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E-Commerce Effects on Consumer and Supplier Relationships

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It is April 27, 2010, and Kate has decided she wants to buy a new car. Her WebPad brings up many sites, and she narrows her choice to two: Ford.com and Buildyourowncar.com.

On Ford.com, she settles back with a cup of coffee as a list of options is presented to her. (She has given the Ford site permission to look at data generated from her previous web surfing and purchases, so it knows that she is a 28-year old who likes windsurfing and who often takes her 4-year old nephew on outings. The information includes full body measurements for both of them.) The site starts with available models, listed in order of potential appeal. Her list starts with the Ford Focus, an inexpensive compact, and ends with the Ford Behemoth, a 22-foot vehicle that can transport an entire soccer team. She clicks on the Focus, and looks at a range of options. Prominently displayed is a roof rack specially configured for windsurfing boards; with a smile, she selects it without hesitation. A little further down is the "Lego car-seat", which includes a desktop and several receptacles filled with Lego blocks. "Wow! Perfect for my nephew!" she says as she clicks on the item. Next, based on Kate's height (5' 3"), the Ford choiceboard suggests extra-high seats; Kate agrees.

She remembers that her father, a traveling salesperson, has a navigation system in his car, so just for fun, she looks to see what's available. Based on the driving records from her past vehicle, the Ford site recommends the basic navigational package, which costs only $400. (Most of her driving is local and her longer trips are generally to a small set of outdoor recreational locations.) The next recommendation is for a service provided by a Ford alliance partner that allows two-way interaction with local businesses in the areas where she travels most (restaurants and movie theatres, gas stations and dry cleaners) through a voice-activated interface embedded in the instrument panel. Kate has been skeptical of these in the past, but with a monthly fee of only $7.95, she decides it is worth a try. She also notes that the Focus is equipped with the new Win-Shield interface, which will let her plug in various IT devices (e.g her e-book, so she could listen to the next few chapters in the thrillers she loves to read, or her Palm LXVI, to organize her To Do list and send some dictated e-mails.) She's offered a chance to visit the Win-Shield store of accessories, but passes -- she's already got plenty of gadgets, but it's good to know she can now use

1. Thanks to Morris Cohen, David Ellison, Charlie Fine, David Levine, Jim Rebitzer, and Anita McGahan for helpful discussions. We are also grateful to the many people in the industry that we have interviewed, most of whom have asked that their firms not be identified.

them all during her commute, and that she can upgrade the Focus's memory and disk storage capacity at will.

She makes a few more choices, and clicks to get the final price on her custom-configured car, which she could have delivered to her driveway in three days. Up comes a list of dealers in her area who could offer a test drive, so she schedules an appointment for tomorrow. The Ford salesperson will come to her home with a car similar to the one she has picked out; she requests one in Denim Blue and gets the warning that not all colors may be available at the time of her appointment. The test drive will cost her $35, but she decides it is worth it. From the last time she bought a Ford, she knows the salespeople are pretty low-key and helpful. Her dad has told her that dealers now make their money selling assorted transportation services. She vaguely remembers going with her dad to the dealer for repairs when she was a kid, but that's hard to imagine now, when all her servicing is handled by the local LetUsWorry repair shop. She decides to ask the Ford salesperson about their CustomLease program; she wants to reserve a minivan for the two weeks her parents will be visiting in June and a off-road SUV for her vacation with three college roommates planned for August.

Before clicking on the "Finance Your Purchase" button, Kate saves her Ford Focus configuration and looks at a brand new site, Buildyourowncar.com. This site lets her pick components from any manufacturer; the parts are then assembled in a plant that assembles cars on contract from Buildyourowncar and other similar firms. Kate is very intrigued by this, because while she likes the styling of the Ford Focus, she has always admired the reliability of Honda engines. She also really wanted a Bose sound system, but this wasn't available at the Ford site. However, Kate has a couple of concerns. Buildyourowncar.com assures her that all of these parts will fit together just fine, due to the standard interfaces agreed upon in 2008 by all manufacturers and suppliers—but Kate isn't sure. Consumer Reports, among others, reports quality problems with these "mix and match" vehicles, including ambiguity about who covers warranty costs.

Also, Buildyourowncar doesn't have any physical dealerships, so there is no way to do a test drive. However, the site does generate a video of Kate in the car she has designed for herself. She sees that it is easy for her to reach all of the controls, and that based on what the site estimates as her upper-body strength (all that windsurfing), she wouldn't need the power-assisted controls now offered for the benefit of aging Baby Boom drivers. Just for fun, she tries out the driving simulation game that the site offers, and plugs in a new BMW engine to get a feel for its cornering abilities when put into the Focus body. She clicks quickly through the bright yellow announcement that the BMW engine is only available in BMW products at present; if she was really looking for a high-performance sports car, she'd never consider buying it through buildyourowncar.

Kate is a little tired from having spent a couple of hours looking for cars, so she takes a break to think about her options. She doesn't really believe her parents when they say that they used to spend days or weeks looking for new cars, and still not end up with one they really *wanted.*

How likely is the above scenario? What would need to be done, when, by whom? Who would gain and who would lose?

In this paper we provide a preliminary exploration of these issues. We argue that the Internet-mediated scenario described above will come about only if several other major changes in the auto industry occur as well. That is, in order to be able to buy a car the way that we buy a computer today (on-line, with the consumer specifying components, software, and services provided by different firms), cars will have to be "built to order" as personal computers are today. To make this possible would require large changes in product development (a more modular product architecture, with more standardized or common parts across models); in the supply chain (a larger supplier role in designing, building, delivering, and possibly even installing modular parts); and at dealers (who would serve as a conduit of information between consumers, designers and assembly plants and would derive revenues primarily from the provision of services rather than from vehicle sales).

This is a daunting prospect, given the infinitely greater complexity of automotive product designs, production processes, and supply chains, the lack of evidence that consumers are willing to pay a premium for customization, and the much slower rate of technical obsolescence (the reason that it is so costly to hold inventory in computers).

Nevertheless, "build-to-order" is the energizing vision of where the Internet takes the auto industry. "Build-to-order is the key," according to J.T. Battenberg, CEO of Delphi Automotive, the world's biggest supplier, "That's the game-changer in the industry," (Taylor, April 17, 2000, p. 174). "Build-to-order" is where the incumbent automakers potentially gain a competitive edge over a variety of dot-com challengers by tying their Internet-facilitated relationships with consumers together with their Internet-facilitated relationships with suppliers into one integrated, "end-to-end" package. A fully realized "build-to-order" system would transform industry structure most dramatically from the status quo, raising the prospect of automakers who focus only on design and marketing, suppliers who control key elements in the dominant design, contract assemblers who build vehicles for multiple automakers, and new kinds of intermediaries for retailing and distribution. We will sketch the "build-to-order" scenario at the start of this paper, not because we believe it is imminent (the most optimistic observers place the implementation of a full end-to-end build-to-order system 10-15 years away), but because it provides a useful framework for evaluating the significance of a host of other trends.

The Internet will still have a very large impact on the auto industry even if the "build-to-order" vision is not realized. At a conceptual level, the Internet is a powerful tool for promoting fast, asynchronous communication among large groups of people, without a need to invest in a specific asset (such as specialized software). The Internet is often seen as having two types of impacts on commerce: 1) aggregation of buyers and suppliers; and 2) facilitation of information exchange (The Economist, March 2000) .

Since the automotive market is already so large, the aggregation benefits of the Internet are relatively small in this industry. (In contrast, aggregation benefits have already proven to be substantial for specialized markets, such as used books or industrial equipment.) On the other hand, the information-exchange aspects of the web have huge potential in this industry. The reason is the vast amount of coordination necessary to manage the design, production, and assembly of thousands of parts into each of millions of vehicles every year.

Auto dealers are already coping with the consequences of Internet-informed consumers and a host of dot.com intermediaries that are challenging the traditional retailing model. Supplier relationships may be even more dramatically transformed by the recently-announced industry consortium backing a gigantic e-procurement website known as Covisint.

Just how large the impact of these developments will be depends on how Internet-fueled reduction in information costs interacts with current business processes. In the second section of this paper, we will lay out the “not build-to-order” scenario to evaluate the consequences for the industry of this less fundamental set of changes.

In this scenario, we see inventory savings of about $500 per car, due to the Internet’s ability to transfer information quickly and cheaply throughout the supply chain. Most of this savings would ultimately accrue to automakers and consumers. E-commerce can promote both market-like dealings with suppliers (through its auction capabilities), and collaborative relationships (by facilitating the transfer of proprietary information); automakers are thus likely to use e-commerce to reinforce whatever supplier relations strategy they have used in the past. A variety of models are also likely to coexist on the dealer side, as we describe below.

Whether taking the long-term or short-term view, the impact of e-commerce on industry structure and competitive dynamics will depend how Internet-related capabilities affect overall firm capabilities. Will the Internet offer a step function improvement in efficiency and effectiveness of core processes for all players (or at least those that stay in the game)? Or will it provide differential advantage to particular firms (and particular nations) based on how it is combined with existing and emergent capabilities? In particular, will the firms with the greatest mastery of lean production systems will be affected by and/or take advantage of Internet-related developments in different ways than firms still heavily influenced by mass production? We focus on these questions in the third section of the paper. A concluding discussion summarizes our views on what scenario, lying between the two extremes presented here, is most likely for the auto industry over the next 10 years.

I. Scenario 1: Automotive Build-to-Order

We start with a brief description of Dell's highly successful business model, which has been the object of much scrutiny by the auto industry. We then explore the changes necessary to adapt this model to the auto industry by working through the value chain, from the final customer back through retail/distribution, product design, manufacturing, and procurement.

The Dell Direct model. Dell has demonstrated the power of a "build-to-order"system enabled by the Internet in the personal computer industry. The highly successful Dell Direct model is based on a reconfiguration of the supply chain, a tight integration of B2B and B2C capabilities, and new approaches to dealing with customers. Consumers choose a custom configuration at Dell's website, arrange purchase and payment details online (often with phone support from a real person who tries to sell related products and services), and then can track the progress of their order through every phase of production, right up until delivery. Orders go directly from the website into Dell's production schedule, parts are ordered from suppliers only after the order (and payment) is received, parts are kitted immediately before production and built up in cells, and the final product is tested and loaded with software before shipment. Accessories such as a printer or scanner are warehoused by their manufacturer and the logistics provider insures their arrival at the customer's site on the same day as the main product.

Consumers as Designers: What Do They Want? It is easy to see the appeal of this model to automotive consumers, who would be able to order the precise vehicle they want, produced on demand in real time. This would stand in stark contrast with the current system, where hypothetically consumers can order a custom vehicle from a long list of options, albeit with a hefty delay. In reality, all the incentives for manufacturer and dealer alike are to persuade consumers to buy a vehicle that is already built, even if it doesn't match their preferences exactly, as we discuss below. Thus a true build-to-order system would deliver not only speed but real fulfillment of consumer demand, as illustrated in our opening vignette.

On-line configuration could also speed the incorporation of innovative features and advanced technologies into new products, with automakers able to capture vast amounts of data on consumer preferences that could be fed directly into product development. These data could also trigger offerings of services customized to the needs of that individual. In effect, the customer becomes a co-designer of not only his/her current vehicles but of bundled services and future product offerings as well.

Consumer demand for "build to order" may well be differentiated along several dimensions. Some customers may be willing to wait to receive a custom-configured vehicle, while others may want immediate delivery, albeit with less elaborate customization. Similarly, some customers may be willing to pay a price premium while others may not. Tradeoffs between time-to-delivery and price may well be part of the choice set offered to consumers.

The volatility associated with a system that "pulls" production based on custom orders from consumers, if left unfiltered, would present overwhelming complexity to upstream operations. But in fact, a successful "build to order" system will be designed to shape consumer demand by controlling what choices are offered. Rather than large numbers of individual features, consumers are likely to be presented with configurations of features to choose.

Configuration choices may be tied to time/price considerations as well. More frequently-ordered configurations might be available cheaper and faster than more fully customized products; similarly, a high degree of customization might only be available for high-end vehicles. The intriguing dilemma that may face automakers here is that the demand for personalization of vehicles over the next decade is expected to be highest among young, Generation Y consumers whose initial purchases will be entry-level vehicles. Thus the logic of reserving customization for high-margin vehicles may be challenged under "build-to-order" by the direct exposure to consumer demand.

Ultimately, the challenge for automakers will be figuring out how to limit configuration choices -- necessary to reduce complexity -- while giving consumers the ability to choose what is really important to them (or at least the feeling of choosing among features that ultimately makes "build-to-order" so appealing).

Automotive Retailing: Replaced or Repurposed? With an early proliferation of B2C automotive buying services on the Web, many observers argued that disintermediation would be the most likely fate for automotive retailing. Yet it appears that physical dealerships linked to automakers will continue to exist, especially if build-to-order comes to pass. First, seeing, touching, and driving the product are still crucial to the purchase decision for most consumers. Second, as margins on vehicle purchase are driven down, the automakers have powerful incentives to form successful service relationships with consumers in order to capture a larger percentage of lifetime ownership expenditures. Dealers may still prove to be the best partners for these relationships.

Nevertheless, build-to-order would clearly enable a "repurposing" of the OEM retail channel. Imagine a "Gateway Country" equivalent in which consumers can examine samples from the full product range, take a test drive, and talk with a product expert for help determining their preferred set of features. The actual order occurs at a computer terminal, either at the dealership or at home, where all configuration choices are offered, services are bundled, and prices are determined. The dealership becomes the place to initiate or reinforce the customer relationship, not the focal point of the purchase transaction. We expect that dealers of this kind will still seek a large role in vehicle repair and maintenance, but they will face competition from specialized firms with no attachment to particular OEMs or brands. With such a major shift in the sources of dealer revenue, OEMs would need to find innovative ways of compensating these new-era retailers.

Could new intermediaries take the place of OEM-linked dealerships? While possible, the logic of "build-to-order" makes it less likely. It is the very ability to link a customer's order with a production process that yields a customized productthat provides the competitive advantage of this business model. Thus we believe that build-to-order strengthens the survival prospects of OEM-linked dealerships, while at the same time requiring dramatic changes in their role and in the nature of their contact with customers. If incumbent dealers can't make this transition quickly enough, OEMs may encourage new entrant dealers to assume this critical position in the "build-to-order" system. [1]

Modular Product Design as Enabler of "Built-to-Order". "Dell Direct" depends heavily on the modular product architecture of a personal computer, which is made up of a small number of separately-produced, physically independent "modules" joined along a common interface. Customized products can be easily built by mixing-and-matching of modules. Modules are increasingly standardized across the industry, creating the opportunity for huge cost savings through volume production and supplier competition. Best-in-class module suppliers can innovate without high coordination costs, through independent upgrades of functionality.

There is tremendous OEM interest in modular design and production as a way to cut costs and manage complexity (Murray and Sako, 1999; Sako and Warburton, 1999; authors' interviews). But there is ample ambivalence as well. To explain why requires a brief description of the dominant design of an automobile, and how that affects the applicability of modular design rules.

We use the following definitions, following Ulrich (1995):

Component: Basic building block of systems or modules

System: Totality of components, interfaces, and software providing one of the key vehicle functions. The elements in a system are typically distributed physically across the vehicle.

Module: A physically proximate "chunk" of components, typically from multiple systems, which can be

1. As we discuss in Scenario 2, most of these changes would require reform of automotive franchising laws.

assembled into the vehicle as one unit.

Product Architecture: The scheme by which functional elements are arranged into physical chunks and by which the chunks interact. Can range from modular to integral, also from open to closed.

The current dominant product architecture for automobiles is still substantially integral rather than modular, and closed rather than open. That is, most components are not standardized across products or companies, and have no common interface, hence they are highly interdependent with other components and idiosyncratic to a particular model. The specifications for components are typically treated as proprietary and model-specific, shared only between an OEM and a supplier, rather than being widely known and accessible to a wide range of suppliers. Components from different companies or even different models within the same company can't be easily combined, so customization requires idiosyncratic modifications.

The design integrity of a vehicle, and certain systemic characteristics such as NVH (noice, vibration, and harshness) are felt by many designers to require such an integral product architecture. In this view, having standard modules designed to be usable in a wide array of products would compromise design quality and/or result in overspecification, with modules having to be designed to meet the highest requirements of the product range.

This product architecture is partly the result of the history of the industry, in which designing for modularity was not a priority. But some integrality seems inherent to the functioning of a car. For example, in designing a safety system, seat belts and airbags need to be in the interior, where the passengers are. But sensors need to be near the outside of the car, where the obstacles are. In contrast, it is relatively easy for computer makers to unite system functions and geography, e.g., to put all functions related to typing in the single physical unit of the keyboard.

Thus, using the safety example above, it is possible to imagine different approaches to the division of labor in relation to systems vs. modules. There could be one ‘safety system’ supplier that could optimize the design of all the far-flung components, with the production and installation of those components distributed according to their physical placement in the vehicle. Conversely, there could be a ‘front end’ module supplier in charge of designing and building all the parts in that area of the car, including the bumper, headlights, and various sensors related to the safety system. The “system” strategy has the advantage of making the safety system work smoothly, but requires the careful integration of idiosyncratic parts by the automaker during final assembly. The “modular” strategy could potentially compromise functionality, but allows the car to be divided into large ‘chunks’ that can be designed and assembled independently and then easily combined in response to customized consumer demand. Either strategy could erode the distinctive “look and feel” of individual brands.

Besides inherent concerns about possible design compromises, there are questions about the cost impact of modularity. In favor of modules is the prospects of design efficiencies from the combination of parts and functions that might lead to cost savings. For example, Visteon has a instrument panel design in which the cross-car beam (the principal structural support) provides heat sinks and brackets for electronic parts (Georgievksi, 1999). Other cost savings could come with the high volumes associated with modules that were sufficiently standardized to be usable across a wide array of vehicles. Automakers have also anticipated cost savings through the outsourcing of modules to suppliers. If suppliers took over module design, automakers could reduce their own engineering staffs. Furthermore, suppliers, often non-union, have labor rates are one-half of those at unionized, vertically-integrated parts plants.

However, there is reason to question whether these cost savings are real or simply represent a shift of costs from OEMs to suppliers or workers. Savings from the redesign of components into integrated modules have been slow, partly because many suppliers are just developing their design capabilities, and partly because OEMs, reluctant to allow suppliers much independence in modular supply, continue extensive “shadow engineering”. This is turn prevents the realization of expected savings in engineering staff. Similarly, expected savings in direct labor costs can be minimal since labor costs are usually less than 15% of a supplier’s total costs, and suppliers relying on cheap labor aren’t always able to meet the productivity, quality, and delivery demands of OEMs. As suppliers take on investment responsibilities, their cost of capital is typically higher than that for OEMs, and they simply pass these costs back in their per unit price. Finally, logistics costs associated with transporting fragile and odd-shaped modules can be high, thus offsetting savings from the outsourcing of production.

Thus doubts about the benefits of modularization are still sufficiently large to prevent any automaker from making a major commitment towards a substantially more modular design based on cost considerations alone. Therefore, the fate of modularity and “build-to-order” appear to be powerfully intertwined: the lack of clearly identifiable cost savings means we probably won’t see modularity unless consumers want the ability to mix-and-match that build-to-order provides. And, we won’t see build-to-order without the variety management capability that modularity provides.

Manufacturing Under “Build-to-Order”. On the production side, OEMs face both costs and benefits from “build-to-order”. Given the current characteristics of the typical car’s design (4,000-5,000 parts; 300-500 suppliers; a proliferation of options), the complexity resulting from customized orders could quickly become unmanageable. Most automakers have been seeking to reduce their build configurations and, at first impression, “build-to-order” would seem completely at odds with this goal.

However, there are potential production advantages from the combination of modular design and “build-to-order”. First, if features are bundled into carefully-chosen configurations and the choices offered to consumers are limited, the total number of build combinations could be less than the status quo, which resulted from the ad hoc addition of more and more options over time. Modules that are designed to be further decomposable into modular elements can allow these configurations to be realized through “mix and match” customization.

Second, modular production, in which suppliers build up modules and deliver them in sequence to the OEM, can make the final assembly process much shorter and simpler. The process sequence can potentially be organized so that customization steps are postponed until as late in production as possible, thus allowing for mass production economies at earlier stages.

Third, building customized products will reduce finished goods inventories dramatically. Not all inventories will drop; this strategy may necessitate that suppliers hold higher levels of parts and work-in-process inventory. However, OEM access to data on consumer preferences, expressed during order configuration, can potentially improve demand forecasting accuracy, thus mitigating the need for inventory buffers.

Running a true “build-to-order” production system also differs greatly from either mass production or lean production. Lean production operates with very low levels of inventory and with quick setups, so it can handle for rapid product changeover, as long as these changeovers are predictable. Predictability is necessary because lean production also emphasizes the extreme leveling of production, or *heijunka,* to avoid the waste of idle capacity or of overproduction. A production system based on 100% build-to-order might have too much volatility to allow for this degree of production leveling. Thus lean production could accommodate “build-to-order” only with production scheduling that combines “pull”- and “push”-derived demand. The customer front-end would need to support such a scheduling system by helping to steer customers towards those combinations that can be most readily built, given production and parts supply constraints at any given point in time.

E-procurement under "Build-to-Order". Electronic, Internet-mediated procurement will provide the underpinning for "build-to-order" by facilitating the rapid and low-cost dissemination of order information, production scheduling, engineering changes, and other crucial information. While a variety of alternate methods of communication between OEMs and suppliers, such as proprietary electronic data interchange (EDI), now exist to accomplish this task, the Internet offers the low cost, high speed, and universal connectivity necessary to make build-to-order economically feasible. Indeed, it is impossible to imagine an integrated build-to-order system, in which production (and hence procurement) is only initiated after an actual customer order is received, without an infrastructure that can distribute large amounts of information simultaneously and at low cost to all upstream links in the value chain.

Beyond this, however, the path taken by e-procurement under "build-to-order" will be a function of what mode of supplier relations is dominant. This in turn will depend on developments in product architecture, as described above. To explain these contingencies, we need to summarize, briefly, two different modes of supplier relations: "exit" and "voice" (Helper and Sako, 1995).

In the 'exit' model, automakers solve problems with suppliers (regarding price, quality, etc.) by replacing them with another supplier. In the 'voice' model, an automaker works with the original supplier to resolve problems. Since the 1930's, the US auto industry has generally been characterized by 'exit' relationships. The Japanese industry has been characterized more by 'voice.'

The advantage of the voice model has been a rich flow of information that can lead to improvements such as the elimination of unnecessary or expensive process steps; the disadvantage has been that the trust required for such information exchange makes it difficult to switch suppliers. Conversely, the advantage of 'exit' for the automaker is that it is not locked in to any supplier.

Maintaining a credible threat of exit has led US automakers to vertically integrate complicated parts of the value chain so as to minimize barriers to entry into supplier industries. Thus, between the 1930s and the 1980s, most suppliers tended to make relatively simple parts that were designed by automakers; these parts were built into subassemblies in the assembly plant. This was consistent with the highly integral (non-modular) dominant design, and also helped maintain OEM power over suppliers. Because of these low barriers to entry, suppliers in 'exit' mode tend to have less bargaining power than do those in 'voice' relationships.

Under pressure from Japanese competition, the US industry has moved toward voice in the last 15 years. (This trend is more evident at Chrysler and much less evident at GM.) A key source of superior Japanese quality was held to be the proximity of design to production, so that defects could be ironed out quickly. This view has led many suppliers to invest heavily in design capabilities in order to take over design tasks from OEMs.

In this sense, the move towards "voice" in the U.S. helped pave the way for the current interest in modularization. Suppliers have hoped to persuade automakers of the benefits of sourcing full modules (such as complete interiors) from one firm. The central argument has been one of "core competence" -- design and production would be integrated on a large scale, by firms that specialized in technologies that the automakers weren't as familiar with. Wall Street looked favorably upon this strategy, and a great wave of consolidation occurred among auto suppliers in the 1990s.

Electronic procurement could end up reinforcing either the exit or the voice model depending on the nature of the product architecture's moves towards modularity. We argued above that build-to-order requires modularization of the car into a few easy-to-assemble chunks. Modules can be produced either a) by vertically-integrated or independent suppliers and b) with or without common interfaces. Decisions made about modules on these two dimensions will have a large effect on the nature of supplier relations.

There are two possibilities that support further reliance on the "voice" model. If modular design advances and is outsourced to suppliers, but with non-standard, OEM-specific designs, extensive interaction between OEMs and suppliers will be required. This high level of interaction would also be required if vehicle design remains integral, yet there is extensive subcontracting of production of OEM-designed components to outside suppliers. In both cases, "voice" could be enhanced by the capabilities e-procurement provides in support of collaborative product design (elaborated in the next section).

Another possibility supports further reliance on "exit". Exit works well if a) there are many suppliers who can make a particular part (so the threat to leave is credible), and b) there is little payoff to interaction between automaker and supplier (so frequent switching does not harm quality). (See the next section for elaboration on e-procurement mechanisms that improve the performance of the exit mode.) If modular design advances but is kept vertically-integrated (because control of modules is seen as a "core competence"), the components whose production is outsourced might be relatively simple parts that could be procured more readily via the "exit" model. An intermediate case might occur if module designs are standardized. On the one hand, this would reduce the need for communication between OEM and supplier as in the exit mode; on the other hand, these parts would be at least a little more complicated to make than individual components, reducing the automakers' ability to switch, as in voice mode.

Automakers may well vary in their choices about outsourcing and standardization. For example, standardization would help a lot with suppliers' inventory problems. (For example, if a given module is interchangeable across products of two customers, then a firm supplying that module to both would be hedged against sales declines at one.[1]) However, agreeing on a module standard across the industry limits any single automaker's freedom to design new capabilities into their vehicles. Thus e-procurement strategy could play out very differently for different firms. (We will elaborate on this theme in the third section of the paper.)

For example, a firm like Toyota, which favors more integral designs and a "voice" approach to suppliers, would most likely move towards modules by doing the design work internally, maintaining model-specific idiosyncracies to insure the integrity of the overall design, and working closely with its long-term suppliers on accomplishing production performance targets. On the other hand, a firm like Chrysler, which sees its core capability more as encouraging innovation across independent suppliers, might welcome the outsourcing of module design but would still want to work closely with those suppliers, in voice mode, to produce proprietary and model-specific applications. [1] And GM, which lately has favored a more modular product architecture, the outsourcing of modules, and an "exit" approach to suppliers, would prefer the standardization of modules that could be acquired as commodities usingmultiple suppliers, with GM able to use its volume purchasing power and threat of exit to drive down module prices.

Summary. This overview of the "build-to-order" scenario is necessarily speculative, but reveals the vast number of interrelated changes necessary to make this production model a reality for the auto industry, including: modular design and modular production; a sufficient prevalence of "voice" mode supplier relations to insure collaborative product development of modules; dealers incentivized to pass information on consumer preferences directly to automakers; and consumers who would be willing to pay at least a small premium for a deeper level of choice and speedier fulfillment.

We now turn to address the alternate scenario, in which "build-to-order" and modular product architecture are not realized. We will return later to consider the conditions under which these near-term developments could lead towards the long-term scenario of "build-to-order" -- or away from it.

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1. If a module supplier was owned by an automaker, other automakers might be reluctant to buy large amounts of parts from it, for fear of dependence and revealing proprietary information, so common interfaces would have less impact in the modules-with-vertical-integration scenario.

1. For insightful discussions of the pros and cons of standardization, see Farrell and Saloner (1992) ; Varian and Shapiro (1998).

II. Scenario 2: E-Effects without Build-to-Order and Modular Design

In this section, we address the impact of the Internet on the auto industry independent of the prospect of a "build-to-order" system. In other words, if barriers to modular design and other factors outlined above (e.g. lack of consumer willingness to pay a premium in the short run; concern about "look-alike" vehicles) prevent a shift towards a build-to-order system, the Internet will still offer new economies, new capabilities, and opportunities for new business development. We focus here on three areas: business-to-consumer links (B2C) affecting automotive retailing; business-to-business links (B2B) affecting procurement; and a new arena for competition: business-to-vehicle (B2V) products and services. Because we can extrapolate from current technologies and current activities of firms, this section is probably a better guide to short-term effects of the Internet than the previous section on "build-to-order" which, as mentioned, is at least ten to fifteen years away.

As we noted in the introduction, the key feature of e-commerce is the de-specification of information technology assets: the ability of firms to achieve fast, cheap, asynchronous communication without investing in proprietary electronic data interchange software or training. Another important aspect is that it seems that the Internet is most useful for transferring this information if it is codified—that is, can be written down and understood similarly by many people. In contrast uncodified 'know-how' requires personal experience or, at a minimum, lengthy description to convey (Nelson and Winter 1978). [1]

B2C Automotive Retailing

One of the earliest B2C applications of the Internet was to arm potential car buyers with massive amounts of information about products, dealer prices, factory incentives, and dealer sales tac-

1. An example concerns the preparation of this paper. While all of the writing was done via email, when we needed to work out an argument, we immediately picked up the phone. That is, we could communicate already formulated ideas via the internet, but we found it less useful for codifying our half-formed thoughts.

tics, in order to even the scales in a transaction where consumers typically felt pressured, misled, and taken advantage of. In some sense, this simply automated and increased the visibility of the growing number of automotive information services that had been entering the market since the early 1980s. Yet the Internet makes it possible to integrate these different kinds of information (product specifications; new and used car prices; safety test results; consumer-based quality rankings) much more quickly and cheaply, in support of a personalized search.

There are now a proliferation of such "buying services". Some offer primarily information (Edmunds.com;), while others provide a referral to a convenient dealer (AutoByTel.com; AutoWeb.com; Carpoint.com). OEM sites, initially no more than on-line brochures, now offer similar services to many of these dot.com sites. Increasingly, a wide array of sites provides information about products in stock at various dealers that most closely match your search specifications, complete with a price. The transaction is then completed through direct communication (e-mail is most common) between the dealer and the end consumer.

Virtual communities of potential car buyers have also emerged as another prominent feature of these sites. On sites such as Edmunds.com, you can now get not only the price information upon which Edmunds built its brand but you can also join "chat room" discussions about the pros and cons of different models that include satisfied and dissatisfied owners as well as shoppers at various points in their transaction. The dot.com buying services see this as the next stage in their business plan. In the words of the AutoWeb CEO, "we are moving from lead generators to providing community and content" with maintenance reminders, on-line scheduling of service appointments, and links to related services such as financing, insurance, and cell phones (Automotive News, Jan. 2000).

Certain sites specialize in innovative pricing models that promise savings without having to negotiate directly with a dealer. In the C2B model of Priceline.com, the consumer names the price he or she is willing to pay, agrees to pay an immediate deposit of $200 if his/her offer is accepted, and to go through with the sale. Dealers let Priceline know the price at which they are willing to sell particular vehicles, and Priceline completes the match for a small fee.

Consumers are using these Internet resources at an increasing rate. A year ago, an estimated 25% of all consumers said they used the Internet as part of the purchase process for a new vehicle (J.D. Power, 1999), and the number has increased steadily since. In another study asking about consumer intentions for their next purchase (Dohring Report, 1999), 37% said they "will" and 20% said they "may" use the Internet. Most of these consumers use the Internet for research and information and then go to a dealer to see and test drive vehicles. Only a small percentage are intent on completing the transaction by avoiding the dealer as much as possible.

Based on one case study we are doing of a traditional Ford dealer and how it adapts to the Internet age, roughly 10% of sales now result from an inquiry over the Internet, typically forwarded from a buying service website (MacDuffie, 2000). The dealership has a separate staff for handling e-mail requests but as a potential sale draws near, they have a dedicated salesperson to "close" deals. The margins on Internet-facilitated purchases are significantly lower than showroom transactions, mostly because these consumers shop heavily on price and rarely trade in a used vehicle as part of the transaction. The dealership accepts these lower margins in order to gain experience with Internet sales, but is hardly eager to see the numbers grow greatly.[1]

For all the increased use of the Internet, there is still a dealer at the end of each purchase transaction. That's because it is essentially illegal in the U.S. for any end customer to purchase a vehicle directly from the vehicle manufacturer, due to powerful franchise laws at the state level. Auto dealerships are independently-owned franchises that decide what vehicles to purchase from the manufacturer, in what quantities and at what time, and how to price and sell them. Dealers

1. It is not clear that an e-sale represents less work for the dealer. In some cases (such as Greenlight.com), the prospect arrives with a pre-negotiated price., saving some haggling time. But, the reduced costs of search mean that some consumers are referred to dealerships when they are not yet really serious about buying.

place orders based on their feeling for the local market, their past experience with the ups and downs of business cycle and its effect on sales, their desire to have sufficient numbers of popular models in stock, and their strategy of using models 'loaded' with options as a way of price discriminating; this often bears only glancing resemblance to actual patterns of customer demand. Successful dealerships are often run by entrepreneurs with strong local network ties who give generously to political candidates and hence have considerable political power. While the state franchise laws will be challenged aggressively as consumer demand for direct purchasing increases, they are unlikely to be eliminated quickly, or completely.

Furthermore, for reasons outlined above, automotive retailers may survive because they offer the customer a chance to see and touch the vehicle, to take a test drive. On occasion the customer may be able to exert some bargaining leverage (i.e. when a dealer is clearly eager to move inventory off his lot). For the OEM, they still offer the best opportunity to wrap additional services around the purchase transaction and to establish a more personal link to the OEM brand. So far, the OEMs appear to be holding their own against the dot.coms in this area, as their own websites (and the support they provide to dealers to manage Internet sales leads) become increasingly sophisticated (Techweb.com, April 24, 2000).

While retailers may survive, there is already evidence of new entrants into retailing that will challenge those tied to OEMs. In the "dealer direct" model, a new player (e.g. Cars Direct, partially owned by Michael Dell) buys at least one dealership in key states, which allows it to sell vehicles to anyone in that state. These new dealers would then aggregate demand of custom-configured vehicles and fulfill those orders through batched purchases from OEMs. Another new entrant, GreenLight.com, has a similar strategy but aims to enlist a select group of dealers as part of its order-taking network.

Financially, this appears to be a viable short-term strategy. According to one estimate

(Lapidus, 2000, p.43), it would cost about $75 million to buy dealerships for the top 40 nameplates in states containing 70% of the US market—quite a feasible sum of money to raise. This model is also immediately viable because it exploits a loophole in the current franchise laws.

However, while these new players are likely to be more nimble than the OEMs in providing an appealing B2C interface for consumers, they will ultimately be constrained by current manufacturing inflexibilities and factory-to-dealer fulfillment inefficiencies. OEMs are in a better position to apply the speed and information cost efficiencies of the Internet to eliminating the worst delays of the current distribution system. OEMs can also potentially offer their own "factory direct" alternative, with more direct control over the inventory needed to fulfill the aggregated orders. The biggest disadvantage for OEMs in this scenario is the burden of getting their existing retailers to make this transition. It may be that the new 'dealers direct' will help the automakers here, by making traditional dealers desperate enough to accept a different sort of contract with the automakers (Lapidus, 2000).

There are substantial savings to be achieved here, even if build-to-order does not occur. Currently, dealers hold 75 days of inventory on average of each car, for a carrying cost of $431 per vehicle (Lapidus, 2000, p. 13). If use of e-commerce could cut this in half, $200 per vehicle could be saved.

The biggest battles ahead in B2C for automobiles in a non-build-to-order world may not be in the area of vehicle purchase at all, but rather in the art of building a relationship with consumers to encourage repeat transactions, brand loyalty, and ongoing access for cross-selling of services.

B2B: Transforming or Reinforcing Supplier Relationships? The rapid embrace of Internet-mediated B2B activities by U.S. automakers, has surprised many observers. On November 2, 1999, in an action heralded by the Economist as “the moment e-commerce grew up,” both Ford and General Motors announced plans to put virtually all of their global purchasing activity into huge, separate web-mediated exchanges. Less than four months later, these e-arch-rivals announced that they would merge their separate exchanges into one and would invite Daimler-Chrysler and potentially most of the rest of the world’s automakers to join as well.

The scale of the economic transactions involved is huge -- GM spends about $87 billion a year, working with 30,000 supplier delivery points, with Ford’s purchases nearly as large, and DaimlerChrysler’s about half of GM’s. Furthermore, if all the suppliers of these OEMs use these exchanges for their own purchasing, the impact will be magnified significantly. All told, e-business activity through these two exchanges could reach $500-$800 billion within a few years. Along the way, tremendous efficiencies are envisioned -- from inventory reduction, reduced administrative time, shortened lead times, faster product development cycles, and facilitated communication and collaboration between automakers and suppliers, as well as across suppliers. While this “500 pound gorilla” of an industry exchange will be impossible to ignore, there are other e-markets that can potentially compete for a share of automotive e-procurement, from specialized materials sites like e-Steel and Plastics.com to dot.com pioneers in B2B like Ariba and ProcureNet. However, with companies like Oracle and Commerce One and Cisco already tied to the GM-Ford-DC venture as alliance partners (and Renault/Nissan, Fiat, Suzuki, and Isuzu already signed up), the bulk of e-procurement activity in the short-term will probably occur through Covisint. Indeed, it may well be impossible for any auto company to avoid dealing with Covisint once the vast majority of purchasing transactions occur there. [1]

Four developments associated with B2B appear to have the most potential for affecting (either changing or reinforcing) past norms of automotive procurement: 1) Open architecture and information transparency; 2) Automation of steps in the purchasing process; 3) New pricing models that commoditize purchases, such as auctions; and 4) New tools to facilitate collaborative product design of complex components or modules. Using information from a recent Goldman Sachs report (Lapidus, 2000), we evaluate (and in some cases revise) estimates of potential savings from each of these developments.

Open architecture and transparency. The now-widespread diffusion of XML (eXtensive Markup Language) provides data tags and data field labels that can be read by any operating system or application with minimal translation effort. This will make it possible to put all participants in a supply chain -- large or small and located anywhere in the world -- on the same information system with access to real-time data. This will reduce the barriers to smaller suppliers, who have been disadvantaged by the high costs of proprietary IT systems in the recent past. However, a key determinant of supplier access to new customers is whether the XML tags will be standardized, or specialized to one exchange. If, for example, Covisint and e-Steel have different ways of describing a purchase order, this will make it very difficult for a firm to link its production system to orders coming from both (Glushko, 1999).

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1. Each of the exchanges will face scrutiny from the U.S. Federal Trade Commission. According to Susan S. DeSanti, the FTC's director of policy planning, the following activities will be examined for possible anti-competitive implications: joint purchasing or marketing that involves agreements on prices or quantities, detailed information exchange among competitors (such as airline ticket price information that can be used to enforce collusion), and exclusion of firms from membership (DeSanti, 2000).. Covisint would appear to do well on most of these grounds, since the exchange seems to be set up to facilitate interactions between individual automakers and their suppliers. It appears that access to the exchange is open to anyone in the industry (though opportunity to purchase equity is not). Since volumes are already large, and most parts are custom-designed for a particular model, it seems unlikely that automakers would want to pool purchases. A technical problem that remains, however, is authenticating the identity of potential bidders. Parts specifications are often a source of competitive advantage, so it would be important that an automaker could let potential bidders see the specifications without revealing them to a rival automeraker who might be trying to masquerade as a supplier.

This new capability could lead to savings from reduced scrap and increased productivity. Goldman-Sachs estimates these savings at respectively 50 and 200 basis points of value added (or $334 per car) (Lapidus, 2000, p. 19). Open-architecture IT should also allow a reduction of in-process inventories held as buffers against uncertainties created by inaccurate or out-of-date information. Goldman-Sachs estimates that these effects should reduce inventory carrying costs in the supply chain (suppliers + OEM) by one-third, or $103 per car. The inventory numbers seem well-justified; the productivity and scrap estimates, though three times as large, are presented with no explanation at all. It seems more realistic to cut the productivity and scrap figure in half, to $167 per car. (Admittedly, we can't justify our number yet, either.)

Automating Purchasing Steps. An even larger effect of the Web's open architecture comes from the ability to automate much of the purchasing process. Expert systems can be created, even for lower-tier suppliers, that can greatly simplify processes such as need identification, vendor selection, receiving, and accounts payable. Goldman Sachs estimates one-third savings for each of these areas, for a total savings of $160 per car (p.13). However, this estimate seems high. The justification given in the report for this number is a series of examples that come from procurement for MRO (maintenance, repair, and general plant operations). MRO is an area plagued by ad-hoc fixes, and suppliers that are infrequently used. So an expert system that would explain how to complete a repair job for a broken piece of equipment in the plant, and an online auction for suppliers to do the work might well save a lot of money. However, MRO is only 7% of total purchases (Lapidus, 2000, p.18). A more realistic estimate might be half of Goldman's, or $80.

Auctions. Auctions now present huge opportunities for reducing prices on parts at the commodity end of the spectrum, and will create huge advantages for best-in-class suppliers to capture high market share by exploiting scale economies. In one dramatic example (Colvin, May 1, 2000), an automaker is buying plastic parts through FreeMarkets.com (GM's original B2B partner, before the announcement of Covisint). It paid $745,000 for the last, pre-auction batch of parts. This time, after 33 minutes of bidding by 25 suppliers, the price comes down to $518,000. That auction was one of five that day run for that automaker. Parts that would have cost $6.8 million under the old procurement system sold for $4.6 million after the auctions.

Small wonder that many interpret the establishment of Covisint as evidence that supplier margins will be more effectively squeezed than in the past (Taylor, 2000). OEMs will run the exchange, levy fees on participating suppliers, and benefit during price negotiations from information transparency that could reveal supplier cost structures. But the use of auctions may be the most powerful means of forcing price reductions. Auction mechanisms can also be used to sell excess production capacity.

Goldman-Sachs estimates that savings from these mechanisms would be $211 per car. ($211 is the sum of the figures for “align specifications”, “consolidate volume”, and “align with low-cost suppliers”; online B2B commerce is expected to yield savings of 50, 75, and 100 basis points respectively.) No justification is given for these assumptions (Lapidus, 2000, exhibit 15). A more realistic number might be $127. [1]

Collaborative Mechanisms. Auctions clearly won’t be used for all components in a vehicle. Indeed, the information-intensity of interactions between suppliers and their OEM customers has increased tremendously in recent years, as design responsibilities are outsourced to suppliers and as the product architecture becomes more modular. E-procurement of complex modules won’t proceed by auction; these parts are rarely sourced entirely on the basis of price. Furthermore, bids for such parts are unlikely to be sought very often, since relationship-specific knowledge must be extensive for suppliers to fulfill customer requirements. For these parts, the value of Covisint will be as a source of timely and accurate information that aids coordination and

1. We get this estimate by assuming that savings accrue at the rate that Lapidus assumes for the 20% of purchases that are commodities, but at only half the Lapidus rate for the other 80%.

collaboration.

Covisint could facilitate collaboration in a variety of ways. Automakers can post production schedules on the web. This step increases productivity, since no one has to call or fax each supplier affected by a change in the schedule.

The asynchronous nature of web communication could facilitate communication with a global supply base. One could imagine an automaker sending a video of a quality problem whose cause was unknown to suppliers of adjoining parts. While this is not as good as having all parties come to the actual site of the problem[1], it is better than trying to describe it over the telephone, or sending a fax.

Designs could also be posted on the web. This step, which should be technically feasible soon, would have a number of benefits. It would eliminate the expense of proprietary design software. Firms that supply more than one automaker have had to operate multiple CAD systems; this software is quite expensive ($100,000) and requires at least one engineer dedicated to staying fresh on each package. It would also facilitate discussions of quality or design problems that involve several suppliers.

However, technical barriers are not the largest obstacles to posting design data. Suppliers would not want their competitors to see their designs without some assurance that they would not lose business to a firm that could cheaply imitate it. Protection of proprietary information with firewalls and secure customer-specific sections of the site will be required. But no technological security mechanism will fully substitute for the presence of trust between supplier and customer, already crucial for the “voice” mode of supplier relations to function effectively. Collaborative mechanisms will need reinforcement from other aspects of the customer-supplier relationship.

Summary. Even in the absence of build-to-order, electronic procurement will result in

1. The problem –solving methods favored by Honda and Toyota place great emphasis on going to the actual site of the problem, because it facilitates intuition about systemic causes that might not at first glance seem to be related to the problem (MacDuffie and Helper, 1997; MacDuffie, 1997).

significant savings over current procurement systems. Some of these are one-time conversion savings, while others will affect every transaction. Ultimately, e-procurement could end up reinforcing either the exit or the voice model, because it facilitates both auctions and collaboration[1]. We explore the implications of this for industry structure and the balance of power between suppliers and OEMs below.

What do these savings add up to? For supply chain (procurement + OEM WIP + supplier inventory, productivity and quality gains,) Goldman-Sachs comes up with $807 per vehicle, or more than 7% of purchased parts and 4.4% of the total cost for a $20,000 car.[2] If we make the modifications indicated above, we calculate a figure of $477 per car—still a large number.

B2V: The Information-Intensive Vehicle

One clear impact of the Internet on new business opportunities in the auto /industry is the acceleration of efforts to bring information technologies into the vehicle. The potential market for in-car services is vast. In the U.S., commuters spend an estimated 500 million passenger hours per week in their cars or 25 billion hours per year. That's equivalent to roughly 10% of the work hours put in by the U.S population, or about 2% of all waking hours for the average person (Goldman Sachs, 1999). Vying for all those hours of captive eyes and ears is a wide array of potential services, from personal productivity (phone/fax, voice-mail/e-mail, custom news/ weather) and convenience (travel and restaurant reservations, concierge services, interactive shopping) to entertainment (Internet radio, video on demand). Already (or soon-to-be) available are services related to safety (emergency connect; sensors to insure safe distances between vehicles), security (remote door unlock, stolen vehicle tracking, roadside assistance), and navigation

1. In the short run, the 'exit' parts of e-exchanges are receiving most attention, both from the press and from the site developers. Neither firm involved in developing the Covisint web site (Oracle and Commerce One) has much supply chain experience, so the site's initial capabilities are heavy on the auction side (Garretson, 2000).

2. 807=695 (supplier product cost savings (exhibit 15)) + 36 (OEM WIP (exhibit 11) + 76 OEM purchasing automation (exhibit 13), all from Lapidus, 2000.

(GPS locators with directions to destination). When the information-intensive vehicle is linked to a “smart highway” or Intelligent Transportation System (ITS), even more services become possible, from toll collection to congestion avoidance to (more fancifully) hands-off driving systems.

Several challenges loom ahead before this futuristic vision of the “online car” can become a reality. The upgrading of the electrical infrastructure in the vehicle is underway, with an industry consortium having agreed to standards for a 42-volt system. Experiments with flat wiring, that is molded into plastic interior parts and eliminates all the loose wire and connectors of wire harnesses, are also in process. New modular designs for the dashboard/instrument panel are on the drawing board that allow the top half to be opened to allow easy insertion of “smart cards” containing new processors, memory, or software upgrades (Georgievski, 1999). Yet important matters of the information architecture for the vehicle remain unresolved. Will the “online car” be based on an operating system from the PC world, like the modified version of Windows now being prepared by Microsoft? Or will a different, more specialized operating system be developed? Will there be one dominant operating system that becomes an industry standard, or competition among suppliers of “wired” interiors? Will the information architecture be open or closed?

Right now, automakers are pursuing these opportunities by forming alliances with a wide array of hardware and software specialists from the IT domain. Ford and GM have been the most aggressive, often announcing deals with separate alliance partners on the same day. Will company-specific initiatives dominate movement towards the “online car”, or will we see a repeat of the pattern with Covisint, with major automakers agreeing to back a single set of standards for the information infrastructure?

What revenue models will succeed is also open to question. Most predictions anticipate monthly fees as the primary source, with network scale effects driving the potential for revenues. A multitude of alliance possibilities present themselves, with Internet portals, mobile telecom firms, customer-service-through-call-centers specialists, and entertainment content providers all potential partners with each other and with automakers and IT suppliers of the operating system.

Finally, there is the annoying detail that drivers need to devote a certain amount of their attention to driving. Absent some technological breakthrough allowing unattended driving, this will limit the ability of even the most skilled multitasker to consume all these additional services. Safety concerns may lead to regulation of what drivers will be allowed to do in their vehicles in all but the slowest-moving of traffic jams. And even if these barriers can be overcome, consumers may resist allowing every minute of their attention while commuting being monetized.

The increased availability of these information services will proceed whether or not there is a substantial move towards build-to-order. Services like GM's OnStar, which allow immediate satellite connections to call center representatives who can help with emergency aid or concierge services are already being offered as "standard equipment" with high-end Cadillac models. Navigation systems may soon be standard equipment on many models; already in Japan, they are installed in 40% of new vehicles. Indeed, the simplest way to think about the diffusion of the information-intensive vehicle is that all vehicles will soon come with a computer in the instrument panel. "Until now, Toyota has sold 1.8 million vehicles per year. But from now on, it will sell 1.8 million computers [in its cars]," said Shigeki Tomoyama, the head of Toyota's B2C subsidiary Gazoo.com (Business Week, 5/1/2000).

This will provide an instant "installed base" of massive proportions, without great differentiation by product segment or customer. But there may well be few 'first-mover' advantages to be gained, because the computer industry has already agreed on standards and common interfaces for modular production.

Thus these technological innovations could become an important part of a "build-to-order" strategy, through the customization of the information services available in a vehicle.

Indeed, one appeal of the information-intensive vehicle is that much of the customizing could be based on software and on the after-purchase addition of “plug-in” information devices. This customizing would not require the full-scale modular design and “pull” manufacturing approach of a more ambitious “build-to-order” strategy -- merely industry agreement on a standard interface for plug-in devices and possibly a standardized operating system.

III. E-Effects on Industry Structure and Stakeholders

We have now presented two scenarios for how the Internet and e-business will affect the future of the automobile industry -- one based on a long-term view of the full-scale adoption of a “build-to-order” model and a modular product architecture, and the other based a short-term view in which “build-to-order” and modular design do not move forward. In either scenario, the Internet is likely to have a major impact on industry structure. We assess that impact in this section, considering the consequences of the trends outlined above for automakers, suppliers, dealers, employees/unions, customers -- and for competitive dynamics in the industry as a whole**.**

Automakers

Ultimately, “build-to-order” may be a new source of competitive differentiation for automakers. To respond effectively to individualized demand from the final customer, firms will need to meld their capabilities effectively throughout the entire value chain. Consider what this strategy requires: designing a modular product that can facilitate “mix-and-match” customization without losing the distinctive characteristics of a brand; maximizing manufacturing flexibility and mastering the tight timeframes of a true “pull” system; managing supplier relationships effectively from design involvement through price negotiations, logistics synchronization, and the meeting of cost/quality/delivery goals; making the right choices about how much customization to offer customers, and providing the right “front-end” for configuration and customer support.

"Build-to-order" would appear to require extensive system integration capabilities that would be difficult to outsource.

Modularity carries its own set of implications for industry structure. If dominant suppliers for key modules emerge, OEMs could end up in a position of extreme dependence that could shift the balance of power, much like the "Intel Inside" phenomenon in the personal computer industry (Fine, 1998). This could pull OEMs to keep the design and production of such modules inside the firm. On the other hand, none but the very largest automakers might be able to buck an industry trend toward modularization once it got started. Imagine suppliers offering the following proposition to an automaker determining to continue with an idiosyncratic module design -- "we'll be happy to do that for you, but if you purchase our industry standard design, which reflects our latest technology and most current design thinking, it will cost you 20% less because we can produce it in such volume." Over time, transactions of this kind would speed the diffusion of standardized modules -- although this still represents a much more haphazard approach than standard-setting by an industry-commissioned organization.

A different scenario would see increased outsourcing and the involvement of new players in a "build-to-order" world. In the computer and consumer electronics industries, contract assemblers have taken over manufacturing and suppliers dominate much of the value chain, leaving OEMs primarily responsible for design and post-sales services (Sturgeon, 1999). Recent rhetoric from automakers (notably Ford) about the appeal of moving from being "heavy manufacturers" to being "consumer services" companies suggests an embrace of this scenario. In this view, a more modular product architecture could facilitate the transfer of large amounts of responsibility for design and manufacturing, for capital investment, and for risk absorption from the automakers to their suppliers. It is hard to imagine that any automaker could stay at the top of its game without involvement in the process of getting the product built. However here, as in so many other industries, it would be dangerous to underestimate the potential for newcomers who can apply a “clean sheet” approach and who understand how to leverage the power of the Internet to achieve “first mover” breakthroughs.

It is important to note that automakers bring different sets of capabilities to these problems, based on their history and past strategies (Freyssenet, et. al, 2000). ‘Lean’ producers like Toyota have in the past been better able to manage certain kinds of variety than mass producers; for example, they have had more success at producing vehicles with different platforms on the same assembly line (MacDuffie, Sethuraman, and Fisher, 1996). In addition, their suppliers (even second and third-tier) have long had experience with the complex scheduling that just-in-time inventory requires -- and that cheap and fast Internet information transfer now facilitates. On the other hand, as noted above, Toyota’s production system depends heavily on *heijunka* or production leveling, and facing the volatility of a true build-to-order system could be destabilizing.

The recent wave of industry consolidations will influence trajectories as well. For example, Chrysler’s growing experience with outsourcing major responsibilities for product design to suppliers may make it more ready to embrace a modular product architecture than Ford or GM, but the influence of Daimler-Benz in the newly-consolidated auto giant, which has always favored highly integral designs, will pull in the opposite direction.

In general, we also expect the expressed preferences of automakers with respect to “exit” vs. “voice” models of supplier relations to affect how eagerly they take up the various mechanisms of information transfer and coordination offered by the Internet.

Suppliers

The path taken by e-procurement could affect the power balance between suppliers and OEMs. As mentioned above, electronic procurement could end up reinforcing either the exit or the voice model, because it facilitates both auctions and collaboration.

With auctions, the technical breakthrough of the Internet could have the paradoxical effect of reinforcing the traditional U.S. “exit” model of supplier relations. The Internet can facilitate this model by reducing the transaction costs of doing business with many suppliers, and with smaller firms that can’t afford proprietary IT software. It is possible that Internet auctions could lead to a reversal of recent (since mid 1980s) trends toward sourcing from fewer firms, and from “full-service” firms that can do design and sub-assembly as well as build to the automakers’ print.

While safety- or image- critical parts will almost certainly never be bought on price alone, the reduced transaction costs of the auction model made possible by the Internet might move some parts back from ‘voice’ to ‘exit’. This trend would reduce supplier bargaining power. It would also allow the entry (or re-entry) of firms that had not invested heavily in capabilities in design and modular production. These firms would have the advantage of far lower fixed costs; however, their quality and ability to innovate might not be as high.

Yet e-commerce can also promote collaboration, in ways that mostly increase supplier bargaining power. Posting production data slightly lowers barriers to entry by new suppliers, since they don’t have to buy and implement costly software for electronic data interchange. On the other hand, experienced suppliers are more likely to be able to take advantage of this improved information, since they are better at scheduling and logistics and at doing quick change-overs from one product to another. And, a prerequisite for sharing design data electronically may well be some commitment by automakers not to use these data to undercut existing suppliers; this too would increase these suppliers’ bargaining power.

Modularization with outsourced modules would also almost certainly increase supplier bargaining power. First, modules are likely to be large and complex, meaning that only a few suppliers will be able to make them. An instructive example here is the case of seats. A seat set for a mid-size car costs about $800, the most expensive part after the engine. Until the 1980s, seats were designed by automakers, and individual components (seat fabric, rails, foam) were sent by small suppliers to auto assembly plants, where they were built up into a finished product. Gradually, however, suppliers have taken over the design and engineering of the entire seat. The result is that two firms (Johnson Controls and Lear) now provide 70% of the world's automotive seats.[1]

This trend toward increased bargaining power would be reinforced if suppliers could design products that consumers would ask for by name. (Again, think 'Intel Inside'.) Johnson Controls is attempting to do just that in its partnership with Lego to produce the seat described in our opening scenario.

Almost all parts of the car today are specially designed for a particular model (even seats). However, this is beginning to change, as suppliers get more powerful, and as open-architecture computers become more prevalent in vehicles. For example, TRW recently introduced a rain sensor that automatically sets windshield wipers to the correct speed. The biggest challenge was designing a sensor that can be used with any type of glass used in windshields; connecting the

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1. Why have automakers agreed to this? The arrangement has had many benefits, at least in the short term. Lear and Johnson Controls specialize in this product, which does not contain core technology for the automakers. Seats are made of textiles and have fashion elements reminiscent of consumer products, in contrast to the steel components with relatively long product cycles that the automakers are familiar with. As a result of their specialization, the suppliers have made seats far more comfortable and stylish than they used to be, at an attractive price for automakers. Because the seat connects to the rest of the car in only one place (the seat rail), it has been a relatively easy part to modularize -- and is so far the only part which is widely obtained by automakers in modular form. Seat manufacturers are now working to make their dominant design more modular internally, i.e. more decomposable into smaller modules, to aid customization. Competition between these two firms and newcomer Magna keep prices and designs competitive, and by multiple sourcing of seats, automakers avoid undue dependence on one supplier.

sensor to all available wiper motors (a product TRW does not make) was reportedly easy (TRW press release, 2000).

Standardization could have a variety of impacts on bargaining power. Studying the early history of the US auto industry yields some insights. (See Thompson, 1954; Hochfelder and Helper, 1996.) In its early days, the industry was quite modular, as auto assemblers attempted to use parts from established carriage and bicycle suppliers as much as possible. (Henry Ford's factory's entire contribution to the assembly of his first car in 1903 was to place wheels on tires, tires on chassis, and body on chassis.) Smaller assemblers wanted to keep parts standard, because it meant they had to design and produce fewer parts themselves. In the 1910's, these firms established bodies such as the Society of Automotive Engineers (SAE) to promote standardization. Early projects focussed on standardizing large parts such as carburetors. But as Ford and GM grew, their engineers increasingly staffed the SAE's committees, and pursued a different agenda. Ford and GM had the scale to make carburetors in-house, and wanted to be able to compete on the basis of a superior design of these parts. So they narrowed the SAE's focus on standardization to parts like nuts and bolts, and grades of steel.

The result was that barriers to entry in the auto assembly business went up dramatically, as independent suppliers of carburetors, bodies, and engines were bought up by firms that became the Big Three. Only suppliers that diversified into other industries (such as Timken and TRW) remained independent and profitable.

The upshot of this discussion is that the variance of profits in the supplier industry is likely to increase dramatically. Suppliers of commodity parts will see their margins shrink (although if these products are useful in other industries (as are switches and small motors) they may benefit from access to new customers.). Suppliers that have tried to escape from producing commodities by doing specialized engineering will face great challenges in getting paid for it. Yet, firms that can make popular modules may find themselves in the drivers' seat, particularly if it is something that consumers will ask for by their brand name. Thus, it is possible that the industry would come to consist of a handful of multibillion-dollar global megasuppliers making returns similar to the automakers, a second, much larger, tier of medium –sized firms earning normal returns, and a very large third and fourth tier of very small, low overhead, technically backward firms that win auctions for commodity parts, but which make life difficult for other suppliers because their low margins don't permit much investment in quality or responsiveness.

In summary, the Internet by itself is not likely to alter make-vs.-buy decisions. As we have seen, it reduces the cost of sharing information, but does not by itself increase the trust and relational knowledge that will continue to be important in the design and production of complex components and modules.

Retailers

Recent years have seen repeated predictions of a "retail revolution" that would overthrow the long-established, often-detested traditional dealership. Before the Internet, the focus was on new competitors such as AutoNation and CarMax -- large public companies buying up dealer-ships and opening new mega-stores as a rapid clip, aiming to apply professionalized management and centralized systems to a determinedly local business. More recently, attempts by OEMs (e.g. the Ford Retail Network in Tulsa, Oklahoma) to control distribution more directly through direct ownership and consolidation of retail outlets in a given geographic area have drawn attention. Add the widespread prediction of disintermediation that accompanied the early B2C dot.coms and you might expect that auto dealers would be in a very precarious condition indeed.

Instead, there is surprising life in this dominant retail channel. The big public companies have failed to generate efficiencies or enduring selling innovations and as their stock has gone out of favor, their pace of acquisition has slowed dramatically. The Ford Retail Network, and a similar effort by GM, have been successfully blocked by local dealer opposition. While there has been consolidation among dealers, with the top 100 dealer groups selling over 2 million vehicles in 1999, this represents less than 15% of total sales; smaller, community-focused dealers still dominate.

Furthermore, as noted above, the dot.com B2C companies have been forced, for a variety of reasons, to work through dealerships. While strong state franchise laws are the most obvious reason, the continued need for consumers to examine and test drive vehicles is another. The most innovative of dealerships have also moved quickly to embrace the Internet, and the OEMs are getting smarter about finding ways to support dealer efforts without getting into zero-sum struggles over territorial control. The dot.com vision of expanding beyond referrals into the provision of services and the creation of communities is being pursued by dealers as well, and here the existence of a physical infrastructure as a point of contact has largely been an advantage.

Still traditional dealerships who resist changes in their retail practices and who spurn Internet sales are not likely to last for long. They will face pressure from OEMs and customers alike and local owners will find eager buyers, not least from investors associated with the new group of retail competitors -- dot.coms offering a “dealer direct” model. With two competing business models now on the scene (CarsDirect.com aims to own its own dealerships in all key markets, while Greenlight.com plans to work through a select network of dealers) and more on the way, there will soon be evidence of which approach consumers prefer. Assuming that this model of aggregating demand for custom-ordered vehicles is successful, it will put continued pressure on OEMs to move towards a full-fledged build-to-order system -- not least because it will be the only way to capitalize fully on their control of upstream production scheduling and inventory management.

Meanwhile, dealers will continue to find ways, we predict, to supplement their current approach with Internet-based capabilities applied to both sales and service. Here the OEM thrust to move towards greater provision of consumer services, in order to grab a higher percentage of “vehicle lifetime” expenditures, will reinforce dealer primacy as the “mortar” portal in a “clicks and mortar” strategy.

Employees/Unions

In our past research (and that of our colleagues at the International Motor Vehicle Program (IMVP)), we found major differences in the nature of work and in the employment relationship between mass and lean production (MacDuffie, 1995; Pil and MacDuffie, 1996, 1999). What are the further implications of “build-to-order” production? Any jobs affected by the customization process may well be changed, from the engineer who works on module rather than component design to the auto salesperson who works with a customer who has already configured a new vehicle online, from the production scheduler who tracks the “pull” from customer orders to the worker who installs a module on the much shortened final assembly line.

What form will these job changes take? Many transaction-related jobs may be eliminated as coordination efficiencies are achieved through use of the Internet. Production jobs might become more routinized as module standardization and the use of common interfaces simplify installation; the latter has been the trend for consumer electronics. Automotive repair work may also be deskilled, as module replacement rather than component repair becomes more common. On the other hand, diagnosing problems internal to a complex module may take a higher level of analytic skills and electronics training. Furthermore, if horizontal collaborations between suppliers become more common in a “build-to-order” world, managers and engineers will need to learn new ways of communication and coordination to replace the direction provided by the OEM’s “shadow engineering”. Both upskilling and downskilling outcomes seem likely.

In terms of managerial and engineering jobs, as the demand for IT-related skills rises in the auto industry, it will bring the tight labor markets and intense competition for talent found elsewhere. Careers will increasingly depend on finding innovative ways to leverage e-business initiatives for competitive advantages, and on the ability to speed the implementation of new business processes. More fluid movement of managers and engineers in and out of the auto industry is also likely as IT-based innovations become more central to vehicle design and as B2B and B2C initiatives bring alliances with firms outside the industry.

The role of unions and the structure of industrial relations are also likely to change if there is a linked move to modular design and “build-to-order”. If power shifts from OEMs to suppliers, this may further weaken union coverage, particularly in locations like the U.S. where the OEMs are unionized and the majority of suppliers are not. Module suppliers are increasingly less likely to fall into traditional industrial segments, like metalworking, given that module design often requires mastery of several production processes and a wide variety of materials; this too could affect union strength. The wage premium associated with semiskilled labor in heavily unionized sectors of the industry is likely to shrink while wage differentials between information technology (IT)-mediated work and manual work are likely to grow, due to increased relative demand for the former. [?].

Yet the auto industry remains one of the most heavily unionized in the world, and there is ample reason to expect adaptation by unions and management to the changes brought about by e-business rather than simply a decline in unionization rates. While restructuring in the U.S. has often had a zero-sum quality in terms of labor relations, European companies have more often found way to negotiate creative arrangements to deal with difficult transition periods. (It is still not clear what stance Japanese unions will take towards the restructuring initiated by foreign investors at companies such as Nissan and Mitsubishi.)

A key decision may be how workers become trained to take advantage of the information provided by e-commerce. One possibility is to revive the traditional apprenticeship, which would strengthen unions. Another possibility is that junior colleges (paid for by the employee or by the employer) provide the training, and that more maintenance be done remotely, by equipment suppliers.

Furthermore, there may be new models for unions to pursue in the e-business era. Consortia of automakers and suppliers that co-locate in support of modular production represent an opportunity for unions to regularize wages and benefits throughout the value chain, albeit on a local rather than national or industry-wide basis. As new models of compensation roll through all levels of the organization, unions may want to bargain for equity stakes in lieu of wage increases. The communications potential of the Internet offers new possibilities for coordination of union activities across industrial and national boundaries. Recent initiatives like Ford's that will provide every employee with a PC could change the nature of both company and union appeals to worker interests.

Consumers

Most of the changes described here benefit consumers. Having prices displayed openly on the Internet gives even the worst bargainer an idea of what to shoot for, as well as offering more "no haggle" options. Competition among the smaller but more global set of dominant automakers and a continuation of the production overcapacity situation will create pressure to pass cost savings on to consumers in some form. With speed increasingly important as a competitive factor (particularly if build-to-order moves forward strongly), consumers favoring convenience may be able to choose more precisely their desired tradeoff between price, customization of features, and delivery date.

However, depending on the outcome of battles over Internet privacy, retailers may retain some ability to price discriminate. One could imagine retailers capturing information about consumers based on their previous Internet purchases and viewing habits, and using this to develop predictions about their willingness to pay. Based on this information, consumers could be sent emails offering them special prices, just for them. Thus, the Internet does not always increase transparency. (See Beloaba, 2000 for an example of how this might work in the airline industry.)

A final influence of consumers might be as voters-- through legislation regarding pollution and traffic congestion that would upset the dominant, integral design. If fuel cells became the power source of choice, for example, this would disrupt the dominant design in ways that might greatly speed the diffusion of a modular product architecture, and hence facilitate “build-to-order.” Similarly, a move to allow only low-emissions “mini-cars” into city centers would create opportunities for new entrants -- particularly those making the golf-cart-like low-speed vehicles that are appearing with greater frequency in gated retiree communities around the U.S.

Rhetoric about the power of consumers is ubiquitous, but at a time of great turbulence and volatility for the auto industry, there is ample reason to believe that consumer signals about their preferences for vehicle design, level of vehicle customization, bundling of products with services, and retail experiences will have a definitive influence on the direction of industry trends.

IV. Conclusion

How likely is any of this to happen? It seems clear that consumers want to use the Internet to buy cars. Already, as noted above, 25% of car-buyers use the Internet to do research on their purchase (Lapidus, 2000, p.13). If security and legal issues can be resolved, it would seem likely that in the near future, many consumers would purchase cars on-line.

Our long-term scenario, build-to-order, is more problematic. We don’t know how many consumers would pay a price premium for more customization. And, as discussed above, the logistical issues are far more complicated than they are for computers. A key component of making build-to-order feasible is modularization. Yet modularization with outsourcing would require the automakers to give up control of key design aspects of the car (or retain duplicate engineering staffs, which would be expensive). Modularization without outsourcing would require the automakers to increase their asset bases, reversing the trend of the last two decades and certainly not a move likely to please Wall Street.

Without build-to-order, finished-goods inventories will decrease some, due to faster transmission of orders from consumers to manufacturers and better information about consumer preferences captured from the clickstream. However, it will still be necessary for dealers to maintain a selection of cars with different option packages for consumers to choose from, so much of the current 30-60 day 'normal' inventory of each car model will probably continue to exist, even if the worst inefficiencies of the distribution pipeline are eliminated.

If modularization doesn't occur, then automakers are unlikely to radically change their procurement strategies. The Internet is thus likely to reinforce, rather than alter, existing supplier/customer relations. GM, with its 'exit'-based purchasing strategy, will probably move aggressively to adopt auctions for many (though not all) of the components it buys. To facilitate price comparisons, the firm may well do more of its own engineering and design work. In contrast, Toyota may try to figure out how to use the web for collaboration, perhaps having suppliers jointly design adjoining parts. They also may be able to achieve significant inventory reductions. Toyota and its suppliers have been working to minimize inventory for decades, developing innovative strategies for quick changeovers and accurate logistics (Liker, 1999; Nishiguchi 1994). Therefore, they will be in a good position to take advantage of improved Internet-based forecasting. In contrast, suppliers with long change-over times will continue to produce in large batches, even if they receive accurate daily forecasts.

To state these points more broadly, it is clear that the impact of the Internet is not by any means technically determined. For maximum effect, the nature of a firm's e-commerce investment should be complementary to its other investments, the investments of its competitors, and the nature of its competitive environment. In this sense, "e-effects" on the auto industry will depend on the extent to which complementary changes occur in retail strategy (build-to-order , factory direct , dealer direct), design strategy (modular versus not, standardization versus not), procurement strategy (voice vs. exit), automaker technology strategy (continuous vs. radical technical change), and government anti-pollution strategy (regulatory regime).

These e-effects could be path-dependent: the order in which these changes occur could affect the ultimate outcome. For example, if the short-term effects of the Internet are to promote exit relations with suppliers, and to facilitate the rise of third-party retailers, the build-to-order scenario would become less likely than if information exchange with suppliers and OEM-linked dealers were to dominate. The reason is that the less tightly-linked suppliers would probably not develop the skills to produce complex modules. Similarly, third-party retailers would have less incentive to share detailed consumer information with automakers than would traditional dealers.

In most cases, however, we will not see dramatically different players in the industry as a result of the rise of e-commerce. There remain enough of the traditional automotive-specific competencies that new suppliers or automakers are unlikely to enter the fray. Even with the increased importance of electronics in the vehicle, most of the development of the electronic infrastructure will occur through existing automotive suppliers. (In part, this is due to lack of attractiveness of the auto industry to electronics suppliers—the margins are much lower.)

However, alliances outside the industry and the provision of add-on products and services from new suppliers (particularly if a standardized "plug-and-play" interface is established for the information-intensive vehicle) are both highly likely. The consortium model established to launch Covisint, including most of the world's automakers and some powerhouse IT firms, may prove influential as the industry wrestles with issues of modularization and standardization.

In addition, most of the players in the industry have rushed to learn new Internet based skills. In retail, traditional bricks and mortar may yet prove to be an encumbrance on incumbents, but in the short term, barriers to disintermediation are providing opportunities for dealers to make the transition to an Internet era. Even with a full build-to-order scenario in place, we see an important role for a physical retail presence, particularly as a point of contact for the provision of services. However, much of the real estate around dealerships currently occupied by new and used car lots may become available as the retail function is “repurposed”; indeed, some investors are already anticipating this, taking over the management of dealership real estate through Real Estate Investment Trusts (REIT) in order to gain access to development rights.

The most radical outcome for the auto industry would certainly be affected by the Internet but would hinge much more on the complementary changes mentioned above. With a new dominant design built around fuel cells creating an opportunity for a full modular design, OEMs eager to shrink their asset base and diversify their risk could outsource much design to suppliers and virtually all production to contract assemblers. Automakers could then focus solely on determining the meta-design rules that would guide a modular product architecture, on developing and extending their brands, on differentiating their product line with respect to customization, and on developing and personalizing a full array of “mobility services.”

Whether or not this vision comes to pass will depend as much on what consumers want and how clearly their preferences are felt as it will on the current industry structure and the capabilities of key players. The Internet’s impact may be greatest, therefore, in the extent to which it amplifies and accelerates the delivery of the voice of the consumer to the ears of industry leaders -- and to the many stakeholders in this “industry of industries.”

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