EDI and Interorganizational Coordination in the European Automotive Industry

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Abstract
In the automotive industry, some of the most complex partnerships between car manufacturers and suppliers can be observed. Electronic data interchange (EDI) can provide an integrated information infrastructure that contributes to the formation of collaborative interorganizational arrangements. Adopting a multiple case research methodology, this research explores the influences of EDI on the cooperative strategies of organizations and the structure of interorganizational relationships in the European automotive sector. A multidimensional research framework based on transaction cost analysis, resource-dependence theory and the network approach has been developed to analyse the complex effects of EDI use on efficiency, socio-political and structural aspects of interorganizational relationships. The findings suggest that the emerging hierarchical production networks are clearly dominated by manufacturers who currently seem to benefit most from EDI use. Although efficiency gains were achieved, suppliers become increasingly dependent on manufacturers, except for ‘preferred’ suppliers who can create dependencies to a certain extent. To achieve mutual benefits and ‘true’ partnerships, the management of reciprocal interdependencies as well as the permeability of organizational boundaries seem to be crucial for future strategies.

1. Introduction
During the last decade, numerous product and services markets have been subject to radical changes as a result of sharply increased competition. The increasing globalization of trade, the dismantling of trade barriers and increasing deregulation have meant that previously peaceful markets have been suddenly transformed. The globalization of trade, facilitated by radical improvements in transport and communications, includes the globalization of production as multinationals stretch across borders in their search for lower cost suppliers or optimum sites for new factories. In a buyers’ market, consumers have become increasingly selective regarding the quality and price of products, as well as demanding a wide range of different models and styles. Uncertainty and change characterize this difficult trading environment with product life cycles becoming ever shorter and production technology also
subject to constant change. Previously incremental and evolutionary change seems to have
given way to a discontinuity (Handy, 1989) that is forcing organizations to re-evaluate totally
their processes and structures.

This increased competition is having a major impact on the structures of both organizations
and markets. Large vertically integrated hierarchies are beginning to crumble in the face of
strong pressures to reduce costs and improve flexibility, responsiveness and innovation. Thus,
organizations are focusing on their core competencies (Prahalad and Hamel, 1990) and
outsourcing the production of components and the provision of peripheral activities (Huber,
1993; Quinn, 1992). This is leading to new forms of partnership and governance structures
(Scott Morton, 1991) as organizations seek to coordinate complex activities with their
suppliers through techniques such as just-in-time manufacturing.

Increased coordination requires a highly effective communication and information
infrastructure and IT-mediated relationships, using for example electronic data interchange
(EDI), are fast becoming essential components of this new industrial landscape. However,
although EDI can considerably reduce the cost of coordination and improve the management
of the supply chain, it may also significantly influence power-dependency relationships,
shifting the balance of power and control between trading partners, and leading to increased
conflict (Saunders and Clark, 1992).

This research explores the influences of EDI on the cooperative strategies of organizations
and the structure of interorganizational relationships in one particular market sector, the
European automotive sector. The study pays particular attention to the implementation of new
IT-mediated relationships and the distribution of benefits between trading partners due to new
coordination mechanisms. This sector is particularly interesting as it features some of the
most complex partnerships, because of just-in-time manufacturing and an increasing trend
towards vertical disintegration. Because of the competitive pressures, manufacturers have
changed their role from car producers to coordinators of a production network and
increasingly rely on their relationships with ‘preferred’ suppliers.

Given the few empirical and theoretical research studies that examine the impact of EDI on
interorganizational coordination and structure (Clarke, 1992; Cunningham and Tynan, 1993;
Malone and Rockart, 1991; Sheombar, 1992), an in-depth pluralistic examination based on
case studies is believed to provide a valuable contribution. It builds on two previous
quantitative studies conducted in the automotive industry (Bensaou, 1993; Klugherz, 1992).
This study moves beyond single organizational relationships and, taking a network
perspective, the unit of analysis becomes a network of organizations rather than individual
dyadic relationships. We focus the investigation on the relationship between car
manufacturers and their first tier component suppliers. EDI links between these parties are
most advanced and their relationship has undergone major changes (Reekers and Smithson,
1994). Data collection involved a series of seventeen in-depth interviews with representatives
from two German and two British car manufacturers and six supplier organizations. All the
interviews followed the same protocol, lasting on average approximately one and one half
hours. Semi-structured questions were used to elicit information on specific issues, and ample
opportunities were given to allow participants to recount their own experiences. The
interview data were supplemented with information gleaned from annual reports and internal
documentation. An informal triangulation was achieved by using a variety of sources while
focusing on the same events.
The following sections briefly survey the literature on new organizational forms and IT-mediated coordination mechanisms. Before presenting the findings, we develop a multidimensional research framework that identifies a number of key concepts which guided the data collection and analysis. This is followed by a discussion of our findings, which are summarised in the conclusion.

2. New organizational forms

The new forms of coordination, such as ‘networked organizations’ (Rockart and Short, 1991), ‘strategic networks’ (Jarillo, 1988) and ‘value-added partnerships’ (Johnston and Lawrence, 1988), are tending to blur the traditional boundaries between firms and have caused theorists to reconsider the underlying theories of economic organization. These new relationships are characterized by collaboration, trust, dependence and the pooling of expertise and information, characteristics which do not match either conventional arm’s length market contracting or vertical integration. Thus, the traditional dichotomy of markets and hierarchies (Coase, 1937; Williamson, 1975), based on a trade-off between production costs and transaction costs, is breaking down, although a new consensus has yet to emerge. Furthermore, the distinctions between the various new forms of organization are not always clear (Powell, 1987,p.68).

Many writers (e.g. Sydow 1991; Thorelli 1986) argue that these new organizational forms are merely an evolution of the traditional forms and can be located along a continuum between discrete market transactions and highly centralised hierarchies. In between these extremes, intermediate forms have evolved that combine characteristics of both interorganizational (market) and intraorganizational (hierarchical) transactions. This is reflected in the ‘move to the middle’ hypothesis of Clemons et al. (1993). Thus, Williamson (1991) extends his former dichotomy to include these hybrid organizations as a third generic form. Holland and Lockett (1993) support the notion of a variety of forms and argue that no single mode of coordination will predominate; rather there will be an assortment of ‘mixed modes’.

These new forms typically involve a number of nominally independent firms collaborating together for their mutual benefit in a network-like configuration. Thorelli (1986,p.37) groups these ‘in-between forms’ under the generic term ‘network’, which comprises a continuum of institutional arrangements ranging “from loose to tight, from arms-length bargaining to total integration, from spot transaction via standing relations to the internalisation of markets” but excludes the poles (market and hierarchy). According to Thorelli, the tightness of a network depends on the quantity, quality and type of interactions between its members.

However, other writers (Alter and Hage, 1993; Powell, 1990) reject this notion of an evolving continuum and regard these new organizational forms as the emergence of a new, fundamentally different, paradigm that will replace markets and hierarchies. They reject the notion of networks as a hybrid between markets and hierarchies, and argue that all three forms have their own distinctive logic and procedures. According to Powell (1990), networks are a unique form of organization distinguished by coordination based on mutual dependence. Powell rejects his earlier belief in the continuum (Powell, 1987) as follows:

“The continuum view [also] misconstrues patterns of economic development and blinds us to the role played by reciprocity and collaboration as alternative governance mechanisms. By sticking to the twin pillars of markets and hierarchies, our attention is deflected from a diversity of organizational designs that are neither fish nor fowl, nor some mongrel hybrid, but a distinctly different form.” (Powell, 1990,p.299)
Other authors treat network arrangements from a more strategic perspective, stressing the advantages of long-term, purposeful arrangements (Jarillo, 1988; Miles and Snow, 1992). It is claimed that these allow their members to gain and sustain competitive advantage from their relationships with other network members. Jarillo identifies ‘coordination through adaptation’ as the essential mode of organization (as opposed to a market or hierarchy). This is mainly driven by a ‘hub-firm’ which sets up the network and thus such relationships retain an element of hierarchy, reflecting the dominance of the hub-firm.

While recognizing these theoretical disputes, we shall adopt the term ‘hybrid’ as a descriptor for the ‘in-between forms’ in order to reflect both the similarities and differences with traditional markets and hierarchies. Similarly, we shall use the term ‘production network’ (Hakansson, 1990) to describe our network of organizations collaborating together in the manufacture of automobiles, as this term reflects the manufacturing nature of the endeavour.

3. IT-mediated coordination mechanisms

There is widespread agreement that IT can reduce transaction costs (Ciborra, 1993) through improving the efficiency of coordination and thus favouring a more market-oriented organization. This, according to Malone et al (1987) supported the emergence of electronic markets where the technology is used to support market mechanisms, such as the search for trading partners. However, they also noted the appearance of electronic hierarchies where the technology was being used to cement long-term relationships at the expense of market competition. This notion that IT can be used to enable a range of organizational forms, from pure markets through to increased vertical integration is supported by Gurbaxani and Wang (1991) and Malone and Rockart (1991).

EDI in particular can have a significant impact on the relationship between trading partners but there is some debate over whether EDI necessarily supports moves towards more collaborative supply chain relationships (Webster, 1993). According to Holland (1993) EDI can either accentuate existing types of boundaries and patterns of interaction or change the interorganizational structure completely. EDI can be used to create more efficient electronic markets or, in situations of high complexity and specificity, it can allow the development of complex hierarchies and integrated supply chains. Bergeron (1992) finds that integration, both internally and externally, is a determining factor in achieving strategic benefit from EDI. Horizontally, EDI seems to trigger integration towards a more holistic task processing within an organization (Picot and Reichwald, 1985). Vertically, EDI can foster a tighter integration of both upstream and downstream activities, to produce a ‘collapsing of the value chain’ (Rockart and Short, 1991).

EDI can also contribute to the establishment of new hybrid forms of organization, which rely upon a fully connected, integrated information and communication network, such as ‘value adding partnerships’ (Johnston and Lawrence, 1988), ‘interorganizational systems’ (Barrett and Konsynski, 1982; Cash and Konsynski, 1985), ‘information partnerships’ (Konsynski and McFarlan, 1990), ‘electronic integration’ (Venkatraman and Kambil, 1991) and ‘vertical quasi-integration’ (Blois, 1972). However, empirical evidence as to whether these radical changes have been established is rather thin (Pfeiffer, 1992). Hybrid relationships reflect a move from conflict to collaboration as they require a commitment to collaborate and a shared understanding; to which EDI can contribute by providing an integrated information
infrastructure. However, in turn, at the initial stage of the EDI adoption process, a relatively high degree of collaboration is required to agree on standards and procedural changes. Ideally, this can lead to a harmonisation of information handling practices. At a later stage, electronic trading can dismantle organizational boundaries as it permits sharing of information (e.g. stock levels or production schedules) and thus much closer relationships between trading partners.

However, much of the debate to date has been restricted to the cost and efficiency aspects of relationships between a single manufacturer-supplier dyad, with little concern for either the power and dependency aspects or the consideration of a wider network of interacting companies. In the case of the automotive industry, there is clear evidence of the decomposition of the traditional large hierarchies (vertically integrated firms). However, with the exception of a few, simple, low-value components, there seems to be little opportunity for electronic markets to emerge. The complexity of the components being supplied, and the associated high asset specificity and interorganizational dependence, means that spot market transactions are infeasible. Formerly the epitome of mass production, car manufacturers are now shifting towards more flexible forms of production and emphasize innovation, specialisation and higher quality. Production networks have now become an important contemporary phenomenon within the automotive industry.

4. Framework

The emergence of new coordination mechanisms enabled through information technology seems to necessitate the construction of not only new theory but also a synthesis of existing paradigms and perspectives in order to capture the complexity of the phenomena that can be observed. Out of a number of potentially fruitful approaches (Bakos and Kemerer, 1992) we have drawn on three major perspectives. Each of these perspectives has a unique emphasis that contributes to a broader understanding of EDI use for interorganizational coordination. Transaction cost analysis (Williamson, 1991) emphasises the organizational concerns with efficiency, resource dependence theory (Pfeffer and Salancik, 1978) highlights the degree to which an organization is dependent on other organizations for important resources, and the network approach (Fulk and Boyd, 1991; Sydow, 1991) makes the web of relationships more explicit. These perspectives establish three analytical dimensions that, taken together, allow us to analyse the effect of EDI use on efficiency, socio-political and structural aspects.

Rather than adopting a deterministic approach that establishes clear causal links we adopt an ‘emerging perspective’ that considers the interaction between the environmental context, new coordination mechanisms and various aspects of the relationships. Trying to isolate the effect of EDI use from other developments in the automotive industry is infeasible in the light of the complex interplay between the organizational and technological changes. Our multi-perspective research framework, summarised in Figure 1, shows how the environmental context has affected the use of EDI and highlights the conditions under which car manufacturers and their suppliers have adopted electronic trading. Given the environmental context, a coordination strategy emerges within a production network that increasingly relies on EDI use. This strategy affects political, structural and efficiency aspects of the production network. Feedback loops show that changes in efficiency, structure and dependence are likely to influence the coordination strategy, and the entire production network, in turn, has an impact on the environment. In the following sections we apply this framework to our study.
5. Environment: the automotive industry

During the 1980s, increased competition from Japanese and Korean car manufacturers forced European car manufacturers to change from mass production to a need to make individualised automobiles in small lots. Customisation as well as frequent model changes led to increased uncertainty and complexity of automobile production (Wells and Rawlinson, 1994). This radical change in the market led manufacturers to increase their flexibility by adopting the concept of ‘lean production’ (Womack and others, 1990) that aims to shorten production cycles, reduce work and space expenditure and lower inventory levels while increasing product variety and improving quality. A number of closely related strategies significantly changed their relationships with suppliers, such as the Japanese ‘kaizen’ (continuous improvement) principle, globalisation, just-in-time manufacturing and simultaneous engineering. The increased complexity of components supply led manufacturers to recognise that the efficiency of external suppliers largely determined retail prices, the quality of the final products and, ultimately, their own competitiveness. Therefore, manufacturers changed their level of collaboration with ‘preferred’ suppliers from traditional arm’s length relationships to cooperative and long-term arrangements. Forming supply networks, they

Figure 1. The research framework.

Environmental Context
- Competition
- Dynamics
- Complexity
- Uncertainty

Dependence
- Culture
- Power
- Opportunism

Structure
- Size
- Centrality
- Connectivity
- Multiplexity

Coordination Strategy
- Scope of EDI use
- Intensity of interaction

Efficiency
- Transaction costs
- Complexity
- Uncertainty
- Asset Specificity

Production Network

- Interdependence
- Adaptation
- Division of Labour
- Stability
- Redundancy
subcontracted components and final assembly at unusually high levels and, within sole sourcing arrangements, shifted more responsibility for quality control and research and development to their suppliers.

6. Coordination strategy

A chief concern of manufacturers is to coordinate and synchronise the deliveries of materials with the production of their suppliers. Through backward coordination of the supply chain, manufacturers call-off materials more frequently in ever smaller quantities at shorter notice. This enables manufacturers to increase flexibility while shuffling-off inventory costs to their suppliers. To deal with these demands for more transactions and high flexibility, suppliers have to increase the flexibility of their own production through improved production control and increased buffer stocks. Increasingly, manufacturers include former external areas such as shipping and warehousing into their trans-organizational rationalisation efforts.

For these production networks, rapid communication between manufacturers, suppliers and shipping agents is crucial to coordinate tightly coupled production and logistics operations and thus EDI is an important element of manufacturers’ coordination strategies. Deterministic material requirements planning (MRP) systems from the 1960s and 1970s were unable to provide sufficient coordination because their prediction of requirements was based on previous production and sales data rather than on actual consumption (‘push-principle’). Changes in sales and production affected planning relatively late and, to ensure continuous production and to maintain a minimum of flexibility, expensive buffer stocks were needed. The introduction of EDI in the late 1970s allowed real time production control (‘pull-principle’) based on actual order positions.

As can be expected, the level of EDI use varies considerably between suppliers. Not only between the two main groups of ‘preferred’ suppliers and ‘sub-suppliers’ but also within these groups. As opposed to manufacturers and a few large suppliers, the majority of suppliers are small and medium-sized enterprises (SMEs) who do not have extensive internal information systems. Driven by car manufacturers to implement EDI as a condition of further trade, these organizations have to make investments in technology and, more importantly, in the reorganization of business processes. However, nearly all suppliers have implemented at least the delivery call-off message. Some orders are still transmitted through telephone or fax but in the very near future, manufacturers expect all their suppliers to implement the EDI order and call-off message. Considerably fewer suppliers receive the invoice message mainly due to the lack of interest from manufacturers who do not expect significant savings. EDI use for the actual payments is also at a very early stage due to complex negotiations with banks. Shipping data and quality control data interchange including links to shipping agents are at a very early stage of implementation. However, interviewees expect significant growth for these applications. The exchange of construction data through EDI has not been realised. Only one supplier we visited exchanges construction charts on tapes with the manufacturer. The main problem here is the lack of a single message standard and the incompatibility of CAD systems. Table 1 shows the major EDI messages and their function in the business cycle.
Ordering  Order  Enables the buyer to initiate a transaction with the seller. Orders can be ‘fixed’ or ‘open’.

Planning  Trend  Long-term (6-12 months) manufacturer production forecasts issued to enable advanced planning by suppliers.
        Schedule  Rolling six month forecast issued by manufacturer to enable more refined production scheduling. Often issued weekly/monthly.
        Call-off  Call-off against schedule. Initiates delivery from supplier to customer. Contains precise delivery instructions. Issued daily or hourly.

Distribution  Despatch advice  Allows the consignor to advise the consignee of the detailed contents of a delivery.

Payment  Invoice  Enables the seller to claim payment for goods supplied. In the case of self billing the ‘invoice’ is generated by the buyer based on goods received and is sent to the seller.

<table>
<thead>
<tr>
<th>Business Cycle</th>
<th>Message</th>
<th>Function</th>
</tr>
</thead>
<tbody>
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<td>Ordering</td>
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Table 1. Major EDI messages and their function in the business cycle.

7. Efficiency

In all the cases, suppliers claimed to have realised operational or first order benefits from the use of EDI, in addition to the major benefit of staying in business with the car manufacturers. Frequently, interviewees reported quantifiable cuts in transaction costs such as the reduction of costs for personnel, paperwork and transactions and an increased speed of day-to-day communication with trading partners:

Large supplier: “EDI frees up time from routine transactions for more challenging and more important activities. We have got more time and more information in problem situations. There are much less benefits from CAD/CAM applications.”

Supplier and advanced EDI user: “Quick, paperless information exchange across boundaries is essential between customers, suppliers, production plants, shipping agents, external depots, banks and the authorities. Without EDI we would not be able to manage huge amounts of data anymore.”

The direct investments in EDI systems, such as hardware and software, are not a major concern for suppliers or manufacturers. However, the indirect costs when integrating EDI into existing internal systems and the running costs represent substantial asset specific investments, as pointed out by one interviewee:

Large supplier: “The technology to start with EDI is relatively inexpensive. The real cost occurs somewhere else. The indirect costs to reorganize our internal data processing, maintain the link and to handle errors are very high. EDI customers require more programming effort to process their data with our complex production planning systems and to automate the synchronisation of production.”

From a manufacturer’s perspective, EDI is regarded as a productivity enhancing tool that enables them to manage complex outsourcing arrangements. For suppliers, the service enhancing capabilities are more important than the cost savings. To stay in business with car manufacturers, who often account for a large portion of their turnover, suppliers have to be
continuously innovative and meet the demands of these important customers. As a result, more transaction specific investments in terms of organizational and technological changes are required which help reduce the transaction costs of the manufacturer:

Manufacturer: “EDI is absolutely necessary for rationalisation. Traditional paper based transactions are too expensive. The market forces us to cut personnel costs because people get too expensive! Paper has to be eliminated first.”

On the other hand, the extra service provided by the EDI system is likely to increase the transaction costs of the supplier:

Large supplier: “Our additional service is not for free. Partnership with the manufacturers’ hand in our pockets cannot work in the long-run.”

Higher level benefits from EDI use seem to be more difficult to both achieve and measure. These are mainly strategic or second order benefits. The speed of communication and the sharing of information helps to reduce environmental uncertainty and makes suppliers more flexible to react to unforeseen changes in the production programme of manufacturers. It allows proactive suppliers to provide a better customer service which may give them a competitive edge over competitors. The following statements illustrate EDI’s potential to improve cooperation and coordination:

Medium supplier: “EDI encourages the sharing of information. The same information for all minimises misunderstandings and inefficient action. When talking to someone on the telephone both parties have the same numbers on their screen.”

Manufacturer: “EDI enables us to keep our suppliers informed about changes. We update our orders continuously so that suppliers can act accordingly.”

However, since the introduction of EDI, suppliers have noted significant variances of up to +/-15 per cent between initial orders and actual quantities delivered. In many cases EDI data insufficiently reflects reality. Typical problems reported by interviewees are: lack of manufacturer’s input control, double ordering, use of similar older parts or lost products. Instead of trying to make a few exact forecasts, manufacturers simply make frequent changes without considering the confusion these changes might cause for their suppliers:

Large supplier: “EDI reduced the planning moral of manufacturers. It makes it easy for them to constantly change their orders and difficult for us to plan our production properly. EDI makes the transmission of unnecessary information quite easy. One side has trouble to generate that information and the other side doesn’t really need it.”

Supplier: “EDI is a world of illusion. It is useless as long as manufacturers’ production processes are not sufficiently planned and stable. If customers neglect input controls, EDI data does not reflect reality.”

Thus, the unreliability of production information and the large number of production changes at short notice make it very difficult for suppliers to stabilise their production. The need for ‘helicopter missions’ (special flights to transport urgent parts) and the infeasibility of suppliers to stick to their own production plans illustrate that these flexible production systems do not work as well as manufacturers may claim. Sometimes chaotic situations can be observed:
Supplier: “First we get the three month schedule, then the one month schedule, then the one week schedule, then the daily schedule, then the fax message, and finally the telephone call desperately seeking urgent delivery of the component.”

Supplier: “We have got larger amounts of quicker and more accurate data but not necessarily better information of what’s really going on. We receive a few fax messages a month from a Japanese customer with all the information we need. And this is reliable information that is hardly changed afterwards.”

8. Structure

Rather than manufacturing the whole car themselves and practising extensive vertical integration, car manufacturers reduce the depth of their production by setting up production networks. Currently, it is estimated that 60 per cent of the total value of an average car consists of supplier parts (German Motor Association). Out of these, 10-30 per cent were purchased as pre-assembled modules or systems in 1991 and this is expected to increase to 20-50 per cent by 1996. Table 2 illustrates the trend from in-house production towards outsourcing for four major German car manufacturers represented as the relation between the value produced in-house and the total production costs.

<table>
<thead>
<tr>
<th>Year</th>
<th>Daimler Benz</th>
<th>Ford</th>
<th>Opel</th>
<th>VW</th>
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<tbody>
<tr>
<td>1987</td>
<td>49.0%</td>
<td>46.8%</td>
<td>51.0%</td>
<td>49.7%</td>
</tr>
<tr>
<td>1995</td>
<td>43.2%</td>
<td>41.4%</td>
<td>42.2%</td>
<td>44.1%</td>
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</table>

Table 2. Depth of Production for major German car manufacturers.

In addition to outsourcing, manufacturers are also reducing the number of suppliers with whom they interact directly and the connectivity of the production network. By the end of the 1990s, interviewees estimate that only 20 per cent of current suppliers will remain ‘systems’ or ‘preferred’ suppliers while the majority will lose their direct contact and will become sub-suppliers of simpler parts to systems suppliers. In terms of the number of functionally equivalent relationships (redundancy), Table 3 shows the extent of the change of purchasing strategy from multisourcing to single sourcing by 1989. In that year up to nearly 95 per cent of suppliers were the single source for a certain part or system for a car model.

<table>
<thead>
<tr>
<th></th>
<th>Daimler Benz</th>
<th>Ford</th>
<th>Opel</th>
<th>VW</th>
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<tbody>
<tr>
<td>Total suppliers</td>
<td>1,250</td>
<td>1,300</td>
<td>1,150</td>
<td>2,500</td>
</tr>
<tr>
<td>Single suppliers</td>
<td>1,187</td>
<td>800</td>
<td>1,000</td>
<td>900</td>
</tr>
<tr>
<td>Percentage</td>
<td>94.9%</td>
<td>61.5%</td>
<td>86.9%</td>
<td>36.0%</td>
</tr>
</tbody>
</table>

Table 3. Number of single suppliers in 1989 for production material.

These trends lead to more stable and intensive links between manufacturers and the remaining suppliers that become more closely integrated in the manufacturer’s production process. However, systems suppliers not only have to deal with volumes previously supplied by three or more suppliers but also need to coordinate the assembly of more complex modules with sub-suppliers. As most suppliers belong to production networks of other manufacturers as
well, the multiplexity of links causes additional pressures to meet each customer’s individual demand.

Medium supplier: “Module and system production is a great challenge for suppliers in the 1990s. We have to deal with new parts from sub-suppliers we never assembled before. We not only need to change our internal organization and production technology, the management of a larger number of sub-suppliers has to change, too.”

Figure 2 shows the traditional supply structure where manufacturers maintain relationships with a wide basis of suppliers and the evolving pyramidal supply structure with a polarisation of suppliers into systems and sub-suppliers (see also Deiss 1992, p.369).

9. Dependence

As relationships in the automotive industry become closer, interdependencies become more important. All suppliers agree that they are dependent on car manufacturers who make up a large share (in some cases, nearly all) of their turnover. Depending on their importance to car manufacturers, suppliers mention differing degrees of dependency.

Small supplier of standard parts: “We are completely dependent on manufacturers. Customers dictate what to do and force us to rationalise.”

Medium supplier: “We are directly dependent on manufacturers. If a major customer catches a flu we start coughing.”
Large supplier: “We are an important supplier and our customers can’t switch to another supplier easily. But we can’t afford to lose a car manufacturer as a customer. Therefore, we are always trying to fulfil our customers’ requests but we don’t want to commit ourselves too much. If the customer has got a works council meeting we don’t want to interrupt our production.”

However, through the reduction of the number of direct suppliers, manufacturers also become increasingly dependent on their ‘preferred’ suppliers. Coordination of production between manufacturers, systems suppliers and sub-suppliers leads to close mutual adaptation of production rhythms (e.g. holidays in parallel or additional Saturday shifts), scheduling or delivery systems. Single sourcing and modular sourcing creates a small numbers situation for manufacturers as they cut back their own production and make supplier specific adjustments. Suppliers can provide their customers with features that they want, or cannot do without, thus making important customers more dependent, e.g. sophisticated logistical services. The failure of such a key supplier would have far reaching consequences for manufacturers. With high dependence on the ‘preferred’ supplier, the manufacturer may not be able to replace the supplier easily because of the rigidity of the relationship formed after the implementation of EDI. However, manufacturers cannot consider each of their large number of suppliers individually but have to make general requirements that are binding for each supplier who wants to do business with them, such as determining the way information is exchanged between parties.

Manufacturer: “We can’t simply switch to another supplier. A synchronous supplier is like one of our plants and very important to us. We depend on our suppliers’ know-how. Complex and innovative components are difficult to get because it takes a long time to build up a good relationship with important suppliers.”

Although manufacturers increasingly depend on their suppliers, it can be observed that the manufacturers’ influence over suppliers increases quantitatively (in terms of degree of influence) as well as qualitatively (the range of operations influenced) and that power is centralised and shifted to manufacturers.

Supplier: “Benefits of EDI are largely on the manufacturers’ side. Suppliers are expected to adjust to their requirements. Manufacturers want to know essential internal parameters and share the savings we achieve through rationalisation. This shows who dominates.”

Dramatically increased information sharing would provide manufacturers with direct influence on the suppliers’ production plans, giving them increased control over their suppliers. However, suppliers are reluctant to give customers instant and direct access to their internal production systems. In one case, however, a supplier provided a read only access for the manufacturer to read its own orders. Even this limited facility caused some conflict between the supplier’s IS department and its production planners. As mentioned by a production planner:

Large supplier: “We don’t want to give away too much information. Nobody likes to be looked over the shoulder.”
10. Discussion

The findings show that for suppliers, as well as manufacturers, efficiency gains can be achieved. Companies benefit from faster and more secure flows of information and materials that allow them to reduce capital tied up in stocks. EDI provides up-to-the-minute information for decisions about production and deliveries. In addition, EDI enables organizations to develop and rationalize their operations. It is a potentially significant investment to enhance competitiveness and raise profitability.

From a power-dependency point of view, however, the supplier’s decision is virtually restricted to whether or not to stay in business with the manufacturer. If the supplier decides to continue the business relationship, and in many cases suppliers have little choice but to do so, their planning autonomy in terms of investment and production is considerably influenced by the manufacturer. Forced rationalisation investments are the result of the continuation of the manufacturer’s internal rationalisation of material flows across organizational boundaries. Due to their size and power, manufacturers can usually get their way. Within the emerging production pyramids that are enabled through EDI, the suppliers’ decisions are more and more replaced by systemic requirements that restrain their entrepreneurial autonomy. Once initial and specific investments are made by the supplier, the manufacturer’s influence shifts to the production sequencing itself. A ‘production dependency’ (Nagel and others, 1990, p.112) on the manufacturer is likely to evolve as it is the manufacturer who centrally coordinates the production network. This creates a dilemma for suppliers: to optimise production within the network, planning is more and more synchronised with the manufacturer’s production by closely integrated information flows and organizational and technical adjustments. But, due to frequent changes of call-offs, suppliers cannot achieve the desired optimisation. Instead, external planning errors are directly transferred into their own system making the supplier’s production unstable and difficult to predict. As planning is outside the suppliers’ influence, they are under pressure to fulfil material call-offs even if orders are changed at short notice. This requires drastic organizational and technical adjustments to rationalise and to ensure flexibility.

If manufacturers could improve their long-term and short-term forecasts and control the deviations from intended orders to actual orders, suppliers would be able to smooth their material procurement, production and capacity plans as well as distribution plans. This would reduce the additional costs, such as stock holding, and would enhance value adding processes. However, if manufacturers still try to optimise their own production at the expense of their suppliers, this may have a negative impact on cooperation with suppliers, perhaps preventing long-term ‘true’ partnerships. Possible reactions suggested by suppliers could include delaying deliveries which would slow down the manufacturer’s production and reducing support when the manufacturer is in trouble and needs extra parts. Ultimately, if an important systems supplier terminates a business relationship it may be very difficult to replace this supplier.

11. Conclusion

The empirical results derived from case studies in the German as well as the UK automotive industry provide insights about EDI use in two particularly advanced user communities in Europe. The integration of complementary theoretical perspectives into an eclectic framework has proved to be more useful in capturing the multi-dimensionality of the phenomenon than a
single theoretical perspective. Referring to the internal organization, Lawrence and Lorsch (1967) state that when environments are changing rapidly by demanding higher quality of products and services and a broader range or mix of products and services, then organizations must become more complex and differentiated in their internal structure and processes in order to meet these expectations. Our findings show that this thesis can be applied to interorganizational relationships. The automotive industry is a good example of the integrative potential of EDI that contributes to the formation of new cooperative arrangements. These represent a significant cultural change from adversarial to long-term relationships that are characterised by responsiveness, frequent interaction and a high level of integration of interorganizational processes. In providing continuous information exchange, EDI is an important enabler to gradually build up a common production philosophy as well as a shared understanding of the business.

The new organizational structures in the automotive industry are hierarchical production networks that are clearly dominated by manufacturers who currently seem to benefit most from EDI use. Suppliers become increasingly dependent on manufacturers, except for systems suppliers who can create dependencies themselves because of their technological competency and provision of advanced logistical services. In the future, the management of reciprocal interdependencies as well as the permeability of organizational boundaries seem to be crucial if companies want to achieve mutual benefits and true partnerships.

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References


