Chapter VI

Automotive Industry Information Systems:
From Mass Production to Build-to-Order

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EXECUTIVE SUMMARY

Building cars to customer order has been the goal of volume vehicle manufacturers since the birth of mass production. Eliminating the vast stocks of unsold vehicles held in distribution parks around the world represents potential savings worth billions, yet the current supply chain resembles islands of control, driven by production push. Despite recent advances in information technology offering total visibility and real-time information flow, transforming an "old world" industry to adopt customer responsiveness and build-to-order represents a significant step change. This requires overcoming barriers both within and between supply partners and at all levels of the supply chain. Yet, what are these barriers really like and how can the industry overcome them?

ORGANISATIONAL BACKGROUND

Automotive manufacturing is a global industry producing 56 million new cars per year, and represents a significant proportion of gross domestic product in developed countries, for instance, 5% in the United Kingdom (Crain, 2002). Yet despite steady sales, the industry in Europe is facing a period of significant change, driven by poor profitability, excess finished stock and over-capacity. Current vehicle manufacturing and distribution represents an old-world industry struggling to come to terms with a digital economy, driven by increasingly price conscious, demanding customers who require vehicles built to individual specifications and delivered in short lead-times. Vehicle manufacturers can no longer rely on selling cars from existing stocks and are shifting their business models away from mass production toward mass customisation and build-to-order (BTO).

The 'double prize' for manufacturers in achieving BTO is eliminating the vast car parks of unsold inventory, and reducing vehicle discounting by dealerships that can demand a premium price for vehicles tailored and delivered according to customer choice. However, this increases the importance of existing systems for efficient order execution and integrated information flow, where manufacturers' IT infrastructure still reflects the hierarchical, function-orientated nature of communication in many corporations.

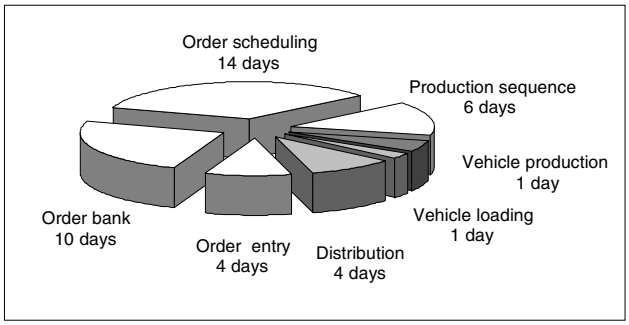
The rise of BTO reflects the increasing dissatisfaction in the marketplace with the traditional vehicle production philosophy that typically builds the vehicle first before finding a customer. In Europe, manufacturers expect dealers to hold between 60 to 100 days of inventory that amounts to billions of dollars (ATKearney, 2003). Even in the USA where vehicles are usually sold from dealer stock, 74% of customers would rather wait and order the vehicle instead of buying one from the dealer lot that is incorrectly equipped (*Business Wire*, 2001). Customers are beginning to realise that they are paying for the waste in the automotive distribution system. Hence, many manufacturers are now exploring the possibilities of reducing order-to-delivery lead-time to the customer through their own initiatives: that is, BMW — 'Customer Orientated Sales and Production Process'; Ford — 'Order Fulfilment'; Renault — 'Project Nouvelle Distribution'; and Volvo — 'Distribution 90'.

SETTING THE STAGE

The ability to communicate effectively both locally and globally increases the reliance on information systems (IS) and information technology (IT). The auto industry operates complex IS, where current systems act as a major inhibitor both to time compression in the order fulfilment process and to organisational change. These inhibitors or information barriers, are the subject of a research programme called '3DayCar'. A key finding from this research shows an average delivery lead-time of a new car in the UK is around 40 days. Moreover, only 5% of the delay is taken up by manufacturing, and 85% of the process is related to customer order, supplier schedule, and vehicle sequence information systems (Figure 1).

A transformation is required in order to satisfy customers and remove the functional chimneys, silo mentality and waste, towards the integration of IS across the whole supply chain. 3DayCar (3DC) is a complex project that aims to understand the current practice,

Figure 1: Delay in the UK Customer Order Fulfilment Process (Holweg & Pil, 2001)



relationships and technology. It involves universities and independent research institutions to examine the role of BTO and the barriers to change across the automotive supply chain in the UK. The programme is unique as it encourages the participation of sponsors from all parts of the supply chain and some beyond, including vehicle manufacturers (VMs), dealers, component suppliers, logistics, consumer groups, trade associations, and financial corporations. The key objective of 3DC is to develop a framework in which a vehicle can be built and delivered to customer specification in minimal lead-times, with a three-day order-to-delivery as the ultimate goal.

The generic map of the current order fulfilment process presents the extent of the problem to order, build and deliver a new vehicle within a short lead-time (Figure 2). It uses process mapping to record information and physical flows during the order to delivery process. In response to the productivity gap between Japan and the West — highlighted by the best-seller, *The Machine that Changed the World* (Womack, Jones, & Rods, 1990) — the past two decades have seen vehicle manufacturers optimising their own production operations while transferring more responsibility to upstream and downstream partners. Figure 2 highlights the challenge for the industry today, where competitiveness no longer depends solely on assembly plant performance and 'metal bashing', but on the collaboration of all stakeholders across the entire vehicle delivery process — from extraction of raw material to final inspection at the dealership.

Identification of the barriers to change is essential if they are to be incorporated into planning for the redesign of the industry (Figure 3). This will promote a successful transition from the current mindset of 'production push' and the erosion of profits through discounted sales, towards responsive production and 'customer pull'. The following accounts explore the experiences of key industry stakeholders, and highlight the major difficulties both in identification and amelioration of information barriers.

CASE DESCRIPTION

Customer & Dealer

"We don't confirm the delivery date to the customer until the vehicle actually arrives at the showroom, so much can go wrong." (Sales Director)

Figure 2: Generic Map Showing UK Leadtime and Order Fulfilment Process (3Daycar)

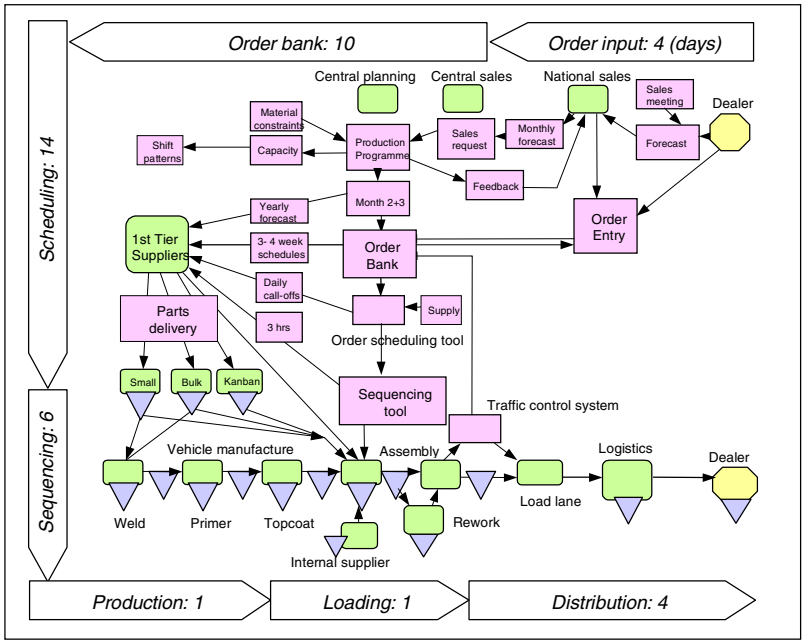
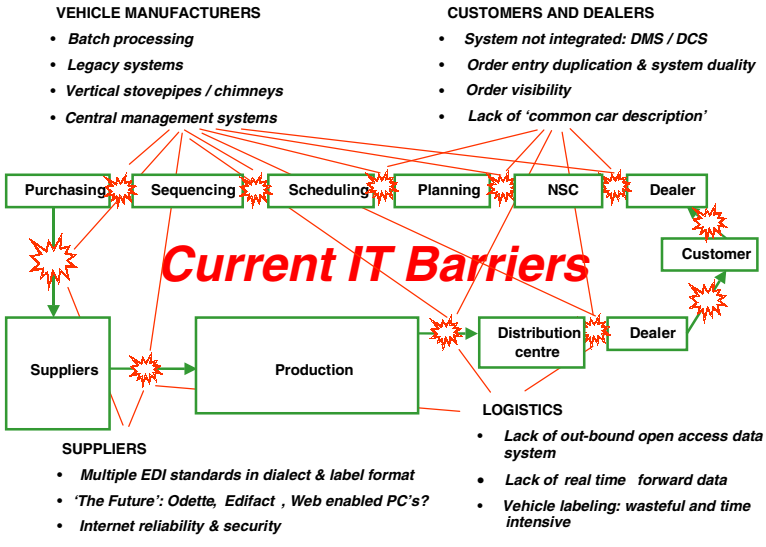


Figure 3: Current IT Barriers (Howard, 2000)



The lack of integration between Dealer Management Systems (DMS) and Dealer Communication Systems (DCS) is causing high levels of hand-keying and information duplication. Dealers operate two distinctly separate systems: DCS is linked with the VM and provides information on vehicle availability, price, incentive and orders. DMS provides the dealer with their own independent database of customer details, costs, and sales. When an order for a new vehicle is placed, significant levels of duplication occurs, where identical data such as vehicle description and owner details are hand-keyed into both systems. Ideally, dealers can do without the complexity and delay caused by maintaining two systems.

Other stand-alone PCs are also used to support activities such as finance schedules. Hence, in terms of changing the entire vehicle delivery process from a manual to an electronic system, much development is required, as there are still up to 20 'hard copy' documents per vehicle. For example, this research found the process to require an Order Form, Cash Back Claim Form, Vehicle Invoice, Supplementary Invoice, Vehicle Registration Certificate, Vehicle Swap Sheet, Vehicle Delivery Note, Purchase Invoice, Product Delivery Inspection Note, and Requisition Note.

Dealerships in the UK still operate within a territory, and their customer data is considered confidential both from the VM and other dealers. It is suggested that integration is possible if DMS system architects can be persuaded to use a common middleware implementation with DCS capable of masking specific data streams. This means that each system must retain the facility for hiding certain information fields from other organisations. Extensible mark-up language (XML) will be a key enabling technology in this situation. XML is a universal standard for representing any kind of structured data. 'Markup' means the insertion of information into a document to convey information about its contents. The power of the language is that users can access documents in an intelligent manner based on the grammar they use. Thus, specific files can only be accessed according to a standard, predetermined syntax.

System Support

The system support provided for dealers is often inadequate and not aligned with the needs of the business. Hardware choices promoted by the VM may be inappropriate. For example, current DCS satellite bandwidth is often too narrow to transmit all necessary information to the VM. Consequently, some dealers are reverting to traditional terrestrial systems. Due to the complexity of the process and the duplicative systems, training system administrators for the role can take between one and two years.

Despite Sunday being a busy day for order enquiries (confirmed by 3DayCar market research), no IT system back-up is provided by VMs because the weekend is traditionally reserved for system maintenance.

Liaison over systems designed for the dealer network does not appear to adequately involve 'Dealer Councils'. The manager of one dealership stated that he had heard of 13 new DCS software 'improvements' currently being prepared by the VM, but had not been consulted about any of them during their development process. There is a distinct feeling of 'IT Specialists' at the VM creating new software without working with the end user first. This extends to the use of the Internet by dealers for new car sales: the lack of their involvement in the VM's going online is making dealers uncertain of the future and provides the gap for new entrants, particularly Internet brokers, to enter the market.

Order Visibility & Customer Information Needs

Order visibility beyond stocks held in VM compounds and distribution is highly variable, but all dealers can see UK market stock for their franchises. If the vehicle required by the customer is visible in the stock locator, such as held in a compound or at another dealer, then response is either instantaneous or reasonably quick.

Once a factory order has been placed, some versions of DCS can provide data further upstream in production, but feedback can be slow. If the vehicle is in the VM pipeline, then it can take 24 to 48 hours for this information to be given to the dealer.

Some dealer franchises can see into production, others cannot. Some dealers can see all orders in the pipeline; some can only see their own orders. Some VMs raise all stock orders; some systems operate totally from dealer orders, requiring the dealer to phone another dealer who has an unsold model and 'agree to a swap' before they can acquire it and specify it for their customer. All systems allow different levels of order specification amendments.

Many DCS either do not give a delivery date, or have significant time delays in confirming them, which is a particular problem for customer-built orders. When dealers are given delivery dates on the system, these can and often do change and are not guaranteed. Dealers will add on days for quotation to the customer to compensate.

Dealers and customers need a search facility for stock and pipeline that supplies the information they need when they want it. If they request a certain specification, product mix, and delivery date, they want to know whether these service needs can be met, and what near matches are also available.

Uncertainty Over the Internet for New Car Sales

Dealers are in an uncertain position on how to embrace the Internet for new car sales. The introduction of vehicle selling over the Internet is seen as a threat by some dealers, concerned that they will lose significant market share of price driven, online purchasers either buying direct from the manufacturer or from importers such as Jamjar or Virgin Cars.com. Others feel that brokers such as Autobytel are building an Internet presence for dealers and customers in the gap left open by VMs. These brokers are able to advertise over any geographical area and allow customers to search for value offers by contacting many dealers quickly and efficiently. Some dealers feel that the customer prefers a face-to-face purchasing experience, built on the more traditional concept of 'service and trust' and that the Internet cannot replace these elements of new car buying.

'Clicks and mortar' summarises the use of the Internet in the USA where it is generally perceived as an extension to existing customer services and where vehicle enquiries are directed to the nearest available showroom. In the UK, leads to customers are being generated for dealers via manufacturer sites and brokers, but very little through their own sites. However, it must also be remembered that the UK is behind the US in most respects in e-commerce, although it is catching up fast. The 3DayCar National Franchised Dealer Association (NFDA) survey highlighted that dealers feel slightly threatened by the Internet, but would have faith in a 'clicks and mortar' approach if the manufacturers gave them more of a lead in implementing an integrated online new car sales presence.

Dealers & Change

Dealer IT Systems currently suffer from excessive hand-keying, duplication of processes and poor integration. They have largely failed to capitalise from the techno-

logical advances of the last decade, shown by their reliance on manual controls and hard copy documentation. However, to what extent have barriers emerged through a lack of technological integration as opposed to process re-engineering?

Significant conflict exists in vehicle retailing at present between the traditional 'territorial sales' approach encouraged by the VMs, and the 'empowered customer' approach currently being adopted by new entrant IT specialist companies. New entrants who offer customers the facility to trawl for a quote from any number of dealers, are undermining the current system based on local sales territories. Despite the imminent threat of losing market share to importers, the traditional boundaries between VM/dealer and dealer/dealer remain, where system ownership and resistance to sharing is obscuring the potential benefits of a collaborative solutions. One dealer is quoted as saying:

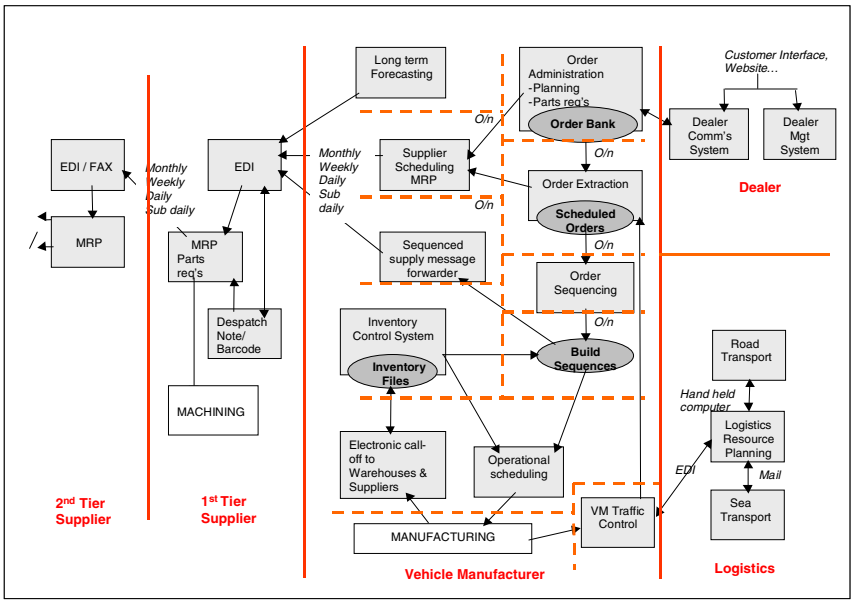
"Technology is the easy bit, 90% of our problems are process related".

Vehicle Manufacturer

"The Internet is the 21st century equivalent of the moving assembly line." (Jac Nasser, Ford Motor Company CEO, 1999-2001)

'Batch Processing' represents a major IT systems barrier to 3DayCar where large numbers of customer orders are processed prior to production at a set time every 24 hours. The current configuration of VMs' systems typically results in individual mainframe systems updating overnight, processing batches or 'buckets' of orders in time intensive cycles that adds four to five days to the order lead time (Figure 4). Due to the fact that the information flow through the batch processing systems is largely un-sequenced, it

Figure 4: Generic IT Map of the Automotive Supply Chain (Howard, 2000)



is possible for the output of one process to miss the start of the next window, adding further time into the process.

IT managers confirmed that there was an increasing emphasis on developing the capability for building-to-order. Proposals had been made to 'speed up' the system by shortening batch processing periods to around 10 minutes (currently around four hours, overnight). This represents a logical progression for VMs that can avoid scrapping existing databases, and only needing to replace IT software in order for it to handle such a change.

IT System Legacy

Legacy systems were originally built for a 'different world' of IT capability, specific tasks, and where technology was associated with 'control'. Systems today are still driven by in-bound logistics and pushed by production, rather than by order demand.

It was found during the research that the total lead-time required to develop, pilot and 'roll-out' systems across several continents could be as much as 10 years. Once committed to an operational IT strategy, VMs have little choice but to complete them almost regardless of any changes to the external business environment that may occur during the period.

Changes to the IT infrastructure have been achieved in the past by simply 'bolting on' additional systems alongside existing mainframe architecture. For example, in the 1990s, PC-based, client-server architecture offered a powerful industry standard on which to base new systems. However, very few of the old systems were ever fully engineered out of the business and switched off, resulting in a mess of complex, overlapping networks. Today a typical production plant runs over *200 separate IT systems*; hence, many VMs are faced with an expensive and ongoing burden of replacement and repair of an aging 'spaghetti' infrastructure.

Often, the fault lies not with the legacy databases themselves (the 'IBM AS 400' remains one of the most popular and reliable models from the 1980s), but the network of cabling, applications/software and user terminals, that require replacing without disrupting the order flow.

The introduction of 'middleware' technology such as Tuxedo (BEA Systems) has significantly increased the flexibility of writing IT applications as business services and linking this information with local area network and Internet-based environments. However, the success of this approach depends on the reliability of the legacy system. Some VMs have begun to recognise the weakness of simply building onto existing infrastructure and are now systematically replacing sections with 'modular solutions' that offer a universal platform and the flexibility to accommodate future change. There are products available now that allow core systems to be retained without having to renew the entire network.

Stovepipe/Chimney

IT systems tend to be designed to meet the specific objectives of the different players in the supply chain within an organisation. They are not, therefore, driven by true customer order fulfilment philosophy and inhibit smooth order flow. 'Stovepipe/chimney' refers to the mentality that focuses on the requirements of specific parts of the process without considering what effects may result in other areas. This multiplies the

series of batch systems operating, such that once an order has entered the system, it is often invisible to the rest of the organisation and other supply chain partners until it reaches the order sequencing or operational scheduling stage.

The stovepipe/chimney mentality also extends inside the functions. Manufacturing is a particular example where, once an order enters the order bank, it often cannot be amended, before emerging from production in, at best, eight days time. The extent of IT legacy means that the ability of VMs to move toward a BTO environment is severely limited. VMs are largely governed by a centralised 'package' mentality, built around an in-bound logistics optimisation view rather than out-bound customer delivery. There is some evidence of a growing emphasis being placed on removing internal stovepipes and increasing system visibility. However, where this is the case, change is quoted by automakers on a timescale of five to 10 years.

Central Management Systems

Central management systems are popular amongst VMs because of the ease of maintenance and the purchasing advantage gained through economies of scale. However, the time lag introduced at regional plant level, where central batch processing cannot allow for local time differences, can result in higher levels of inventory.

The research also found examples of managers flying around Europe looking for the original IT system architect. In some cases, it took weeks to locate and resolve the system query because the problem originated from central VM headquarters, located on the opposite side of Europe.

Driven by material optimisation, IT systems are designed for the purchasing and in-bound logistics (pull to production) aspects of supply rather than for the flexibility to respond to individual markets (pull to customer demand). Is there a case for examining the balance between central versus regional systems?

Supplier

"Once you get past Tier one, there aren't any system standards." (IT Manager)

EDI Standards

Electronic Data Interchange (EDI) emerged in the early 1980s as a bespoke, dedicated communication link between two organisations for logistical and technical messaging. Suppliers perceive the major IT system barrier as a lack of adherence to EDI standards by VM's in terms of protocol and data format (label layout). Protocol means the language used during transmission: for example, OFTP (Odette File Transport Protocol) and TCPIP (Transport Control Protocol — Internet Protocol). Data format refers to the visual interface containing predetermined fields or subsets into which information is entered: for example, supplier name, address, date, material, and quantity.

Odette was set up as the original EDI system with the support of Ford Europe in the early 1980s, but they felt the system was not developing fast enough and went on to develop VDA and Fordnet. While many European Suppliers still use a version of Odette, France has developed its own system called Galia. No VM uses EDI in exactly the same way. The differences usually manifest themselves in the layout and content of the data. In an attempt to make systems more compatible, all VMs have pledged to adopt a new standard called Edifact where everyone will use universal 'fields' (i.e., *NAD* — Name and

address, *QTY* — Quantity, *DTM* — Date and time) with free-text fields left for specific comments.

Currently, EDI format changes are made by VMs up to three times a year. Suppliers are already receiving messages in about a dozen different formats, all of which must be converted to a common standard before they can be processed internally. This all causes delay and disruption to the system, particularly in the event of a system malfunction. During the research it was calculated that each format change costs a supplier around two 'IT manager weeks' of labour. Considerable time is also spent with IT software consultants, where suppliers are understandably reluctant to build and maintain a customised system with diverse inputs from around a dozen demanding customers who seem to change their minds on a whim. Suppliers are currently concerned about the significant costs of IT system administration caused by the undisciplined approach by VMs and the implications of adopting new technology on an unregulated, firm-to-firm basis.

With traditional EDI, there is usually no acknowledgment, where messages are sent at a pre-agreed time to ensure the equipment is switched on and operating correctly. Internet communication offers many business-to-business benefits, particularly in areas such as automatic electronic invoicing that may soon become widespread across the industry. However, like many aspects of electronic communication discussed so far, homogenous procedures need to be established by all players.

Internet Security

There is some concern by suppliers who have adopted Web-enabled systems that do not offer sufficient reliability or security to conduct transactions between businesses. A total system failure, whether caused by the Internet or otherwise, cannot be buffered by the low stock levels typically held at most assembly plants. However, Internet security is being improved with the use of a virtual 'firewalls' which are inserted between the host organisation's core communication platform and the external electronic environment. Supply partners wishing to share information must first verify their identity via a password.

Some suppliers question whether the Internet is ready to support mission-critical operations, despite its success in other areas of commerce (e.g., Internet banking) where delay in delivering a message could ultimately mean the stopping of a vehicle assembly line. Accountability would ultimately rest with the supplier. The delays and occasional inconsistencies currently experienced in e-mail delivery, not to mention the new dimensions of Internet crime such as hackers and viruses, are regenerating some support for traditional, dedicated 'machine-to-machine' links such as bespoke EDI.

Visibility

Internet technology potentially offers total connectivity and visibility to the auto industry. At present, the component supplier does not know the true demand for his product. The end customer is seen as the VM, not the new car buyer. Current IT systems reflect this: There is no customer delivery date attached to any parts ordering. A component may be used within days of its despatch or may remain in inventory for a considerable period.

In the transition from traditional EDI to Web-enabled systems, the full potential of total visibility across the entire supply chain must be exploited: The system must not simply emulate the original functional, stovepipe/chimney mentality. A recent development is 'WebEDI' which emerged in the late 1990s using XML code and standard computers to offer a flexible, low-cost solution for suppliers seeking a connection to other business partners via the Web. It is increasingly used by tier 1 suppliers to overcome the high costs of installing bespoke EDI to connect smaller upstream partners, where improvements in efficiency and responsiveness can reduce the need for safety and buffer stock.

Questions remain about how suppliers will fit into the consortium automaker portals like the 'Covisint' Internet trade exchange founded in 2000 by Ford, General Motors, and DaimlerChrysler (also known as a portal or 'e-hub'). Some industry observers think a single automotive e-hub will evolve linking everything from the lowest-tier suppliers to dealers. Others believe a variety of exchanges will emerge, not a single online marketplace that dominates the industry. To date, the fortunes of the e-hub in the auto industry have been mixed, with Covisint suffering from a Federal antitrust case, delays in the introduction of new technology, and departures of a succession of CEOs. Current total investment in the hub stands at $500 million with still no sign of the business reducing its losses (ANE, 2004). Yet 'SupplyOn' is a successful third party managed hub originally founded by Bosch, which currently serves 2,700 suppliers. It receives a monthly subscription from each firm in return for the provision of electronic training, a connection service, and online collaborative product engineering software.

Logistics

"E-commerce and IT will wring out cost from our massive supply chain management systems." (Ford press release on their alliance with UPS Logistics, USA, 2000)

System Integration & Data Quality

In-bound logistics IT systems for materials and components to be delivered to the assembly line are more developed than out-bound vehicle distribution, but this contradicts the value of the goods carried. Despite having their own systems, the lack of contractual commitment given to logistics providers by VMs on out-bound delivery promotes a short-termism that hinders long-term investment and the development of new IT.

Vehicle manufacturer annual capacity is based upon a production plan and sales forecast, which will differ over the year. Capacity judgments by the logistics provider are based more on risk management than firm data. More information is required by logistics providers prior to vehicle release from production. The key issue is poor data on projected volumes and resource planning, as part of the general quality of advance information from VM's central control.

Labelling

In supplier-to-supplier logistics, or in-bound logistics, to the VM assembly plant, there are no universal standards in terms of Odette label formats. Upon receiving an EDI transmission, labels are individually printed off, attached to a crate or 'stillage', and the

bar-code portion scanned before departure and upon arrival. However, subtle label format differences require significant levels of VM-specific knowledge by all individuals who come into contact with the system, creating confusion and inevitably resulting in time lost during the process.

Converting electronic data to 'hard-copy' documentation is becoming a very lengthy process for suppliers faced with delivering vehicle parts to depots in transit to other destinations. Typically seven duplicate copies of documentation per part are required, specifying carrier, warehouse, depots, and final destination. Some areas of inbound delivery work well, assuming constant demand, such as sequenced in-line supply. However, it will be some time before logistics providers, suppliers and VMs achieve a truly 'paperless revolution' where electronic tagged containers automatically trigger a goods-received message as a truck completes its delivery, which in turn sets off a sequence of electronic billing.

Connectivity: Wide Area Networks & Extranets

Lack of connectivity is the main technical obstacle, particularly in current outbound logistics. Wide Area Networks (WANs) will replace Local Networks (LANs) and these WANs can be combined with company intranets to provide a shared space, an extranet, portal, or electronic hub. The combined power of e-hubs can be harnessed to provide a high portability of information, ease of transfer and access, eliminate re-keying of data and time lost on updates.

The replacement of traditional LAN-based access within companies by e-hubs will allow increased portability of information, reports and real-time data exchange between departments increasing their 'single world view'. This should improve the chance of non-contradictory messages from VMs being exchanged with supply chain partners, a common issue for logistics providers for out-bound transport. A common platform is needed to facilitate sharing spare capacity, particularly on return runs (called 'back loading') between rival haulage firms, although this requires significantly higher levels of trust between VM/logistics and logistics/logistics partners.

Planning & Routing

Load consolidation and planning is executed as vehicles come in from the manufacturer. There is no direct consideration of load consolidation and planning by the manufacturer in passing advance information to the out-bound logistics company. In a 3DayCar scenario, this would be unacceptable. Currently, around three days is given to move product, including time taken for consolidation.

Transport providers use off-the-shelf routing and load-planning software, but the development of more sophisticated network planning systems is under development and can learn from route planning. This software uses "genetic algorithms" that claim to cut journeys through experience and recalculation: A route is reworked over result generations to improve overall journey minimisation.

Proactive decision making systems are required, such as suppliers taking control of replenishment, based upon a signal to build for delivery date from order placement at the factory. Mid-journey re-routing could also be harnessed by logistics companies using global positioning system (GPS) and Internet technology in order to provide a '24/7' operating environment, which is totally responsive to changing requirements and

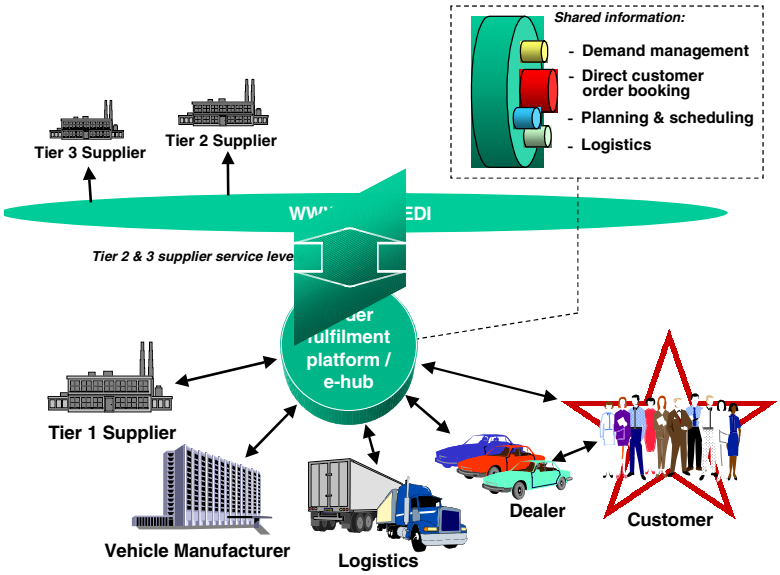
takes into account fleet capacity. However, this represents a significant speculative investment for logistic providers.

CURRENT CHALLENGES FACING THE ORGANISATIONS

Organisations wishing to begin the transition from mass production to build-to-order face a number of significant challenges. This is because the problem lies less with 'technology', and more within the people who use it. A mindset change is needed away from vertical, hierarchical reporting and the optimisation of only part of the system (i.e., production) and toward embracing the concepts of information transparency and responsiveness from the perspective of the end customer. Four core challenges for the automotive industry as a whole are raised here:

1. There is considerable work to do in Europe (and the US) in building an electronic infrastructure that overcomes the proliferation of standards and protocols that creates so much additional work for supply partners. A situation where information systems expand through poor regulation, such as the case with bespoke EDI, must not be repeated with Web-enabled e-commerce.
2. Better measures are needed to encourage supply chain collaboration and the adoption of inter-organisational systems over the nature of the realised benefits from building-to-order, and a clearer vision over who — other than VMs — are likely to share in them.
3. A coordinated adoption of information systems across multiple stakeholders is needed, driven by 'electronic leadership' skills that are currently lacking at boardroom level. The premature departure of Jac Nasser as CEO of Ford shows that even top executives are not immune from the outcome of business decisions involving the Internet.
4. In order to meet the requirements of 3DayCar and build-to-order, there must be a reduction in the number of processes that an order goes through prior to production. Eventually, customer orders should be treated as 'batch sizes of one' capable of being handled in real time. Hence, a major challenge facing the automotive industry today is how to adopt an Internet-enabled inter-organisational system that supports total supply chain transparency and connects all stakeholders with the customer (Figure 5).

Figure 5: Core Information Systems for 3DayCar



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