Internet to create a marketplace where suppliers compete against each other for orders from Dell. Dell uses the Internet to exchange demand and inventory information with its suppliers. This allows suppliers to set appropriate production levels and help the Dell supply chain to better match supply and demand.

When it comes to utilizing excess or surplus capacity (i.e., any capacity left after utilizing base capacity), the story is very different and on-line auctioning may provide significant opportunities. Exchanges provide the ability to aggregate and display all available surplus capacity across an entire industry. As such, a market is created to better match *surplus* capacity with unmet demand. For example, a manufacturer in need of unforeseen additional transportation may place an emergency shipment out to bid if their regular trucking company has no trucks available. By matching uncertain components in demand to aggregated surplus capacity (supply), online auction markets may improve the overall match of demand with supply obtained from long-term contracting. Our analysis would suggest a two-pronged purchasing strategy: for stable, recurrent demands the Internet focus should be on reducing transaction costs and improving supply chain performance, while online auctions may be used to satisfy uncertain demand where the value of aggregation is the greatest.

Incentive problems and credibility suggest that the auction market is best provided through an intermediary. The key issue may be to account for the *total* cost in the auction, including product, transportation, and other relevant costs. For example, if a seller is offering a stamping press currently in Northern Italy, an offer from that region is more attractive than an identical offer from Belgium if the seller incurs the transportation cost. While incorporating such non-price factors may be automated for more commodity products, it is much harder for customized products.

Conclusions and Guidelines

The scorecard provides a tool to analyze the impact of the e-channel on a supply chain and how it is best positioned. It also indicates detailed areas for potential concern, which must be considered when setting up an e-business.

From a supply chain operations perspective, the analysis suggests some guidelines that may help the e-business in practice:

- Think about integrating the Internet with the existing supply chain network, rather than setting up a separate e-business. Integration will leverage and improve current processes, while separate channels may add inefficiencies to the supply chain.
 - Structure e-business logistics to accommodate packages instead of pallets. The goal should be to mitigate the loss of economies of scale due to increased volume in smaller sizes. This suggests new logistics opportunities such as order consolidation (merge in transit, mega distributors) and order pick-up sites.
- Devise shipping pricing strategies that reflect the costs of activities. Disregarding or underestimating transportation costs has contributed to the losses incurred by e-grocers to date.
 - Design the supply chain to efficiently handle returns. Because the Internet cannot match the traditional customer experience of touching, feeling, testing and even smelling the product before buying it, returns in an e-business will always exceed those of traditional store.
 - Keep customers informed throughout the fulfillment and returns cycle.

M. E. Porter, "What is Strategy?" *Harvard Business Review*, Nov-Dec 1996.