ELECTRONIC DATA INTERCHANGE CONCEPTS AND ISSUES

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INTRODUCTION

Over the last decade, the use of information technology to support the exchange of information, both within and between organizations, has been constantly growing. One of the most important areas of growth has been the application of technology to the exchange of structured information between companies, generally referred to as "Electronic Data Interchange" or just EDI. While some reports indicate widespread adoption of EDI in the US (Benjamin et. al. 1990; Masson 1992; O'Callaghan et al. 1992; Swatman and Swatman 1991), reported usage of EDI in Europe is scanty (CEC (Ed.) 1991, Pfeiffer 1991). In this chapter, we will describe the 'basics' of EDI. We focus on a typology of EDI, discuss some theoretical notions that underpin EDI, and describe the normative expectations about EDI benefits, before we conclude with some remarks on EDI message standards.

DESCRIPTION OF EDI

EDI is, above all, a way of conducting inter-organizational transactions electronically. In this regard, EDI systems should be seen as a subset of inter-organizational systems (Cash and Konsynski 1985). However, what differentiates EDI from other inter-organizational information exchanges is that EDI data is meant to be used directly by computers. In other words, Electronic Data Interchange is 'the inter-company computer-to-computer communication of standard business transactions in a standard format that permits the receiver to perform the intended transaction' (Sokol, 1989, p.12).

'Inter-company' specifically refers to the electronic transmission of data between different companies. This implies that two or more companies trade electronically and that they must have common communications capabilities. As this is not always the case, the companies involved either purchase communication hardware and software, or seek the services of a third-party service provider to act as intermediary. As a project that spans company boundaries, EDI requires a great deal of coordination and involves representatives from trading partner firms and possibly third-party service providers.

Not only are data moving between organizations, but they are, in fact, moving 'from computer to computer' between applications. The computer applications are assumed to be in place at both ends (the sender and the receiver) prior to the implementation of EDI. In the traditional environment the sender application generates a paper-based transaction and a person mails it to the receiver. The receiver enters the data and processes it by running the receiver application. In an EDI environment the sending application generates a business transaction, transmits it to the receiver, and the receiver uses the data as input to the receiving application. This places a good deal of responsibility on the sending application to generate complete and accurate business transaction data and on the receiving application to interpret the data received.

Ultimately, EDI is intended to allow the receiver to perform a 'standard, structured business transaction' automatically, e.g. accept and process a purchase order or bill a customer. While paper-based transactions are somewhat free-form in nature, and sometimes require human intervention to complete or correct them prior to processing, machine readable transactions cannot be interpreted correctly by the receiving computer application if they contain any ambiguities or errors. Exceptions must be handled by hand, which eliminates many of the benefits of transmitting them electronically. Difficulties can also arise when the sending application must be enhanced to provide additional data or when the receiving application is not prepared to use all data fields that it potentially can receive. For this reason, many organizations set-up EDI linkages on standalone microcomputers (front-end) without integrating EDI with the applications running in the mainframe. For these organizations, the difficulties associated with the integration seem to off-set the benefits that would, otherwise, be derived from a fully automated data interchange system.

In order to be recognized by the receiving computer application, the transmitted data must be in a 'standard format'. Cooperation between trading partners is thus essential. Trading partners must agree beforehand on the form and content of business transactions in order to have a successful EDI implementation. Use of a standard is agreed to by trading partners, who also agree to support the standard syntax and usage rules in order to insure that the receiving computer application can interpret the incoming data correctly and process the transaction properly. Since the standard format is meant to serve only as a way to facilitate communications, no change of the internal application is required in order to implement EDI. Instead, a piece of software ('translation software') must be developed by both the sender and the receiver, which acts as a bridge between the internal application and the standard format. The sending application still generates the data for the paper-based transaction. However, rather than print it, the data necessary for the standard format of the transaction is mapped into the appropriate fields. The transactions are communicated to the receiving party. They are fed directly into the receiver's 'translation' software, which maps the standard data fields into the input format required by the receiver's application software.

Consider the following example of how Electronic Data Interchange works: Figure 1.1 shows a participant or buyer, a seller and the EDI data transmitted from the provider's computer to the participant's computer. The buying company generates the transaction in its purchasing application. However, instead of using the purchase order data to develop the traditional paper-based transaction, it passes the data through the 'translator,' the piece of software that maps it into a standard machine-readable data format. This format is then transmitted to the seller's site, where it is passed through his 'translation software' which maps it to the internal format expected by the seller's order-entry application. The order-entry application processes it just as it would do with any incoming purchase order.

Insert figure 1.1 about here
Title: An example of an EDI purchase order

Today, some software vendors offer EDI front- or back-ends to their application software packages. These software packages avoid the need for a translation software by performing themselves the interpreting and mapping functions between the standard format and the internal format.

TYPOLOGY OF EDI

In discussing EDI systems it is useful to classify them by a variety of factors. In this section we identify those factors that can be used to categorize EDI systems and we provide definitions for terms that will be later used in analyzing and interpreting the cases contained in this volume and to represent particular EDI configurations.

Agents in the EDI exchange

The **supplier** or **sponsor** of an EDI system is the individual or firm that provides EDI service usually in return for a fee. The supplier puts up capital for the design and implementation of the EDI system; determines the standards or protocol upon which the EDI system will be based; defines the business transactions to be handled by the system, e.g. invoices; develops and distributes the EDI software; establishes policies and procedures; and sets conditions for membership in the business venture. In return, the supplier usually receives revenue payments from the participants or direct users of the EDI system.

Participants or **direct users** of the EDI system are individuals or firms that make use of the EDI service provided by the supplier, usually by paying a fee. This service consists mainly in the ability to exchange business transactions with other participants and possibly the supplier. While participants may play a part in the conception and initial design of an EDI system, their role is often less influential than that of the supplier. **Trading partners** are members of the EDI network, usually participants and the sponsor, who exchange business transactions with each other, through the system.

Third-party **agents** provide value added services to an EDI system. For example, a communications provider may have a packet-switched network service that the supplier uses to interconnect participants. The network services supplier may become a partner in the EDI venture because of the potential the system has to generate network traffic. Third-party agents are usually paid a fee based on transaction volume for the services they provide. Such an agent would not be considered a trading partner.

Indirect customers do business with the trading partners in EDI system. They may also interact with the supplier or the agent directly, thus becoming participants, especially where the primary cost of joining the EDI system is the cost of obtaining network access. Frequently, some of the benefits of the EDI network are passed on to the indirect customers in terms of faster response time or better service.

If one wants to understand the motivation for joining an EDI network, it is important to know how benefits are allocated among these various classes of trading partners. While an intuitive answer is that the major benefits accrue to the supplier, because he is instrumental in conceiving the system and in financing it, in some well-known examples almost all of the benefits have been passed on to participants (e.g. McKesson's Economost). In addition, it is our contention that the allocation benefits may well change over the life of a system, starting out accruing to the participants, then shifting to the supplier as the system grows, and then shifting back to the participants as the system matures. Finally, it is useful to understand how customers are effected, for example, by obtaining reduced cycle time or cost. Customer-participant interaction often determines the value of an EDI network.

Topology of EDI networks

For networks without a third-party agent, there are three possible configurations: 1:m, 1:1, and m:m. Networks with one supplier and many participants are called **1:m** (the supplier is designated by the first number while the participant is shown as the second). When there is only one participant the network is called **1:1** (the degenerative case). Networks with multiple suppliers and multiple participants are called **m:m**. These can develop into **electronic markets**.

Networks may be either non-competitive or competitive. In **non-competitive** networks, neither the participants or the suppliers are in competition with each other. In these situations there may even be direct communication among participants. Knowledge of the competitive position of the actors in an EDI system is important in understanding various behaviors and system requirements, for example, what may be shared among the various actors or natural conflicts. **Competitive** networks are ones where either participants or suppliers or both are in direct competition with each other. Competitive 1:m networks require some degree of confidentiality to be maintained by the supplier as the network may involve differential pricing of products or services provided by the participants. Competitive networks may require additional facilities, such as settlement and authentication services.

Kinds of information partnerships

Portions of existing organizations may come together as suppliers, participants or agents to provide the EDI service. The realization that a firm need not own all of the assets involved in a business relationship has given rise to the notion of information partnership where firms work together instead of competing (Konsynski and Warbelow 1991). This joining of forces without merging has many advantages. It can provide access to new groups of customers; it can allow firms to take advantage of new distribution channels; it can promote product differentiation, and it can result in significant sharing of risk.

Four different kinds of information partnerships have emerged. **Joint marketing partnerships** permit firms to have the increased flexibility of coordinating with rivals where there is an advantage in doing so and yet to specialize where this is beneficial. An example of this kind of partnership would be the large network of **combined marketing programs** provided by airlines, hotels, rental car companies, and bank credit cards that has emerged. In marketing partnerships, participants gain access to both new customers and territories as well as potential economies of scale if demand builds. The agent in this situation has an opportunity to use excess channel capacity productively. **Intra-industry partnerships** involving small or medium-sized companies who see a need to pool resources. For example, in order to create the ATM infrastructure of electronic banking a number of financial institutions joined forces. Such systems can provide services directly to the customers of an industry that permit the industry to compete more effectively.

Customer-supplier partnerships often provide an opportunity to establish an EDI system. These systems may permit reallocating functions among firms that are beneficial to both. For example, a firm may be able to dispense with, say, an inventory function, while another firm, by taking on this function and through economies of scale, may be able to provide an inventory product that is differentiated on the basis of cost or function from their competitors. **IT vendor driven partnerships** occur when a platform provider permits the creation of novel products or services that make use of the platform. This can occur when a manufacturer provides advance (beta) copies of equipment or software for a vendor to test and for product development prior to general release to the public.

Information partnerships are an effective way to obtain the benefits working together without complete commitment of ownership. EDI systems facilitate information partnerships because they work out many of the details of interacting.

Other classifications of EDI systems

Directivity of flow

EDI systems can be classified as supporting either one or two-way information flow. Systems where information can only flow in **one** direction send transactions to either the participant or the sponsor. Since the transaction flow is only one way there are fewer opportunities to obtain value. Systems where EDI transactions flow between participants **and** sponsors are called **two-**way. Such systems are reciprocal and thus tend to balance benefits among different EDI actors. They also provide more opportunities for adding value. In general, the more opportunities to add value in an EDI network, the more likely it is to be successful.

Scope

Scope is **range** of transaction types handled by an EDI system (Truman, 1994). Systems usually start out handling **one** transaction type, such as order entry, and then expand to incorporate a number of others. The first transaction is the most difficult as the administrative details for handling it, such as the meaning of data elements, need to be worked out. It is also the most costly transaction as duplicate work must be performed to process both EDI and normal input versions of the transaction. However, as additional transactions are added, the marginal administrative costs decrease greatly as most of the mechanics of handling them have been resolved.

Intensity

Although a particular type of transaction may be committed to EDI, not all sources of that transaction may be capable of being handled by EDI, because the proper equipment and programs may not be available to all customers. Some customers may decide not to use EDI, or some firms that generate the transaction may not be members of the EDI network. The proportion of a particular transaction type handled by EDI is refereed to as the transaction's EDI **intensity** (Truman, 1994). When a transaction's EDI intensity reaches 100% there no longer is a reason for a firm to have multiple processing channels (EDI and non EDI) for handling it. From a cost perspective, a firm is best served by first increasing transaction intensity, because it permits releasing administrative staff associated with the non-EDI processing of that transaction, and then expanding EDI scope.

Functionality

EDI systems differ in their functionality. For example, systems that provide only information **access** need not be concerned with the difficulty of maintaining the integrity of on-line data bases, although they must contend with problems of security and authentication. Systems that permit information **update** along with access are more complicated because they must contain facilities for data checking and control of concurrent data change.

Reach

EDI system **reach** is the depth to which the functionality of the EDI system penetrates the organizational activities of a participating firm. That is, reach is the degree of **integration** between the EDI system and the firms suite of operational information systems. EDI systems may operate only at the boundary of a firm, requiring manual transfer of information to internal information systems. When information is transferred manually between systems, additional costs of double data entry and data correction are encountered. EDI systems may connect directly to internal information systems permitting direct transfer of information to these systems. However, this requires more coordination and it binds the participants more closely together.

Mass

An EDI network's mass is the number of trading partners participating in the system. There usually is a minimum number of participants beyond which the system can be considered to be economically viable. This is refereed to as the system's **critical mass.** Participation above this amount makes the network more profitable and may also involve network externalities with additional incentives for joining the network.

THEORETICAL NOTIONS THAT UNDERPIN EDI NETWORKS

A variety of concepts can be used to explain the dynamics of electronic trading. These concepts are useful, also, in predicting and understanding the effect of EDI network on trading partners and customers.

Transaction Cost Analysis

A central tenet of the transactions cost economics is that profit-oriented firms will organize in a manner that minimizes both production and transactions costs. Williamson (1975, 1985) defines transactions costs as those of searching for a supplier; drafting, negotiating and safeguarding a contract; or adapting to contract misalignments, setting arbitration disputes, and establishing secure commitments. Williamson identifies three critical factors that determine the magnitude of transactions costs: asset specificity, uncertainty and transaction frequency. Asset specificity refers to the degree to which an asset is specialized to an exchange relation, and where the asset value depends upon the continuation of the exchange relation. The higher the amount of such sunk investments devoted to a particular relationship, the higher the potential magnitude of "quasi-rents," or losses from the hold-up of the transaction by the other party (Klein, Crawford, and Alchian, 1978). The greater the uncertainty about the future performance of an exchange, or the value of the item to be exchanged, the more difficult it is to write contracts covering the exchange.

Increasing uncertainty and asset specificity, therefore, increase transaction costs as more complicated contracts and control mechanisms are needed to manage the exchange. If a specific transaction is repeated frequently, transactions costs can be reduced through the specialization and reuse of the governance mechanism, i.e., the contract. As transactions costs increase, firms will tend to internalize production through their hierarchy instead of undertaking exchanges with the market unless the market enjoys significant production economies.

Malone et. al. (1987) propose that the increased use of information technology, such as EDI, will result in a shift away from using internal sources of production (hierarchy) to external sources, such as those provided by the market. They suggest that cheaper and more efficient information processing reduces the transactions costs of writing contracts, and monitoring and ensuring secure commitments, thus making external provision of production more attractive. The resulting increase in demand enables external producers to aggregate production and, through economies of scale, achieve lower per unit production costs than can be obtained internally, permitting product costs to be lowered further. This results in external suppliers becoming even more attractive.

This explains partially the attractiveness of EDI networks and their tendency to grow. As more participants become members of the network, per unit governance costs decrease and there are more opportunities to obtain the product or service. This has the effect of lowering production costs through competition. The electronic connection further lowers coordination costs and encourages a more equal flow of information. This in turn increases the attractiveness of the EDI network.

The economics of an EDI network and its dynamics may change over time. For example, at birth, when capital is scarce and the system is below critical mass, the supplier may price participation low in order to encourage participation. Coordination costs would be relatively high and there may not be sufficient competition on the network to lower production costs. As the network matures and critical mass is achieved, the supplier may decide that the relative lowering of coordination and production costs through economies of scale and competition, respectively, has made the network sufficiently attractive to warrant an increase in the price for membership. It is our contention that EDI networks pass through a series of phases involving different membership and pricing dynamics (Kambil and Turner, 1994).

Agency Theory

Coordination failure occurs in competitive markets where there is interdependence between actors in an exchange. When there are problems in measuring the value of a good to be exchanged, or when individual valuations are unknown, significant resources can be spent in acquiring information. These can lead to haggling and sub-optimal patterns of bargaining and exchange behavior.

However, in a centralized authority system, such as a hierarchy, where producers and exchange parties are integrated into a single organization, inefficiencies are introduced by the central authority or management when they intervene in transactions. Inefficiencies arise when internal exchange parties invest substantial resources to *lobby* and *influence* management. Given unequal influence of individuals within hierarchies, management may not be an efficient allocator of resources. An EDI system may reduce the amount of management influence as the routine nature of EDI transactions short circuit many internal operations and thus reduce opportunities for intervention.

The agency perspective considers a firm to be a nexus of contracts among self-interested individuals. These contracts exist between the owner of the firm and its employees, all of whom seek to maximize their own utility. Agency costs are incurred due to incentive misalignments between the agent and the principal. Specifically, three forms of agency costs are incurred, primarily by the principal. *Monitoring costs* are those incurred in measuring the performance of the agent. *Bonding costs* are losses incurred as agents seek to reassure the principal of their good intentions and work. *Residual loss* refers to losses incurred due to incentive misalignments. In addition, within an organization there are significant internal coordination costs incurred in processing information and communicating between decision makers. Organizations tend to act in a manner that minimizes their agency costs.

EDI has the potential of lowering bargaining costs because it defines the terms of an exchange, it clarifies business transactions to be handled, and it provides structure for the relationship between principle and agents. This reduces agency costs as there are fewer opportunities for workers to lobby and attempt to influence management as well as little reason to do so. Since the terms of the arrangement are public or at least easy to obtain, it reduces the cost of obtaining information and bargaining costs in general.

Inter-organizational systems

Most information systems are developed to serve the internal needs of an organization. EDI systems differ in that they are developed to span organizational boundaries. As such these systems are more difficult to develop because they must accommodate a more diverse set of requirements and customers, and they must conform to international standards for EDI information exchange. It is less clear, also, where the locus of control resides with inter-organizational systems and how well the incentives of the development team are aligned with the goals of the system. Finally, the implied contract for development of EDI systems may be considerably different than the one for internal systems.

The research on the implementation of internal system recognizes two factors, top management support and user participation, as being key to implementation success. It is not clear what factors replace these when there is no obvious shared top management and most of the user community is yet to be identified.

NORMATIVE EXPECTATIONS ABOUT EDI BENEFITS

The characteristic that makes EDI different from other IOS is that EDI transactions may require no human intervention prior to processing. EDI messages are machine-readable transactions that can be interpreted correctly by the receiving computer application, without any errors or ambiguities. Therefore, EDI is the transmission of electronic messages which allow the receiving organization to perform automatically a business transaction. In practice, this has many organizational implications, such as direct savings in transaction costs, shorter lead times, fewer errors, and a the facilitation of strategies that imply a closer integration with trading partners. These benefits for using EDI are discussed next.

The use of EDI allows a company to reduce the costs of operations and to increase efficiency. The savings come from improvements in a number of areas: reduction in document handling tasks, reduction and/or better use of personnel, reduction in inventories, and reduction in other costs such as exception handling and premium freight (e.g. due to a mistake in a purchase order). The savings in document handling are dependent upon how the document was processed prior to EDI. For example, order processing and transmittal costs vary greatly depending upon whether the traditional method of preparing the document was manual or automated, and whether the traditional method of transmittal was via phone, mail, or personal delivery. EDI reduces the cost of processing by reducing or eliminating the following activities:

- repeated keying of redundant information
- manual reconciliation of different documents
- correction of errors caused by incorrect data entry
- sorting, distributing, and filing documents
- document mailing or telephoning of information.

The reduction in direct costs of document processing and transmittal, even if a very small saving on a per document basis, can have a significant impact on the organization's profitability. Across all industries, the number of documents required to process just one transaction has been estimated at anywhere from 5 to 20 documents. Therefore, for companies with a high transaction volume, the total savings may be quite significant.

Another type of cost often reduced due to the use of EDI is the cost of personnel. Companies may be able to operate with fewer personnel, or reassign them to more productive activities. A reduction of personnel costs result from the following:

- elimination of redundant re-keying
- elimination of manual reconciliation
- reduced time spent correcting errors
- 'freeing' professional personnel from administrative tasks.

Another type of cost that can be reduced through the use of EDI is inventory. EDI helps shorten the duration of the transaction (i.e. order cycle) and reduces the uncertainty associated with a request for re-supply. As a result, the need for safety stock is reduced. For many companies, inventory reduction is the most significant savings resulting from the use of EDI. Under a paper-based system, it may take several days for an order to get to the supplier and for the supplier to process the order. With EDI, the mailing and processing time are eliminated and, therefore, the need for the associated safety stock to cover this order processing time. EDI can thus reduce inventories without adversely affecting customer service levels.

But EDI can affect other costs as well. EDI may reduce transportation costs, particularly premium freight charges. Because EDI provides accurate information quickly, better planning and management of transportation can be done. For example: aggregation of otherwise small shipments (small shipments are more expensive on a per-unit basis than are full truckload shipments). EDI also reduces error costs by reducing the number of business documents that are either incorrect or lost. An error in a business document can be very costly. For instance, if an error is made in the quantity entered in a purchase order, the error will go unnoticed until the order is delivered. At that point, special handling and premium freight may be required to correct the problem created by the incorrect order entry. Along the same lines, a lost order can also be costly. In many cases the buyer does not know that the order was not received until the moment the items are delivered. In manufacturing companies, this can lead to a shut-down in the production line.

The use of EDI reduces these problems in several ways. First, because EDI reduces the number of times the same information must be entered into various computer systems, the number of opportunities for errors decreases. In other words, information received is the exact information that was created originally. No new errors can be introduced since no re-keying is done. Second, through edit checks in EDI software, some data entry errors at the source will be caught early. And third, EDI systems return an acknowledgment to the sender of the electronic message. This functional acknowledgment lets the buyer know, for example, that the document was received by the seller. Furthermore, an electronic purchase order acknowledgment, confirming the content of the order, can also be sent. While EDI does not eliminate all errors, it does allow for early, and less costly, detection and correction of errors.

Although the savings described can be significant in some cases, for many organizations the benefits of EDI come from improved internal operations and improved responsiveness to customers. In other words, EDI can be viewed as a new way of doing business, not just a cost saving device. The following paragraphs discuss such possibilities.

The implementation of EDI within an organization provides a chance to improve internal operations and even to re-design business processes altogether. The improvements can result from a review of current operations that should precede the implementation of EDI, from the integration of EDI with other systems, from better use of personnel, and from the management of more accurate and timely information.

Implementing EDI requires a review of an organization's existing operation. Before it is possible to replace paper flows with electronic flows, the paper flows must be understood. Therefore, a first step in the use of EDI is a complete review and evaluation of current operations. This step often forces many companies to 'take a hard look at themselves' for the first time. This assessment may include, for instance, examining inventory procedures, the management of multi-division operation, or redefining the relationships with suppliers. This reassessment often results in improvements to internal operations and the re-design of business processes (organizational re-engineering) even before EDI is implemented.

EDI can also be used as a tool to enable or support existing processes, management systems and business strategies. The strong growth of EDI in the automotive industry is due, in part, to the need for improved communications to support such management systems as Materials Requirements Planning (MRP) and the Just-in-Time (JIT) production. Both of these systems require fast and accurate communication between the focal company and its suppliers, and EDI fills the need. Here, EDI becomes not an entity in itself, but a link in an integrated manufacturing system. In the automotive industry, the use of EDI has become the primary form of communicating with suppliers. It has reduced lead times to a few hours (instead of days), it has increased schedule stability, and, in summary, has enabled JIT manufacturing.

The use of EDI provides one additional organizational benefit. Due to EDI a company has access to much accurate information, and has access to such information in a timely manner. When EDI is fully integrated within the organization, once information is received by a company, this information is available for use throughout the company. Data received via EDI need not be re-keyed in accounting, purchasing, shipping, or whichever department needs to access it. The use of EDI ensures that everyone in the organization is working with the same information and that it is both accurate and up-to-date. The availability of timely and accurate information leads to another significant benefit of EDI - that of improved responsiveness to customers.

Because EDI information is more accurate and available on a 'real time' basis, management can more effectively respond to changing customers needs. EDI's ability to quickly transmit orders, coupled with point-of-purchase tracking, allows manufacturers to adjust quickly to changes in the marketplace. Companies can thus provide quality service due to EDI. Not only does EDI help the focal company be perceived as 'easier to do business with,' but its increased responsiveness can also lead to increased sales and profitability.

Improving responsiveness is likely to also improve the relationships with cooperative trading partners and with other organizations in the logistical supply chain. As competition increases, the traditional view of trading partners as adversaries is reduced. A movement toward stronger, more cooperative relationships with trading partners emerges. EDI enhances this trend toward improved channel relationships. Perhaps the most important reason for improved relationships is that EDI implementation requires considerable cooperation and coordination to be successful. In addition, EDI fosters the sharing of information between trading partners, and this is a move toward longer, more cooperative relationships. EDI eliminates many issues that have traditionally caused conflict, such as lost and incorrect orders.

EDI can be used also to reduce the skill level of workers. Rather than mastering the skills previously needed to handle all of the exception conditions encountered with manual processing of transactions, workers using EDI need only understand the operation of the EDI system. EDI can also be used as a way to 'extend' organizational boundaries to include trading partners. The EDI link tends to strengthen the ties between trading partners by encouraging stronger levels of commitment. However, as the closeness of the relationships between trading partners increases, the number of trading relationships may decrease. It is our contention that companies that use EDI will find themselves dealing with fewer vendors, with whom they will establish longer-term relationships.

Another benefit of EDI is in the ability of a company to compete on a global basis. EDI can help by more closely linking manufacturers and also by improving the flow of international documentation. In order to compete internationally, manufacturers have found that they must develop products through concurrent processes whereby design and production are done simultaneously. Because of increased market segmentation, product proliferation, and shorter product life cycles, manufacturers must be able to respond to changes in the market and to introduce new products quickly. Concurrent development helps manufacturers to respond by cutting down the time it takes to get a new product on the market. For concurrent development to work, manufacturers and suppliers must exchange information quickly and efficiently. This is where EDI comes in. Purchasing, engineering, and manufacturing components of a company can respond more quickly to requests for quotes, engineering sketches, models and production drawings when using EDI.

As experience with airline reservation systems has shown, EDI systems produce information that has value. For example, customer lists and consumer preferences that result from EDI network activity in combined marketing partnerships provide a valuable source of revenue to the network supplier. In an EDI system, it is likely that revenues will increase rather than costs decrease. This occurs because many firms are unable to achieve the potential cost savings of EDI due to intensity and mass limitations and the difficulty of realizing. However, network externalities increase transaction volume resulting in revenue increases that offset unrealized cost savings.

The benefits of an EDI network are frequently different for suppliers and participants. Suppliers may see reduced overhead due to lower per-unit transaction costs. As the order-entry system at American Hospital Supply has shown, an EDI system can bring closer relations with customers due to higher switching costs, convenience and habit. The sponsor is also in a good position, due to the information available on transaction activity to better understand market and competitive conditions. Participants while also seeing reduced transaction costs, benefit from increased speed and accuracy of transactions. They have a larger potential market of suppliers or customers to do business with because of the increased connectivity and lower coordination costs of the network and may benefit from network externalities. Then, too, an EDI network, may contribute to massive industry change, as in the case of pharmaceuticals (McKesson).

Finally, a compelling reasons to implement EDI is that EDI is 'a requirement of doing business' in a number of industries where the ability to send and receive information electronically has become a necessity. If EDI becomes the norm in an industry, organizations may have no choice but to implement EDI in order to survive. In the US, EDI has become the preferred method of doing business in the automotive, chemical, grocery, warehousing, medical supplies, and pharmaceutical industries. Major companies in these industries have made EDI a vendor selection criterion. Some companies publicly informed their trading partners that they must implement EDI. Their purchasing policy seems to be 'no EDI - no purchase order.' The pressure from customers to implement EDI is credited to be a significant factor contributing to the growth of EDI.

In summary, EDI is much more than just a faster method of transmitting documents. When integrated into other systems, EDI enables a company to change how business is conducted. EDI encourages reassessing current operations, reevaluating relationships with suppliers, and questioning traditional methods. While EDI provides significant cost savings, implementing EDI with only cost savings in mind is short-sighted and limits the benefits that can be achieved. Examples of such benefits of EDI are presented in the following chapters, which discuss how EDI is being used in a selection of companies across Europe.

EDI STANDARDS

As explained earlier, the ultimate goal of EDI is that the receiving computer application accept and process the data transmitted without additional human intervention. This implies that the data be coded in some pre-established format (agreed by trading partners), rather than just send text in a free form which will need to be interpreted (such as in an electronic mail message).

An order entry clerk can receive purchase orders from different customers in different formats and is able to understand and extract the relevant data. A computer cannot without being told explicitly what the different data mean and how it is coded. The computer will not recognize automatically similar information in different formats or in different positions. Therefore, the computer must be told in advance what data to expect and in what format. EDI standards provide the structure required for computers to be able to recognize and process the data of business documents. The standards specify which documents can be transmitted electronically (e.g. a purchase order, an invoice, etc.), which data can be in each document, the exact meaning or interpretation of each individual datum, the sequence the data should follow, and the form of the data (e.g. numeric, identification codes, dates, etc.).

In a typical paper document, the information is provided in several blocks of data. A purchase order, for example, includes: date, order number, the name of the buyer, the shipping address, the billing address and the lines with the products and quantities ordered. Each of these blocks, in turn, is usually made up of separate data fields. An address, for example, is made up of the following pieces of information: street name, street number, city, province/county, country, and postal code. In EDI terminology, each block of information, such as the shipping address, is called a data segment. Each individual piece of information, such as "street", is called a data element. EDI standards precisely define how information is to be taken from the paper format and structured in electronic format in terms of transaction sets, data segments, and data elements.

Individual transaction set standards constitute a specification list for an electronic document defining the content requirements. In other words, the transaction set standards specify what blocks of data (data segments in EDI terminology) belong in each electronic document and also show in what order they should appear. Standards committees recognize that some data segments (e.g. a product identification) will be found on all purchase orders regardless of the industry, the company, the type of product, or other factors. Therefore, these segments have been made *mandatory*. However, the inclusion of other data on a purchase order may vary from organization to organization (e.g. buyer's phone number). Therefore, standards also specify *optional* segments that may be used at the discretion of the sender.

EDI standards identify the specific data elements to be included in each data segment. Every segment begins with a Data Segment Identifier that indicates which segment is being sent. The stream of data elements follows. A Data Element Separator precedes each data element to indicate when a new data element begins. Finally, a Data Segment Terminator indicates the end of a segment. In addition to providing the sequencing of the data elements, the standards also define the content of each data element (i.e. the length, the format, and whether it is mandatory or not). EDI standards typically include a Data Element Dictionary which describe in detail the precise content and meaning of each data element.

The first attempt to develop standards occurred in the late sixties in the transportation industry in the United States. In 1968, a group of companies formed the Transportation Data Coordinating Committee (TDCC) for the US. The purpose of this committee was to develop a common language, or standards, for use in the exchange of transportation documents. TDCC published its first standard in 1975 and has since developed and published standards used in the air, motor, rail, and water industries. The grocery and warehousing industries followed and developed their own EDI standards: UCS (Uniform Communication Standards) and WINS (Warehouse Information Network Standard).

In 1978, the American National Standards Institute (ANSI) realized that EDI standards could be used across industries and chartered a committee (the so called X.12 committee) to 'develop standards to facilitate electronic interchange relating to order placement and processing, shipping and receiving information, invoicing, payment, and cash application data.' The ANSI X.12 committee, using the basic structure and syntax established by TDCC, developed and continues to develop EDI standards.

In Europe, the development of EDI standards followed a pattern similar to the United States and different industry-specific standards proliferated. For examples: TDI, used primarily in the UK for warehousing and distribution; ODETTE, used in the European automobile industry; DISH, used in the shipping industry; CEFIC, used in the chemical industry; EANCOM, used by manufacturers, distributors and retailers of bar-coded consumer goods; and others.

In 1987, efforts to create an international standard were started by EDIFACT (EDI for Administration, Commerce, and Transport). EDIFACT is the responsibility of two international organizations: ISO (the International Standards Organization), which is responsible for developing syntax rules and the data dictionary, and the United Nations Economic Commission for Europe, which is responsible for the development of the document standards. Europe and North America have representatives participating in the development of EDIFACT. The international groups used ANSI X12 standards and the TDI standards as a basis for the EDIFACT standard.

The EDIFACT standards development is an ongoing process. The persons responsible for this process are called UN/EDIFACT Rapporteurs. They are nominated by the Working Party 4 (WP.4) of the United Nations Economic Commission for Europe. A Rapporteur has the mandate for a certain geographical area and establishes a supporting Rapporteur's Team (EDIFACT Board) with Working Groups for specific areas (such as Western Europe, Eastern Europe, America, Japan/Singapore, and Australia/New Zealand). At any time, groups of EDI users may request standards for new messages or changes to existing messages. The request may originate from any national or international organization or association, or from a Rapporteur's Team. Each new message type and its components have to be evaluated by all Rapporteur's Teams and also in the organizations participating in WP.4. The number of EDIFACT standard messages has increased from 1 in 1988 to 168 by the end of 1993.