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ELECTRONIC DATA INTERCHANGE; AN OVERVIEW OF ITS ORIGINS, STATUS, AND FUTURE

By

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Working Paper # 422

March, 1997

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Foreword

Since the 1970s, when standards for its use were first introduced, Electronic Data Interchange (EDI) has played an ever-increasing role in supporting the automated exchange of transaction and payments information among business trading partners and their banks. In fact, EDI has become a competitive necessity for many firms expecting to do business with major suppliers or customers. Initially, EDI communications links were achieved through point-to-point communications between businesses, but these have largely been supplanted by Value Added Networks (VANs) specifically developed to support EDI. However, the advent of the Internet has opened the possibility of major changes in how such transactions can be supported, due to the almost universal availability and low cost of this communications medium in the industrial nations. This possibility will not be realized widely until the security of transactions on the Internet can be assured, but some companies are already starting to experiment with Internet EDI systems.

Due to the major changes that can be foreseen in the electronic communications systems supporting business-to-business transactions, this is a good time to review EDI and what it can mean to businesses involved in electronic commerce. Jason Schwandt, who is an MBA student in the Michael G. DeGroote School of Business, undertook this study as a term paper which accounted for part of his term mark in a course entitled Telecommunications Networks And Their Business Applications. The resulting report, which appears in this document, is well-written, highly comprehensive, and far beyond what was required for the course. It is being published as a working paper, since it can serve as a very useful reference in the future for others interested in EDI, and we congratulate Jason for the high quality of his work.

Norm Archer, Professor

Yufei Yuan, Professor

Abstract

Electronic Data Interchange (EDI) is a method of allowing business trading partners to exchange information in a standardized way without human intervention. Since its origins in the 1960s, EDI has grown and has become a pervasive entity in the global business marketplace. In 1994, over 40,000 organizations had implemented EDI worldwide. Growth has been based on both increasing pressure from large companies on their suppliers to adopt EDI, as well as numerous perceived benefits. These benefits include reduced costs, faster cycle times, improved customer service levels, increased monitoring abilities, and improved document integrity. Obstacles to EDI implementation and growth include relatively high setup costs as well as a continuing need for widespread standards. National and international standards, such as X.12 and EDIFACT respectively, are being implemented, but growth is gradual. Besides standards, other major components of EDI include software, hardware, as well as communications links. Traditional EDI communications links were achieved through point-to-point connections between trading partners, but have been mostly replaced by Value-Added Networks (VANs). VANs offer the advantage of providing numerous additional services such as data backups, transaction logging, and security to companies. However, VANs charge for these services on a per-use basis, and as transaction volumes grow, many companies are finding costs associated with VAN use to be increasingly prohibitive. More recently, the use of the Internet is being examined for use as an EDI network due to its fast response times and low-cost flat rate pricing structure, but concerns about security have so far prevented its widespread use.

The following report discusses all of these issues and serves to provide and introduction to Electronic Data Interchange. In addition, issues concerning corporate EDI readiness, security, legalities, and auditing are discussed. A cost/benefit analysis is also provided, as well as some final recommendations for implementing EDI.

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1.0 INTRODUCTION

Webster's dictionary defines innovation as "something new or different introduced". When applied to the world of business, innovation has become not only the domain of a few progressive enterprises but the key to survival and success of the many. One of the most prominent aspects of business that innovation is affecting is the area of Information Technology. Innovation in Information Technology (I/T) is broadening the global business environment, increasing the emphasis on shortening business cycles, and improving customer service. Furthermore, I/T is a continually-enabling power for new ways to do business, thus, changing the way businesses operate.

Future competitiveness for an enterprise is becoming increasingly dependent on a strong, competent, flexible, and forward-looking I/T organization as a business partner. To adequately service customers over larger and larger geographical areas requires up-to-date information technology and computer systems. One of the most notable advances in the I/T area that is key to serving a global marketplace is the notion of Electronic Data Interchange (EDI). EDI refers to the "electronic transfer from computer to computer of business information using a standardized data format" (Hutcheson, 1990).

EDI occurs between companies, and is thus inter-organizational. Over the past 30 years, there has been markedly rapid growth in the use of computers and other advanced technologies within companies. This same trend, however, has not occurred to the same degree *between* companies. Up until the early 1990's, organizations still tended to rely on a traditional paper-based, non-electronic means of conducting business with one another, despite the internal transition to more digital processes (Sharda, 1996). This trend, however, is changing rapidly. EDI has already earned a reputation as the most useful new business tool since the invention of the telephone (Tallim, 1993). Every business day, hundreds of North American companies join thousands of others already actively using EDI to conduct common, everyday business transactions (Sharda, 1996). EDI is now firmly entrenched throughout a broad cross-section of industries and businesses as a vital tool for companies of all sizes seeking a competitive advantage in today's global marketplace. These changes have allowed companies to exploit the global market, and have in essence re-defined the traditional supplier-customer relationship.

Clearly, computing and communications power have influenced productivity, information access, decision making, and empowerment. In five years' time, successful companies will be those with linked internal and external databases, those with advanced decision support systems, and those that take full advantage of EDI and the commercial networks for Electronic Commerce (Taylor, 1996). Indeed, as Thierauf (1990) states, "the information economy of the future will rest on a global network. EDI will be the driving force behind this".

The following report will serve to provide an introduction into the world of Electronic Data Interchange. The origin and history of EDI will be discussed, along with reasons for its explosive growth. The components of EDI, including both hardware and software, are also reviewed along with the emergence and importance of standards. EDI infrastructure is discussed, as well as an overview of the benefits and risks associated with EDI implementation. Finally, implementation issues and recommendations are discussed along with future challenges.

2.0 BACKGROUND

2.1 What Is Electronic Data Interchange?

Electronic Data Interchange (EDI) refers to the "electronic transfer from computer to computer of business information using a standardized data format" (Hutcheson, 1990). Standardized EDI messages are based on common business transactions and are sent from one computer application to another over telecommunications links without human intervention or interpretation. These transactions are conducted with a company's trading partners (i.e. business partners with whom the company exchanges business or technical information electronically) who may be customers and/or suppliers.

The types of documents exchanged via EDI are numerous and varied. Since a major goal and purpose of EDI is "to improve the flow and management of business information" (Sharda, 1996), any information that exists on a paper form of any kind is thus appropriate for EDI. Some of the most common examples of EDI documents, or transactions, include purchase orders, invoices, quotations, bills of lading, status reports, and purchase order acknowledgments. The standardized electronic versions of these business or technical information forms that trading partners exchange via EDI are known as transaction sets. The most frequent types of transactions sets transmitted via EDI and their respective usage rates are as follows:

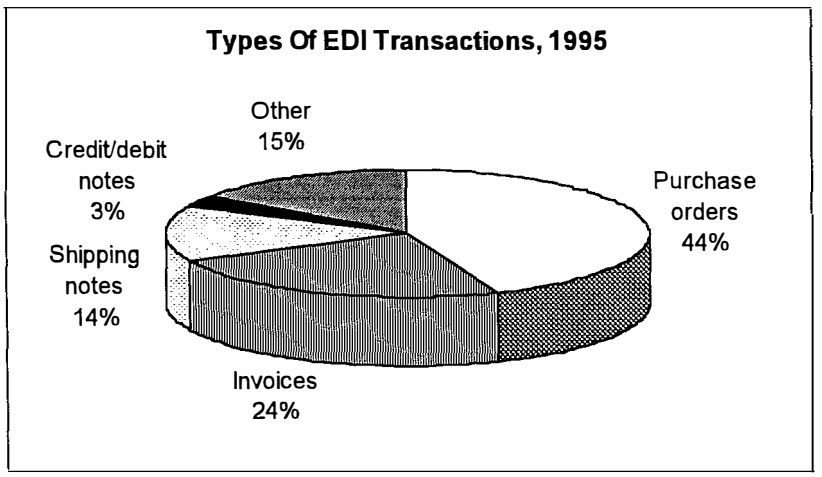

Figure 1: Types Of EDI Transactions
Source: Sharda (1996)

Clearly, purchase orders constitute the bulk of EDI transactions.

One of the most critical aspects of EDI is that the information must be exchanged in a format that can be easily understood by a trading partner, regardless of differences in computer systems. Because communication in EDI is computer-to-computer, rather than person-to-person, the data must be exchanged in a standard format. This means that the information must be contained in some pre-established, uniform arrangement that can be read and deciphered by a computer without human intervention.

Thus, in order to implement an EDI system with a trading partner, several unique components must be available for both partners. These components include:

- **Hardware**

  Computer hardware is necessary to both run each of the partners' information applications, as well as transmit the exchanged data. Hardware platforms can range from small personal computers to minicomputers to large mainframes depending on the complexity and volume of EDI transactions conducted. EDI software is available for each of these hardware configurations. Additional details regarding EDI hardware are available in Section 9.0 of this report.

- **Standards**

  Standards provide the structure required for computers to be able to read, understand, and process business documentation. For EDI, standards serve as agreements on how data are to be structured, arranged, and sent for electronic communication. In terms of EDI, important standards include document-content standards as well as communication standards. Although others are available, the most commonly used EDI standard in North America is called the American National Standards Institute (ANSI) Accredited Standards Committee (ASC) X.12 standard, typically referred to as X.12. Standards may be proprietary or trading-partner specific, industry-specific, national, continental, or international. EDIFACT is the most widely accepted

international standard for EDI communications. Standards are discussed in greater depth in Section 6.0 of this report.

- **Software**

  Software allows the communicating hardware devices to achieve a useful result, and is present in a number of different roles. Perhaps most visibly, software is present in the applications running on each partner's computer that generates or accepts information. While standards are necessary to establish the proper format for an electronic message, EDI software is also necessary to translate the business documents generated by applications into structured standard formats (such as X.12) for communication. Similarly, once a transaction is received, software serves to re-interpret the data. Section 8.0 of this report discusses software in greater detail.

- **Communications Link**

  Naturally, the hardware and software present at each trading partner's site need to communicate in order to exchange data once it has been created and is in the correct format. This may be achieved through a number of mediums. The first option, referred to as point-to-point communications, allows the sender to directly link (typically through normal telephone lines) to the receiver's computer via a modem. Another alternative, and currently the most widely used method of EDI communication, is to employ third-party networks known as Value-Added Networks (VANs). VANs serve as electronic post-offices, and still require a modem to access the VAN. More recently, the feasibility of the Internet is being investigated as an EDI communications link. Communications links and supporting infrastructure are reviewed in Section 7.0 of this report.

These components form the basis of EDI, and serve to begin to illustrate the complexities involved with EDI. It is also important to distinguish between some popular misnomers concerning EDI.

2.2 What EDI Is Not

A common misconception of EDI is a supposed purpose to completely eliminate paper processes. Although it *can* provide a paperless environment, the purpose of EDI is not to eliminate paper, but rather to eliminate the time and data entry associated with paper (Tallim, 1993). One statistic claims

that 70 percent of one computer's business data output becomes a second computer's input (Sharda, 1996). In a paper environment, this results in the same information being re-keyed several times into both computers. EDI links the computer processes so that duplicate data entry is not necessary.

Again contrary to popular belief, EDI does not include the electronic transfer of other kinds of data such as interpersonal messages, structured or unstructured texts, image data, or scientific data (Tallim, 1993). In this sense it can be distinguished from other technologies used to transmit information such as electronic document delivery, electronic mail, or file transfer.

Finally, EDI is often thought of as being synonymous with Electronic Commerce (EC). Although similar in basic nature, the two concepts are actually quite different. EC and EDI are two complementary initiatives toward a highly automated and integrated way of conducting business that significantly enables process improvement (Tallim, 1993). Whereas EC focuses on automating management and technical data, EDI focuses on automating routine business transactions such as solicitations for bids, orders, invoices, and payments.

Before discussing the growth of EDI, it is important to review the process that is traditionally in place before an EDI system is implemented by an organization. It is only through reviewing this process that one can truly gain an appreciation for the benefits and advantages of EDI.

2.3 Paper Document Interchange

Nearly every business organization communicates daily with suppliers, customers, transportation carriers, and other partners. Some form of communication is necessary to conduct any business transaction whether it be placing an order, sending a bill, paying a bill, arranging for shipment, or any other of a myriad of business functions. Traditionally, these functions have been performed primarily through the use of paper. Indeed, a 1991 study of North American business organizations revealed that 51 percent of all business documentation is delivered in a paper format (through mail or courier), 31 percent is delivered by voice (either by telephone or in person), and 15 percent is delivered electronically in a textual format (such as e-mail or fax) (Sharda, 1996).

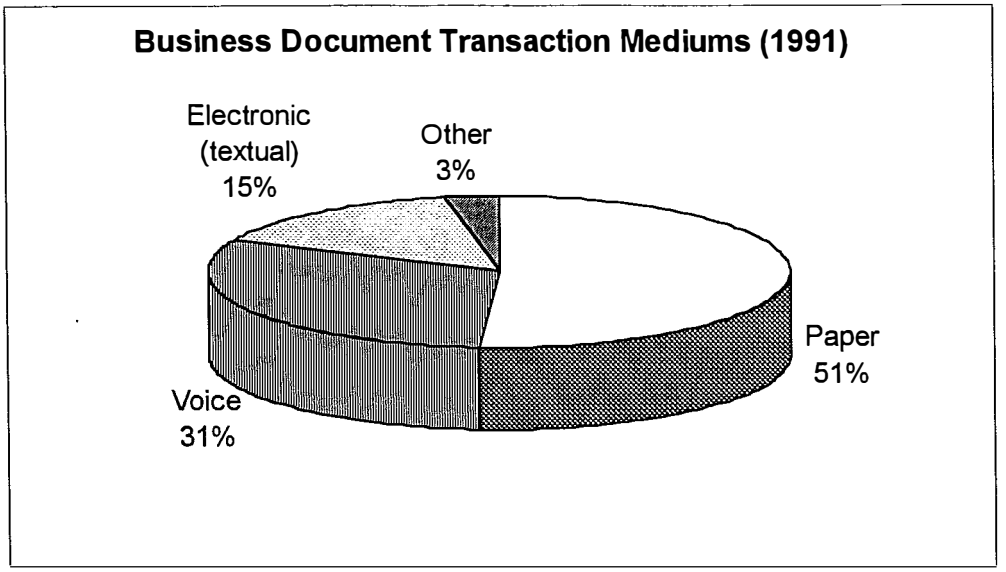

Figure 2: 1991 Business Document Transaction Mediums
Source: Sharda (1996)

An analysis of a typical purchasing department reveals the inefficiencies and redundancies of paper-based processes. In basic paper transactions, a buyer's computerized purchasing system creates an order on a paper form. The paper purchase order is then sent and delivered via some manual postal system to the supplier. Once the order is received by the supplier, an order entry clerk abstracts selected information from the purchase order and re-enters it into an order entry system. Because manual data entry is performed at each step in the process, it is possible for the same data to be keyed-in numerous times throughout the entire paper document interchange. As an example, the purchase order number is likely to be entered into every document produced. Thus, the purchase order number, which does not change from the time the order is placed until it is received and payment is made, will be entered countless times. This process creates a tremendous opportunity for errors. It has been estimated that even expert level data entry operators mis-key 2 percent of entries (Sharda, 1996). The repeated keying of this critical information can result in a greater opportunity for errors, a significant addition of non-value added time, an increase in required labor, and ambiguity due to mailing and processing delays.

As mentioned, traditional paper methods mandate that business documents are mailed via some postal service. Although the expenses associated with this system are not always recognizable, the costs of typing the order (or other business form), addressing the envelope, and adding postage often

exceed five dollars (Sharda, 1996). Overnight packages can add an additional five to ten dollars. These costs accumulate rapidly, considering the number of orders sent each year. Bulk mailing can absorb some of these expenses, but not enough to significantly reduce the costs of sending orders on paper. Additionally, there is a degree of uncertainty and ambiguity associated with postal services. Other than efforts made on either partner's behalf to confirm receipt of business forms, there is little assurance that the documents arrived at their destination.

2.3 Electronic Data Interchange

In contrast, the use of EDI via electronic post office is a much more cost- and time-effective means of conducting business. Because EDI involves the direct computer-to-computer exchange of information, traditional postal services are unnecessary. First, the time delays associated with mailing and other forms of physical transmission are eliminated. Mailing by postal services may take anywhere from two days to a week. Conversely, Value-Added Networks (VANs), which function as electronic post offices, provide 24-hour service and can immediately forward the "package" to a recipient's mailbox. The processing time required for an employee to read and enter data is eliminated by using EDI as well. In paper systems, once an order is received, it must be manually entered in the recipient's computer system. With EDI, however, the document already exists electronically. Thus, it simply needs to be translated and copied over to the company's application. Since the same data are not repeatedly keyed, the chance for error is also greatly reduced, and labor costs are minimized. Finally, because time delays are reduced, there is more certainty in the information flow.

In addition to reducing errors and process time, the use of EDI provides a functional acknowledgment which is not typically found in a paper environment. A functional acknowledgment is a notification that an EDI message was received, and is the electronic equivalent of registered mail. Every time an EDI message is received, EDI software automatically generates and sends back a functional acknowledgment. Thus, in all circumstances, the sender knows with certainty that the message was received.

2.4 A Historical Perspective: The Growth Of EDI

Clearly, the advantages of using EDI over traditional paper-based systems are enormous. The growth of this system can be traced back to humble beginnings in the 1960's. EDI was first developed in North America by industry trade associations for the automotive, retail, distribution and travel industries. Businesses involved in trading operations were quick to recognize the economic advantages of fast, efficient, and accurate information flow. The systems, however, were primitive and not widely employed. As a result, each group of participants used proprietary systems to exchange documents, which primarily consisted of invoices and purchase orders (Newcombe, 1992). Each sector developed its own set of data elements and messages to meet its particular needs, with the result that the various sectors were not able to exchange messages.

Initially, EDI use was limited to large businesses. Companies such as GM, Boeing, and GE are examples of EDI pioneers. These large organizations became involved in EDI due to their business with hundreds of suppliers. More than smaller companies, these monolithic corporations were realizing the inefficiencies and redundancies of paper-based document systems and interchanges. For these companies, the move to EDI capability proved extremely profitable. Another reason that large companies were among the EDI pioneers is that in order to become EDI capable, businesses must convince their trading partners to do the same. This often proves to be a difficult task among smaller companies with fewer available resources and funds. Large companies, on the other hand, often have the clout and financial resources necessary to require EDI of their trading partners.

By the early 1980s, the need to develop EDI standards that could be used across industry sectors and across national boundaries was recognized by standards groups and industry organizations, and hence work to develop the current standards was initiated (Tallim, 1993). In 1980, approximately 2,000 U.S. companies were using EDI (Sharda, 1996). By 1994, over 25,000 users participated in EDI activity in North America, with another 15,000 participants around the globe (Sharda, 1996). Indeed, EDI activity is occurring in all major industries at both federal and provincial/state government levels, and in companies of all sizes. EDI participants include organizations from small "mom and pop" grocery stores to the world's largest shipper, the United States Department of Defense (Sharda, 1996). EDI is currently used in over 50 industries including automobile,

pharmaceutical, grocery, health care, and manufacturing, with the list growing on a rapid basis. A continuation of this steady and significant growth is predicted based upon plans of major companies and their suppliers and customers to incorporate EDI (Gandy, 1996).

As EDI use increases in these large businesses and trickles down to others, the ability of organizations to conduct business *without* EDI will decrease (Sharda, 1996). EDI participants have been putting increasing pressure on their trading partners to join the movement toward EDI. Already, many companies are finding that they must use EDI in order to maintain their business relationships with other organizations in the industry. Indeed, many companies simply give their suppliers a mandate to become EDI capable or run the risk of moving the business elsewhere (Tallim, 1993). Interestingly, smaller companies typically enter the EDI arena out of fear of losing the business of a big customer or supplier to a competitor who agrees to cooperate with the larger organization's request to use EDI (Sharda, 1996).

The most notable example of this "strong-arming" trend occurs in the auto industry. The "big three" U.S. automobile makers now demand that all of their suppliers have EDI capability. The impact of this is quite literally survival for the thousands of suppliers to the auto industry (Tallim, 1993). Similarly, Wal-Mart and several leading Canadian mass retailers have followed the lead of the auto giants and now require EDI capability from their suppliers as well. Thirdly, a little-noticed aspect of the Clinton administration's effort to downsize bureaucracy was the government's requirement that all federal agencies and departments make small purchases (currently defined as anything under $100,000) through a lane of the information highway (Freeman, 1995). EDI clearly fulfills this mandate. As a result, the U.S. Department of Defense (DOD) decreed that all DOD activities develop the capacity to conduct business with suppliers through EDI. Additionally, a DOD goal stated the expectation that 92 percent of supplier transactions be EDI based by the end of 1996 (Sharda, 1996). Thus, EDI capable companies, both large and small, will be in much more advantageous market positions than non-EDI capable companies.

Clearly, then, those organizations that are not EDI capable run the risk of being unable to compete in the near future's electronic business market. It is not overstating the fact to say that EDI is a strategic technology that few, if any, companies can afford to ignore. EDI is becoming the

technological "bandwagon" of the 1990s, electronically linking organizations worldwide in economical and efficient buyer/seller relationships in a fast, convenient, and secure manner. The spread of EDI is now becoming rapid and, according to the Massachusetts Institute of Technology Management in the Nineties program, the inevitable way that business will be done (Gandy, 1996). Several important factors contribute to this growth, as discussed below.

2.5 Growth Drivers

The two major factors that have been identified to contribute most to the rapid rate of EDI adoption. include external pressure to adopt EDI and the perceived benefits from using EDI (Iacovou, 1995). Along with these driving forces, a third factor serves to assist the growth of EDI, and that is the overall enhancement of individual EDI components. This includes technological improvements in both hardware and software, as well as the organization and adoption of standards.

The main driver, however, is pressure from customers to implement EDI. In fact, a 1986 study of EDI pioneers revealed that half of the companies surveyed believed that EDI capability would eventually become a vendor selection criterion (Sharda, 1996). As Figure 3 illustrates, customer or supplier requests accounted for 55 percent of user conversions to EDI. Other reasons for a transition, in descending order of importance, included competitive advantage, improved customer service, accuracy of data, cost savings, and quick access.

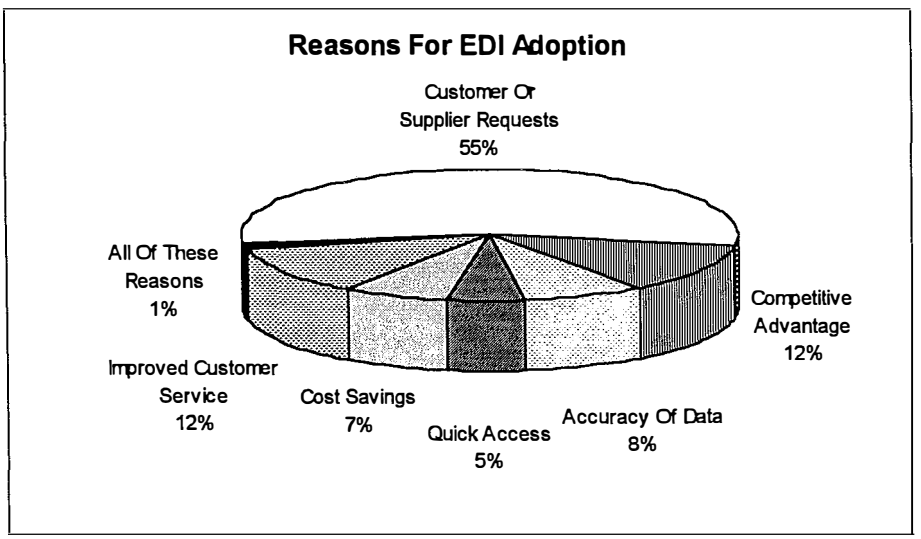

Figure 3: Reasons For EDI Adoption
Source: Sharda (1996)

- **External Pressure To Adopt**

  As Figure 3 illustrates, the most commonly cited reason for implementing EDI was strong customer demand. In an increasingly competitive environment, companies not currently capable of EDI are suffering a competitive disadvantage as their trading partners seek business elsewhere. It is estimated that 50 percent of all U.S. companies must be EDI capable by the year 2000 to create a compatible, automated digital environment (Tallim, 1993).

- **Perceived benefits**

  Figure 3 also indicates that EDI adoption is spurred through the belief of expected benefits, primarily in the areas of cost reduction and improvements in efficiency.

  In terms of costs, EDI often reduces administrative costs, inventory costs, and mailing costs, among others. Tallim (1993) estimates that the cost for processing a single multipart paper document from start to finish can range from $10 to $40, or even more. EDI can reduce these costs by a third to half, and can eliminate almost a full week of order time due to circumvention of postal systems (Sharda, 1996). By reducing transaction times, lead times can be expected to fall, thus in turn allowing the possibility of reducing safety stocks. Finally, increased document accuracy and integrity, along with improved customer service are expected to be benefits of EDI adoption. Additional benefits are discussed in greater depth in Section 3.0 of this report.

- **Improved Systems**

  Several other factors serve to assist the growth of EDI, and act as supplements rather than driving forces. These include the development of relatively inexpensive yet powerful computer hardware as well as the growing proliferation of advanced EDI software. Thirdly, and perhaps most importantly, the emergence of broadly accepted standards (ANSI X.12 in North America and EDIFACT in Europe) greatly assists the connectivity of organizations. In terms of connectivity, the growing use of the Internet may also serve to spur growth of EDI systems in the near future as well.

With benefits such as these, it is no wonder that EDI has captured the interest of the global business community. Today, numerous industries have joined the EDI revolution, with paperless transactions a way of life between many manufacturers, distributors, retailers and service related industries.

3.0 EDI BENEFITS

The full potential of EDI as a strategic weapon is often overlooked since many firms view EDI merely as a cost of doing business and as a tool for maintaining market share (Kumar, 1996). Rather, EDI can bring about many benefits to businesses and industries faced with operating in an increasingly competitive world.

The direct benefits of EDI come from the reduced costs directly associated with handling paper transactions, faster transaction and response times, and improved document integrity. Indirect, or long-term, benefits accrue from effective use of data received electronically, and include enhanced monitoring and administrative abilities as well as improved customer service and satisfaction.

These productivity improvements can be measured, and will be realized either as an expense reduction or an increase in the number of submissions and renewal transactions handled by individual customer service representatives. Details regarding these benefits are described in greater depth below.

3.1 Cost Reductions

By enabling companies to eliminate some activities and improve the efficiency of others, EDI can be a tremendous cost saver. For example, studies in the electronics industry show that the processing cost of one purchase order is US$50 per paper page from "cradle to grave" (Sharda, 1996). By exchanging this document electronically through EDI, RCA, for example, reduced processing costs to $4 per electronic page (Sharda, 1996). Cost savings can be attributed to three main areas including reduced inventories, lower data entry costs, and decreased materials and mailing costs.

- **Reduced Inventory**

  EDI minimizes inventory costs by improving a number of factors that contribute to the need for inventory. The level of inventory that must be held to satisfy demand depends primarily upon demand usage, order cycle or lead time, and the uncertainty associated with the two (Tallim, 1993). In a paper-based system, suppliers need to maintain a stock of a particular good so that it

may be easily accessed and sent once an order is received. EDI can facilitate a reduction in inventory in two ways:

1. By reducing the transaction time, which reduces the lead time, which in turn may reduce safety stock
2. By reducing uncertainty in lead time, providing faster and more accurate information about demand

Thus, EDI allows businesses to take a proactive, rather than reactive, approach to supplying goods to their customers in a timely manner.

For example, under a traditional paper-based system, it is estimated to take six days for a typical order to arrive at the manufacturer and another four days for the merchandise to be delivered (Tallim, 1993). Using EDI, however, the six days of mailing and processing time are eliminated. Therefore, only enough inventory to cover the four days of delivery time needs to be carried. One large company reduced its inventory by $167 million in the first 18 months after implementing EDI (Tallim, 1993). They not only saved the cost of carrying inventory, but were able to reduce the amount of necessary warehouse space.

Maximum benefits for implementing EDI are achieved by coupling it with other technologies and business strategies. Sharda (1996) indicates that some of these include:

- Just-in-Time Inventory Management: Used in the manufacturing industry
- Evaluated Receipts Settlement (ERS): Used in the automotive and retail industries
- Vendor Managed Inventory (VMI): Used in the retail industry

- **Lower Data Entry Costs**

  Tallim (1993) states that the most inefficient and cost and labor intensive part of traditional paper-based systems is the manual entering of data from one computer printout into another computer system. Not only is it inefficient because of the high probability for error, but it is a burden on company costs and time. Since EDI provides a link for the direct transmission of data

from one computer to another, it eliminates the need for duplicate data entry, sorting, matching, filing, as well as the costs associated with the performance of these activities. EDI users have reported that they have accurately transmitted invoices within minutes and processed them immediately without any human intervention (Tallim, 1993). Indeed, rooms full of data entry personnel and equipment effectively become obsolete, thus allowing personnel to be reallocated to more productive activities.

- **Decreased Materials and Mailing Costs**

  Sending a paper order through a postal service is costly and inefficient. EDI eliminates the costs associated with paper transmission processes. With EDI, a business transaction or group of transactions are sent in an electronic envelope typically through a VAN to the electronic mailbox of a trading partner. This significantly reduces mailing and handling costs, in addition to basic material costs such as paper and envelopes. Once the costs of typing the order and addressing the envelope are added to the cost of postage, a single order is estimated to cost five dollars or more (Tallim, 1993). Many organizations justify EDI implementation by the savings in this area alone (Hinge, 1988). Additional savings can be achieved through reduced overnight courier premiums and reduced telephone costs.

3.2 Faster Cycle Times

EDI implementation is found to increase both transaction rates as well as enhance manufacturing operations. As alluded to previously, the period of time between sending and receiving an order by mail can often consume a week or more of valuable time. Because EDI eliminates one day of handling time on both ends, in addition to the two to three days in the postal system, order time may be reduced by almost a full week. In many cases, EDI provides the capability for goods to be ordered and shipped the same day. Also, as previously described, EDI makes it possible to exchange data without ever re-keying the original transaction information. Combining this advantage with reductions in transmission time coupled with the tremendous volume of transactions that accompany EDI, overall transaction cycle times can be reduced drastically. In purchasing, EDI purchase orders have been proven to reduce cycle times by as much as 85% (Kaiser, 1996).

In terms of manufacturing operations, EDI enhances production scheduling accuracy through improved communication with suppliers (Hinge, 1988). This means less downtime due to late shipments from suppliers. Quality assurance information received electronically from suppliers enables shipments to forgo receiving inspection and pass directly into production. Suppliers can receive production schedules electronically and feed this information directly into their production control systems.

Therefore, EDI augments inventory and cycle time reduction programs, including just-in-time production and "quick response" programs.

3.3 Improved Service Levels And Business Opportunities

According to most EDI users, one of the most important benefits of EDI has been improved trading partner relationships (Hinge, 1988). EDI provides greater overall customer satisfaction by enabling the production of better quality goods in an efficient manner and in less time that non-electronic methods.

EDI can enable suppliers to provide services that may be used to differentiate themselves from the competition. For example, organizations in industries such as transportation now have the capability to supply customers with status reports about their shipments; the ability to locate shipments more quickly adds to customer service and satisfaction. EDI also offers users longer term benefits of better inventory controls and JIT (just-in-time) manufacturing and delivery as it is integrated into internal business procedures of EDI users. Thus, EDI does not unilaterally benefit one trading partner; instead, it serves to provide advantages to both parties. Because both parties must see benefits for the EDI system to function, EDI encourages a tremendous degree of cooperation between trading partners. The effort required to develop compatible EDI systems requires a level of mutual commitment rarely seen before (Tallim, 1993). This opens the door to larger, longer purchase contracts and strategic partnerships for mutual competitive advantage. Many smaller organizations have found that a move to EDI resulted in a larger market for their goods and services (Tallim, 1993). EDI thus increases business opportunities and creates a level playing field for organizations who are suppliers of goods and services to many of the larger manufacturers. As a result, EDI has significantly improved the contracting process. For example, personnel in small

companies located in remote areas can now compete for business from their personal computers without ever leaving their offices. EDI has also provided a wider competitive market, opening up global opportunities where none existed before; the use of EDI can assist the free movement of goods, capital and labor across borders because it allows business partners to exchange information quickly and eliminate misinterpretation due to language or cultural differences. With EDI, everybody speaks the same language.

3.4 Improved Monitoring Abilities

Benefits of EDI for monitoring purposes can be divided into both administrative benefits and cash management benefits.

- **Administration**

  EDI data can provide a thorough audit trail of business activities, and can be used to generate activity reports for management and thereby improve management control of information flow (Hinge, 1988). Using electronic journals, companies can also more easily monitor the performance of suppliers in providing the goods and services requested.

- **Better Cash Management**

  By taking advantage of EDI, companies can ensure the purchase of the proper materials at the right time, thus enabling them to better plan cash disbursements (Sharda, 1996). When EDI is used to transmit an invoice for use in an Evaluated Receipt Settlement (ERS) system, the invoice is handled with consistency and both partners know when it will be paid. This consistency allows for much more efficient cash management. Additionally, goods are received faster, invoicing and payments are quicker and more accurate, and corporate balance sheets are up-to-date.

  Another tool for improving efficiency is known as Electronic Funds Transfer (EFT). EFT is essentially the electronic transfer of value. This means that one account is debited to the credit of another automatically. EFT greatly compliments EDI use by allowing trading partners to better plan the use of funds. Paper-based payments, mainly cheques, are the traditional method for inter-organizational trade payments. Although paper cheques are a relatively low-cost way to transmit value, it may take a cheque anywhere from two to four days to arrive at its destination

once it has been mailed (Sharda, 1996). EFT, like EDI, eliminates this "float" period. With EFT, a payment arrives on a pre-planned date. Thus, the money flow using EFT is timely, consistent, reliable, and provides for much more efficient cash management for each party involved.

3.5 Improved Document Integrity

It has been estimated that even professional typists and data entry clerks mis-key two percent of transactions (Tallim, 1993). Examples of typical mistakes include the misspelling of a frequent customer's name, an invoice authorized for a $1,000 payment instead of a $100 payment, or an order to ship 100 items rather than 10 items (Tallim, 1993). Coupled with the fact that data is traditionally re-keyed or transcribed multiple times through the course of a business transaction (and considering the number of business transactions made daily by a typical company), there is great room for error. At the very least, these errors can result in embarassment, not to mention possibly incurring significant costs.

With EDI, however, communication is direct, instantaneous, and immediately verifiable, the results being no more lost, mis-routed, or illegible mail. Documents exchanged are 100 percent accurate and complete. EDI ensures greater information accuracy by exchanging data directly between computer systems. This eliminates the need for manual re-entry, thus reducing errors and increasing accuracy. After a company enters data by keying it directly into its system, EDI software edits the data to ensure accuracy. EDI software displays an error message for inconsistencies such as an invalid account number or part number, or an incorrect price. Additionally, EDI software automatically generates and sends back a functional acknowledgment every time an EDI message is received. Thus, in all circumstances, the sender knows with certainty that the message was received. Following the implementation of EDI, a major organization transmitted 600,000 freight bills electronically in a span of 18 months with absolutely no errors (Tallim, 1993). The elimination of errors alone paid for the cost of developing the company's EDI system.

4.0 RISKS AND PROBLEMS

Although EDI clearly offers significant benefits, there are also numerous problems and risks associated with its implementation. Potential obstacles include a lack of awareness of EDI, information security, a lack of standards, high setup costs, as well as the surprising possibility of *decreased* profits.

4.1 Lack Of Awareness

There are several obstacles to overcome in the implementation of EDI. Some of these obstacles are technical, some managerial, and some inter-organizational. Often the most difficult and all-encompassing obstacle, however, is cultural: society has often lagged behind technology because of resistance to change. EDI often faces a very real awareness problem. Quite often, employees and managers are simply not aware of the benefits that EDI has to offer (Hinge, 1988). By the same token, company management requires a strong degree of commitment to pursue the implementation of an EDI system. Both of these requirements are often found lacking in many organizations, thus presenting an obstacle to EDI growth.

4.2 Security And Confidentiality

Many organizations are reluctant to implement an EDI system due to the perception of a security risk (Krivda, 1995). Naturally, a company will be concerned with confidentiality when sending data such as multi-million dollar purchase orders, up-to-date sales forecasts, or other sensitive information. Companies are also concerned with the possibility of the EDI system itself becoming unavailable for various reasons. Without this critical electronic link, companies could find themselves effectively being cut-off from their suppliers and customers. The vulnerability of an EDI system exists in any of three stages - initiation, transmission, and destination. According to Aggarwal (1996), the categories of inherent risk and related internal control activities include:

1. Unauthorized intruders accessing information
2. Loss of data integrity
3. Lack of transaction completeness
4. Unavailability of the EDI system
5. Inability to transmit transactions

Although most VANs provide security and integrity features to prevent these types of problems, the question of the integrity of the VAN itself may come into question. Most notably, as will be discussed later in this report, the new trend to conduct EDI transactions over the Internet presents an entirely new set of security risks. Despite the enormous benefits promised by EDI technology, concerns still clearly exist over its potential abuse. Additional information concerning EDI security will be reviewed in Section 10.6 of this report.

4.3 Standards

According to a recent survey, the most predominant issue with EDI implementation is standards (Jilovec, 1996). EDI software vendors often use a proprietary file format. Should trading partners employ different EDI software, incompatibility problems may arise. In addition, standards are updated several times a year, with some trading partners upgrading and others remaining on older versions of the standard. Fortunately, broadly-employed standards such as X.12 in North America and EDIFACT in Europe are becoming more commonplace in the EDI arena. Standards are discussed in greater detail in Section 6.0 of this report.

4.4 High Setup Costs

Another potential drawback of EDI use is the technology's high setup costs, applying primarily to larger organizations. Unfortunately, these large investments (of both effort and capital) are unavoidable, yet are essential to implement the necessary communications infrastructure. While EDI requires a significant initial investment, it also requires ongoing maintenance and enhancements. Despite these shortcomings, it must be noted that implementation costs will be amortized over time. Typically, the expense reductions possible through the use of EDI will more than pay for the implementation of the system (Hinge, 1988). Additional information regarding costs associated with EDI implementation are discussed in Section 10.3 of this report.

4.5 Other

Interestingly, a disadvantage that some organizations, particularly Value-Added-Resellers (VARs) have experienced when using EDI is a *drop* in profits. Through EDI, VARs can conduct commerce electronically at a much quicker rate than they ever have before. The problem, however, is that the

technology makes *all* other VARs their competitors. Contracts before EDI that received responses from 60 to 70 bidders are now receiving 900 to 1,200 (Kanellos, 1996). As a consequence, bid winners end up selling at or near cost, thus driving down bottom-line profits.

Corporate managers should be aware of all of these risks and take appropriate action to minimize them during EDI system planning and implementation. The following section describes how some organizations have circumvented these obstacles and exploited the benefits of EDI to increase customer satisfaction, efficiency, and overall profits.

5.0 APPLICATIONS OF EDI

To further illustrate the benefits of EDI use, the following sections present examples of how implementing EDI has helped some major organizations improve growth, alleviate problems, and achieve overall success.

5.1 Prestone Products Corp.

During 1995 and 1996, Prestone Products Corp. has exploited an aggressive $5-million EDI system to tighten its marketing and distribution relationships with such retailers as Wal-Mart, Sears Roebuck & Co., and Kmart Corp (Hoffman, 1996). The EDI links have helped Prestone boost its share of the $595-million US antifreeze and coolant market from 60% to 87% in the past 2 years (Hoffman, 1996). Before implementing World, a client/server-based manufacturing and distribution system from J.D. Edwards & Co. in late 1994, Prestone processed only 30% of its sales electronically. Today, EDI-based sales account for more than 70% of Prestone's transactions (Hoffman, 1996).

5.2 R.J. Reynolds Tobacco Company

R.J. Reynolds Tobacco Company, the largest U.S. cigarette manufacturer, performs nearly 100 percent of its purchasing over EDI links. In the Spring of 1993, the company made over 92 percent of its purchases electronically and notified its remaining suppliers that if they did not become EDI capable within 30 days, they "would have to retrieve orders from a fax extension offered by a service bureau" (Sharda, 1996). The transition to a near 100 percent electronic purchasing system has reduced costs and cycle time dramatically. Before implementing EDI, it took two to three weeks to send an order to a supplier, and 30 to 45 days from the time a part was ordered until it arrived (Sharda, 1996). By 1992, 86 percent of all orders were placed via EDI to 560 major suppliers (Sharda, 1996). The results of EDI capability for R.J. Reynolds Tobacco Company have been remarkable. For example, purchasing costs have been reduced significantly from $75 per paper order to $0.93 per EDI order, and the company is saving more than $5 million annually in inventory costs (Sharda, 1996).

5.3 Egghead Software

Egghead Software of Issaquah, Washington, has also capitalized on EDI technology. Egghead uses the system for its own purchasing in addition to the filling of customers' orders. Since its start in EDI, Egghead had been traditionally functioning as a supplier to a large, EDI capable company. In essence, Egghead was a mere spoke in the EDI infrastructure of the larger company. Today, the company drives the implementation of EDI with suppliers as well, acting now as a hub. Over the years, the company has integrated EDI into its order fulfillment and accounting processes. Egghead now has the capability to receive purchase orders, acknowledge them with return information, and send shipping notices, catalogs, and invoices electronically. Egghead receives orders in hours, rather than weeks, receives payment in days, rather than weeks, and has been awarded several major multi-million dollar contracts a year (Sharda, 1996). Additionally, customer orders have increased from ten to as many as 200 a day, but Egghead has not had to compensate with an increase in personnel to handle the additional orders (Sharda, 1996). The company attributes these successes solely to their EDI capability.

6.0 EDI STANDARDS

6.1 Why Have Standards?

One of the most important components of EDI is standards. Although computers are incredibly efficient and accurate, they are unable to recognize similarities between identical information that resides in different formats. Communicating business data between trading partners without standards is equivalent to speaking completely different languages. Therefore, computers must be told in advance, either by programmers or system operators, what information to expect and in what format. EDI standards, such as X.12 and EDIFACT provide the structure required for computers to be able to read, understand, and process business documentation regardless of hardware, software, and communications components

According to Sharda (1996), Trading Partner Agreements (TPAs), which set forth the rights and obligations of trading parties, should specify the following information concerning standards:

- The documents to be transmitted electronically
- The information to be included in each document
- The sequence of the information
- The acceptable data type (numeric, ID codes, characters, etc.)
- The meaning of specific pieces of information.

6.2 The Origin Of EDI Standards

Data interchange standards were first introduced in the mid-1950s when various industries began to exchange business information electronically (Sharda, 1996). Early electronic data interchanges that relied upon proprietary formats for information interchange and were agreed upon by two trading partners could not be applied to other industries or even to another trading relationship. The disadvantages of programming the widely varying formats required by different partners soon became cumbersome as well as time- and labor-intensive.

The Transportation Data Coordinating Committee (TDCC) pioneered the development of EDI standards in the 1960s (Tallim, 1993). This committee initially created standards to support the transportation industry, and later assisted other industry groups such as grocery, chemical, and

warehousing in the development of other industry-specific standards. In the grocery industry the standards were called Uniform Communications Standards (UCS), and in the warehousing industry the standards were denoted as Warehouse Industry Network Standards (WINS). These groups shortly began a cooperative effort to develop EDI industry standards for purchasing, transportation, and financial applications. Many of these standards, however, supported only intra-industry trading. Others, such as standards for bills of lading, purchase orders, and invoices, were applicable across several industries.

As EDI use spread to encompass several industries, it became evident that incompatible specifications and standards across industries would significantly hinder EDI implementation and growth. There became a definitive need for generic, cross-industry standards. As EDI use grew to encompass the business activities of diverse organizations, the idea of national, cross-industry standards began to receive substantial support (Sharda, 1996).

In 1971, SITPRO, the Simplification of Trade Procedures Board in Great Britain, began work on common EDI standards for Europe (Tallim, 1993). In 1974, the U.K. EDI syntax called Trade Data Interchange (TDI) was published and was first used by U.K. customs authorities. The United Nations began to develop terms of reference for international EDI standardization in 1975, and in 1979, the United National Guidelines for Trade Data Interchange (UN/GTDI) syntax, based on the TDI guidelines developed by SITPRO was published.

Also in the late 1970s, using the pioneering work of the TDCC and the National Association of Credit Management's Credit Research Foundation, efforts began to develop the first national (U.S.) standards for EDI (Sharda, 1996). In 1979, the ANSI ASC X.12 committee was charged with the responsibility of creating and defining national, cross-industry EDI standards that "facilitate electronic interchange relating to order placement and processing, shipment and receiving information, invoicing, payment, and cash application data" (Tallim, 1993).

The value of merging the work of both SITPRO in Europe and ANSI in North America to develop an international EDI standard was recognized and work was initiated within the United Nations/Economic Commission for Europe (UN/ECE) to develop the international United Nations

rules for the Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) standards. UN/EDIFACT is comprised of "a set of internationally agreed-upon standards directories and guidelines for the electronic exchange of structured data, and in particular electronic exchanges that relate to trade in goods and services between independent computerized information systems" (Sharda, 1996).

As Figure 4 illustrates, in the United States, as well as throughout North America, ANSI X.12 is the most widely used standard, being used by 66% of companies involved in EDI. Other standards are used less frequently including UCS, TDCC, and EDIFACT. EDIFACT is significantly more popular in European and other international arenas than it currently is in North America.

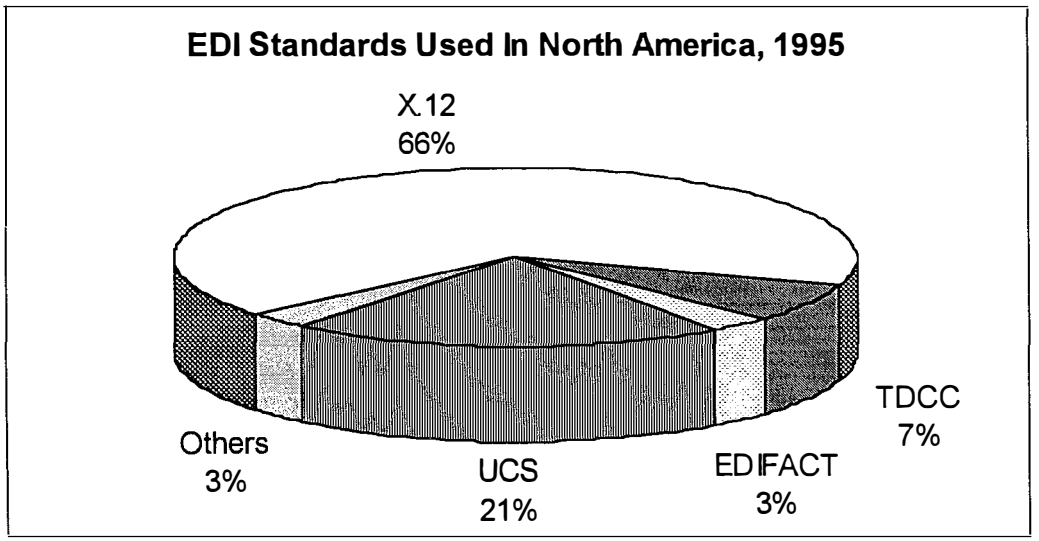

Figure 4: EDI Standards Used In North America In 1995
Source: Sharda (1996)

6.3 Components Of EDI Standards

EDI standards encompass both communication standards (which assign the "language" the communicating computers use to speak to one another), and document content standards (which assign the structure and order in which information is to be sent and received to help the receiving computer to process the information). Both of these types of standards will now be briefly discussed.

6.3.1 Communication Standards

In order for computers to talk to one another, they need to have a language of "control words" to identify themselves, to ask for garbled text to be repeated, to pass conversation control to the partner, and to end the conversation. Several communications standards, or "protocols", exist. Hence, as a company increases the number of its EDI trading partners, it is inevitable that some new trading partner will use an incompatible protocol. To resolve this issue, many companies use an EDI network service (such as a VAN) as the communications intermediary between themselves and their EDI trading partners which serve to translate these incompatible protocols.

Another communications standards issue is line speed. Line speed refers to the rate at which data is sent between computers and is measured in bits per second (bps). Modems for microcomputers typically operate at anywhere from 300 to 33,600 bps. Mainframe EDI users, with high data transmission volumes, can opt for a leased line connection to a third-party network. Leased lines can support far greater transmission rates. For example, a basic Integrated Services Digital Network (ISDN) line ranges in capability from 56 kbps to 128 kbps, and a full T1 connection can provide up to 1.544 Mbps. In order for computers to understand one another, they must send and receive data at the same rate. Automatic line speed conversion is another valuable service provided by EDI value-added network services, but becomes a critical issue for point-to-point communication links (whereby a direct modem connection is used between partners). The major types of communications mediums, point-to-point connections, value-added networks (VANs), and the Internet, will be discussed in greater depth in Section 7.0 of this report.

6.3.2 Document Content Standards

Once communications issues have been resolved, it is practically assured that the data sent is in fact the data received. However, for EDI to be useful, the receiving computer must have the ability to understand what the data means and to do something with it. Enabling computers to process the data received, without human intervention, is the role of document content standards (Hinge, 1988).

Document content standards fix the order in which data appears within a given document. Both trading partners must agree on the precise format for a purchase order, for example, and design their

computer programs to expect purchase order data to be sent and received in that format. Hence, the receiving computer will be able to retrieve information, such as P.O. number, ship-to location, and order quantity, from the data received.

As with communication standards, several document content standards exist:

1) **Proprietary standards**

Proprietary standards are set by one company, typically one with enough leverage to ensure that all trading partners use its standards.

2) **Industry-specific standards**

These are set by an industry trade group and promote industry-wide electronic communication. Several industry-specific standards exist, examples of which include:

Table 1: Industry-Specific Standards

Source: Chan (1993)

INDUSTRY	STANDARD ACRONYM	STANDARD NAME
Grocery	UCS	Uniform Communications Standards
Warehousing	WINS	Warehouse Industry Network Standards
Transportation	TDCC	Transportation Data Coordinating Committee

Industry-specific standards are sometimes used because industries have found that they do not need all of the capabilities provided in the broad X.12 standard (which will be discussed shortly). Often, to bypass this dilemma, industries have developed unique industry-specific guidelines for X.12 implementation, specifying which optional segments and elements will be used. Despite their developments for industry-specific guidelines, today the TDCC, UCS, and WINS all share common syntax rules and basic structure with the X.12 standard.

3) **Cross-industry standards**

Currently, there is one widely-used cross-industry EDI format in North America: the ANSI X.12 standard. It is approved by the American National Standards Institute (ANSI), and is

maintained by ANSI's Accredited Standard Committee X.12 (ASC X.12). Naturally, a company should select an EDI standard which will facilitate communications with the maximum number of trading partners. As a consequence, roughly 66 percent of 1995 EDI implementations in the United States were based on some form of the ANSI X.12 standard (Sharda, 1996).

4) **International standards**

International standards are developed to facilitate business relationships in a global market. As stated, the current defacto international standard is EDIFACT.

6.3.2.1 EDI Document Structure

The EDI document may be compared to its paper counterpart. In paper-based systems, an organization often sends a number of purchase orders or invoices together in the same package, where each purchase order or invoice is a separate document. The header area of the standard business document (such as a purchase order) contains the information pertinent to the entire document, and the body or detail area contains item specifications. A typical paper document contains numerous lines of information. In a purchase order, the name of the buying organization constitutes one line of information and the address of the buying organization constitutes another. Furthermore, within each line, there are a number of individual pieces of information (or words). The address line, for example, is usually made up of three separate pieces of information including the city, province/state, and ZIP code.

EDI documents follow an analogous structure. The contents of an EDI interchange are contained in what is called an interchange envelope. This is equivalent to the paper-based envelope which contains the set of documents. Data within the interchange envelope is first assembled into functional groups. Purchase orders would be an example of one such functional group. Within these groupings, electronic messages appear as an apparently continuous series of characters. As a result, something is needed to separate the series of characters that represent the first purchase order from the series of characters that represent the second, etc. The ST segment, known as the transaction set header, and the SE segment, known as the transaction set trailer, perform the function of separating each document from other documents in the transmission. Additionally, each line of information,

such as buyer's name or address, is called a data segment, and each individual piece of information within the segment (such as the city) is called a data element. Rather than printing the purchase order on a standard form as is done in paper systems, the information is recorded in standard X.12 (or other standard) format. Hence, an interchange envelope contains functional groups which in turn contain transaction sets which are comprised of data segments consisting of data elements. These data elements can then be mapped into a database which stores the information. As explained in this analogy, the EDI version of a business document is functionally identical to its paper counterpart.

According to Tallim (1993), the following outlines the three basic components of EDI document structure standards. Both the ANSI X.12 and EDIFACT standards are based upon these components.

1) **A syntax and encoding scheme for messages which specifies the structure of data**.
   The data should be independent of systems, machine and media constraints, and should allow for human interpretation of the data transferred. As well, the data elements or groupings which are part of standard messages should be independent of each other so that one part may be changed without affecting any other part.
2) **A data dictionary**.
   This component of EDI standards defines the standard business data elements, such as date, time, delivery address, and currency used to create messages.
3) **Combinations of data elements to be used for standard messages**.
   A paper invoice, for instance, normally consists of a header portion stating the name and address of the billing party, the name and address of the paying party, the date of the invoice, an account number, etc. There is also a detail portion which consists of a series of invoice lines, each giving details of a billed transaction such as date, order number, number of units, item number, item description, unit price, and total price. EDI documents contain similar structural combinations.

6.4 Transaction Sets ANSI X.12 Standard

6.4.1 The History Of X.12

Although initiated by the TDCC and the National Association of Credit Management's Credit Research Foundation in the late 1970s, it wasn't until 1979 when the ANSI ASC X.12 committee began work on defining and developing national cross-industry EDI standards (Sharda, 1996). It is thus appropriate that ANSI and the ASC both be briefly discussed.

6.4.2 American National Standards Institute

The American National Standards Institute (ANSI) was founded in 1918 as the coordinator for national standards in the United States. The U.S. voluntary standards system consists of a large number of standards developers that write and maintain one or more national standards. The standards developers include representatives from professional societies, trade associations, government agencies and all facets of trade and commerce.

ANSI itself does not develop standards but provides a forum for all concerned parties to identify standards needs, plan to meet these needs, and agree on standards. ANSI is also the U.S. member of non-treaty international standards organizations such as the International Organization for Standardization (ISO) and the International Electrotechnical Committee (IEC). As such, ANSI coordinates U.S. participation in these groups (Sharda, 1996).

6.4.3 Accredited Standards Committee (ASC X.12)

ASC X.12 is the ANSI Accredited Standards Committee charged with developing EDI standards for use in the United States. The work of ASC X.12 is conducted primarily by a series of subcommittees and task groups whose recommendations are presented periodically to the full ASC X.12 Committee for ratification.

The Data Interchange Standards Association (DISA) serves as the secretariat for ASC X.12. DISA's activities include communicating with ANSI and the public on behalf of the ASC X.12 committee, as well as organizing X.12 meetings and publishing the X.12 standards (Sharda, 1996). Once a year,

DISA publishes the entire set of X.12 standards in a single volume. Known as a release, this volume includes revisions of previously published standards, as well as new draft standards approved by ASC X.12 during the year. Releases are not considered American National Standards until they have undergone the ANSI-required public review process.

One of the primary objectives of the X.12 subcommittees in developing the X.12 series of standards is to minimize the need for users to reprogram their internal computer systems to effect interchange. These standards provide a common format and translation of electronic information that is intelligible to both the sender and the receiver.

6.4.4 The X.12 Series Of Standards

The X.12 series of standards consist of a number of interdependent standards. For example, transaction set standards define the grouping of data into segments and the sequence of these segments to be used in a specified business transaction such as a purchase order. There are also what are known as foundation standards which define the syntax to be used in defining X.12 transaction sets as well as the data elements, data segments, and control structures to be used. The full set of foundation standards required to interpret, understand and use the X.12 series of transaction set standards, consists of:

Table 2: X.12 Foundation Standards

Source: Hinge (1988)

ANSI STANDARD	FOUNDATION STANDARD
X.12.3	Data element dictionary
X.12.5	Interchange control structure
X.12.6	Application control structure
X.12.20	Functional Acknowledgment
X.12.22	Data Segment Directory

The X.12.20 foundation set, a functional acknowledgment, is a prime example of how EDI is used to increase the efficiency and accuracy of document transmission. The functional acknowledgment is a system-generated acknowledgment of receipt of an EDI message. Every time a message is received, this electronic form is sent to the sender for verification of its receipt and syntactic correctness.

In addition, to simplify and standardize the communication of common transactions such as purchase orders, a number of common standard transaction sets were developed. When creating the standard transaction sets, members of the ASC and other standards developers recognized that some data segments would be included on all purchase orders regardless of the industry, the item being purchased, the size of the company, or other variables. For example, every purchase order includes identification of the item being purchased. Therefore, this data segment has been made mandatory in the standard purchase order transaction. However, the inclusion of other, less critical information on a purchase order may vary from organization to organization. Some businesses include a buyer's name and phone number on orders, while others do not. Thus, the standard also identifies optional segments which may be used at the discretion of the trading partners. Prior to implementing EDI, trading partners must jointly decide upon what optional segments and elements will be used in each transaction set, as well as the characteristics of each (Sharda, 1996).

Some pre-standardized ANSI X.12 transaction sets, like the purchase order mentioned above, have been developed around business functionality groups. Examples of these groups include Engineering and Management, Manufacturing, Quality and Safety, Transportation, Finance and Insurance, Warehousing, and Purchasing. Each of these groups contains transaction sets that support a similar business function. For example, the Purchasing group transactions consist of Requests for Quotation, Purchase Orders, Purchase Order Acknowledgments, Purchase Order Changes, and Material Dispositions. There are transaction sets for nearly every business transaction imaginable, thus allowing the potential for businesses to function almost 100 percent electronically. As a result, there are transaction sets for the most common examples of business documents such as purchase orders, invoices, bills of lading, status reports, and shipping notices, as well as for less common, industry-specific business transactions such as government procurement, residential mortgage insurance applications, and healthcare claim payment forms. Each transaction set is also given a code number, similar to the way in which most paper forms are assigned a form number. As a more specific example, the X.12 standard for a purchase order is called the 850 transaction set. Additionally, each transaction has a unique standard designation. For example, the X.12 standard designation for the 850 purchase order transaction set is X.12.1. Other common standardized transaction sets are listed below in Table 3.

Table 3: Common X.12 Transaction Sets

Source: Hinge (1988)

ANSI STANDARD	TRANSACTION SET	TRANSACTION CODE
ANSI X.12.1-1986	Purchase Order Transaction Set	850
ANSI X.12.2-1986	Invoice Transaction Set	810
ANSI X.12.4-1983	Remittance/Payment Advice Transaction Set	820
ANSI X.12.7-1986	Request for Quotation Transaction Set	840
ANSI X.12.8-1986	Response to Request for Quotation Transaction Set	843
ANSI X.12.9-1986	Purchase Order Acknowledgment Transaction Set	855
ANSI X.12.12-1986	Receiving Advice Transaction Set	861
ANSI X.12.13-1986	Price/Sales Catalog Transaction Set	832
ANSI X.12.14-1986	Planning Schedule with Release Capability Transaction Set	830
ANSI X.12.15-1986	Purchase Order Change Request Transaction Set	860
ANSI X.12.16-1986	Purchase Order Change Request Acknowledgment Transaction Set	865

6.5 EDIFACT

As mentioned in Section 6.2, work on UN/EDIFACT, the international United Nations rules for the Electronic Data Interchange for Administration, Commerce and Transport, began in the mid-1980s through the cooperation of both SITPRO (Simplification of Trade Procedures Board) in Europe and ANSI in North America. EDIFACT is comprised of a set of internationally agreed standards directories and guidelines for the electronic exchange of structured data, and in particular electronic exchanges that relate to trade in goods and services between independent computerized information systems (UN/EDIFACT Rapporteur's Team, 1990). It was designed to be a single international EDI standard flexible enough to meet the needs of both government and private industry, and was intended to resolve the inefficiencies, inaccuracies, and high costs of current paper systems and processes used in international business relations. The UN/EDIFACT rules are approved and published by the United Nations/Economic Commission for Europe (UN/ECE) in the United Nations Trade Data Interchange Directory (UNTDID), and are maintained under agreed procedures. The ECE is one of five regional commissions established by the Economic and Social Council of the United Nations. It includes 34 member states from North America, Eastern Europe and Western

Europe. Additionally, any member country of the United Nations which has an interest in a given subject may participate in UN/ECE meetings, and certain approved intergovernmental and non-governmental international organizations may participate in specific committees. A number of intergovernmental organizations such as the Commission of the European Communities (CEC) and the European Free Trade Association (EFTA) participate in the EDIFACT work. Several UN specialized agencies including General Agreement on Tariffs and Trade (GATT) and International Telecommunications Union (ITU) also contribute to EDIFACT efforts. Just as the X.12 standard is the most commonly used EDI standard in North America, EDIFACT is the most commonly used standard in Europe and most other international business centres (Sharda, 1996).

6.6 The Relationship between X.12 and EDIFACT

As the ANSI X.12 standards were already in use when work began to develop the EDIFACT standards, the format and structure of X.12 messages were a useful model. As a result, X.12 and EDIFACT messages share common structural characteristics (Tallim, 1993) including:

- Character-based encoding, with multiple levels of support for various encoding standards such as telex and 7-bit ASCII
- Tagged and delimited data structures
- A global set of data segments and a segment directory to define them
- A global set of data elements and a data element directory to define them
- A message of a predefined type consisting of a specific sequence of segments
- Implicit identification of data elements in a segment by location
- An "interchange" consisting of either "functional groups" each of which contains one or more messages or one or more messages by themselves

There is very little difference between the two syntaxes in the overall design of the transaction set/message. There are however some differences in the way segments and data elements are structured so that a message developed using X.12 syntax cannot be deciphered by a system based on the EDIFACT syntax (without external translators). According to Woods (1989), some of these differences include:

- Looping and nesting procedures are different
- 6 data elements types are defined in ANSI X.12 while only three are defined in EDIFACT
- There is no provision in EDIFACT for optional fields
- EDIFACT allows for two levels of syntax
- EDIFACT uses composite data elements

The differences between the two standards are considered to be minor by the X.12/North American EDIFACT secretariat. Due to the increasing prominence of EDI in the global market, work is currently underway to align the two syntaxes so that software using the UN/EDIFACT formats will also be able to communicate with X.12 based systems (Malhotra, 1991). The goal is to achieve this merger by 1997; however it is unclear whether this will be accomplished on schedule (Sharda, 1996).

7.0 INFRASTRUCTURE FOR EDI

While EDI standards such as X.12 and EDIFACT are designed to allow communications between different computers, they are only message formats. They do not specify how communications will take place between the trading partners. Another networking service is needed to transmit the actual messages between the EDI partners.

The following section will provide an overview of the networking options that can be used to support EDI operations. These options include either the use of point to point connections, the use of Value-Added Networks (VANs), or the use of the Internet.

7.1 Direct Connection/Point To Point Configuration

One of the earliest methods of conducting electronic transactions between trading partners was to establish a direct connection between the parties. This was usually accomplished through a modem and traditional telephone lines (either public or leased). Although providing a reasonably secure data channel, numerous obstacles had to first be overcome before any data could be exchanged. Typically, the most difficult barrier to circumvent was related to establishing standards between the two partners, both in terms of document structure and communications methods and protocols (Hinge, 1988). For example, both parties had to set up formats for various transactions and conform to specified modem line speeds and error correcting protocols. In addition, precise document-exchange times had to be prearranged between trading partners. Lastly, once companies began to expand and acquire additional trading partners, the use of direct connections became increasingly complex and unwieldy; since documents bound for different trading partners had to be sent separately, expensive connect/disconnect efforts were required.

Trading partners also desired supplementary services such as data backups, transaction logs, data encryption, and standards translation. As a result, the use of point-to-point connections has declined substantially in recent years, only to be superceded by the growth of what are termed Value-Added Networks (VANs).

7.2 Value Added Networks (VANs)

7.2.1 What Is A VAN?

The name "value-added network" originated from the fact that these third-party networks use existing communication networks like long-distance carriers as the backbone network and then add "value" by making various services available to network users. In addition to the basic communication connectivity services they provide, VANs offer skills, expertise, consultation, and educational services (Hinge, 1988).

For the most part, a VAN functions similarly to conventional postal services. The main differences are that VANs function in a virtually paperless, highly-automated environment, and they also provide the "value-added" aspects listed above to their communications services. Postal services receive mail from senders, sort it, and then deliver it to the intended recipient. Similarly, a VAN receives transactions from a sender (typically via a modem and phone lines) and then places them in the electronic mailbox of the recipient. In essence, a VAN acts as an intermediary between trading partners. Major VAN service providers include Advantis Systems (a joint venture between Sears and IBM), General Electric Information Systems (GEIS), Harbinger Corp., QuickResponse Services, Sterling Commerce, and Concert (a joint venture between British Telecommunications Plc and MCI Communications).

7.2.2 VAN Functions

VANs also provide security controls to ensure data integrity. Each organization with a VAN account will have a password that must be used to access its mailbox. Data encryption is a prime example of a security control provided by VANs. These controls are used to ensure that an organization's computer software, data, and programs are protected against any unauthorized access, disclosure, or modification. In addition, VANs offer data translation services between different EDI standards, provide an automatic backup system and archiving plan for all mailbox contents, and offer error detection and correction services as well as transaction logs. Additionally, most VANs allow businesses to retrieve messages at the same time they deposit their outgoing transactions. Finally, most VANs provide 24-hour, 7-day-a-week access, along with implementation and consulting services.

Because of this wide array of useful services, the use of VANs has grown significantly. In 1995, for example, there were 15 government-certified VANs in the United States (Freeman, 1995).

7.2.3 VAN Benefits

The benefits of using VANs are numerous. For example, a VAN provides easy connectivity by offering a single access point, rather than multiple accesses to many different trading partners as is done with point-to-point connections. Thus, only a single connection and destination address need be processed by the local systems. Connection is normally provided using a 1-800 number or public data network which has the advantages of low start-up costs.

The VAN often provides conversion services of varying complexity, ranging from conversion of internal data formats and structures to standard messages such as X.12 and vice versa. From the trading partners' perspective, only low-level protocols, such as terminal emulation, are normally required, thereby minimizing the effort and/or expense of developing or acquiring appropriate communication software and applications. Data communication is simplified because the user communicates directly with the mailbox only, and not with many different communication systems.

Other benefits include the user company's ability to retrieve documents from the mailbox at a time convenient to its computer-processing applications. As a result, the VAN's electronic mailbox eliminates document-exchange timing constraints that would normally be associated with a direct connection. VANs are also deemed to be extremely reliable; service agreements assure 24 hour interrupted service. Finally, features such as security (without having to add any external encryption software), backups and logs are all very useful value-added benefits.

Despite these substantial benefits, the use of a VAN does, however, have some drawbacks.

7.2.4 Drawbacks Of A VAN

The two major shortcomings of VANs currently include a lack of interconnectivity as well as user costs.

- **Interconnectivity**

  Until standards become widely adopted, the communication protocols and services offered by VANs are often still proprietary. As a result, the sender and receiver are typically required to use the same VAN. Because VANs generally provide services over private data networks, this problem is compounded by the fact that there is often poor connectivity between different VANs. More recently, faced with the open architecture of the Internet, many VANs are providing Internet gateways to their systems or links to other VANs to increase interconnectivity and remain competitive.

- **Costs**

  Although start-up costs are minimal, usage fees for various VAN services may represent an obstacle for some organizations. With VANs, companies typically pay by the byte to transmit data to their trading partners (up to 25 cents per 1,000 characters), and pay extra for the use of special services (Messmer, 1996). VAN charges are also often shared between trading partners, hence placing an additional burden on smaller trading partners who deal with large organizations. The advent of using the Internet for EDI transactions in recent months, however, has prompted some VANs to reduce transmission rates sharply in order to remain competitive; this battle will likely intensify in the coming years. While costs for individual companies may vary, charges for using an EDI third party fall roughly into the following categories (Hinge, 1988):

  - Communication charges
    - Telephone charge: a local call or an 800 service connect fee
  - Line speed conversion
  - Computer protocol matching
  - Transmission confirmation reporting
  - Electronic mailbox service
  - Open network capability: the ability to exchange information with a non-customer of the VAN
  - Broadcast messages: sending information to all of a company's trading partners on the VAN's network
  - Activity reporting, including:
    - All activities, date/time stamped
    - Counts of data transmitted
    - Status of data groups (accepted/rejected/awaiting)
    - Retrieval from mailbox/retrieved by trading partner

- Compliance checks for completeness of data stream and standard syntax
- Format translation
  - From standard to standard
  - From predefined file to standard
  - From one predefined file to another
  - Error reporting of translation errors
- Maintenance of standard formats
- Data backup and recovery
- Customer service
  - Implementation support
  - Marketing EDI to trading partners
  - Database service
  - Media conversion-converting electronic documents to paper for sending to non-EDI trading partners
- Services available only from a VAN; including control reporting, daily activity log, mailboxing
  - Premium charges for dealing with a trading partner that is not a customer of the VAN
- Data-handling charges
  - Charges for transferring data through the network (Often charged per-thousand characters or by record/segment count)
  - Charges for standards compliance checking, an optional service
- Reporting and mailbox charges
  - Monthly minimum fee for mailbox usage and perhaps for transmission status reports
  - Charge for activity reports, which provide a detailed audit trail
- EDI format translation charges
  - Format translation and document editing, charged by transaction, segment, number of characters, or a combination of these
  - Charge for translation status and error reports
- Other charges
  - Charges for "media conversion " - converting EDI documents to paper and sending these to a non-EDI trading partner
  - Implementation support/consulting services

Despite the extent of this list, the costs associated with a VAN may be worthwhile when compared with the costs to acquire similar services on a direct connection. Also, it is important to consider the fact that the reduction in cost of transmitting documents electronically versus traditional postal methods will likely far outweigh the additional costs of VAN services. Nonetheless, new services and a flat-rate pricing structure offered on the Internet are starting to encroach upon VANs' traditional market territory.

7.3 The Internet

As the Internet was initially developed as a publicly-funded research and academic network, commercial use of the Internet was not permitted. However, this situation is currently changing as numerous commercial networks have become interconnected with the Internet. In fact, a growing number of organizations are using the Internet instead of a VAN to exchange EDI documents with trading partners. Today, approximately 7% of companies using EDI exchange transaction sets over the Internet (Jilovec, 1996b). Although still limited, this number has been growing slowly and cautiously over the last several years. EDI on the Internet can ease the way for smaller businesses that previously could not afford the fees of VANs. For the same reason, the EDI-Internet combination should also help large companies send documents to smaller partners and customers..

As more commercial organizations obtain Internet connections, its use for EDI-based messaging will likely increase. Customers and suppliers throughout the supply chain will use the Internet to send and receive information, making the global computer network integral to the trends and strategies involving Electronic Commerce. Already, a number of corporations are conducting pilot projects or are implementing production systems involving Internet EDI. Companies providing Internet EDI service or software include Premenos Corp., PeopleSoft, Sterling Software, and Harbinger Corp.

7.3.1 Internet Benefits

One of the biggest attractions to doing EDI over the Internet appears to be cost savings. For small and medium-size firms, formal EDI over value-added networks or private lines is simply too expensive and complicated. Internet service is intended to give smaller companies that do not use EDI the ability to conduct EDI transactions with their larger trading partners. When looking strictly at the cost of transmitting messages, EDI exchange via a value-added network can cost anywhere from 2 to 10 times more than using the Internet, depending on the volumes (Jilovec, 1996b). Whereas VANs charge per byte of data, the Internet, with its flat-rate price, common network standards, and worldwide links to electronic mail and the World Wide Web, is becoming irresistible to many organizations.

There are other benefits to sending EDI over the Internet as well. For example, response times are often shortened considerably. Also, the Internet offers greater inter-connectivity and reach than most VANs, effectively removing the problem of proprietary networks. In addition, corporations can use other electronic tools that the Internet provides such as remote log-in, file transfer, electronic mail, and Web browsing. The Internet community is also continuing development of a new message handling protocol known as MIME (Multipurpose Internet Mail Extensions) that provides the functionality required to transmit EDI-structured messages over the Internet. According to Tallim (1993), MIME allows mail messages to contain:

- Multiple objects in a single message
- Text of unlimited length, and character sets other than ASCII
- Multi-font messages
- Binary or application specific files, as well as images, audio, video or multi-media messages

7.3.2 Internet Drawbacks

The primary problem of exploiting EDI on the Internet has traditionally involved security. There have been numerous accounts of security violations involving the Internet in recent years, most notably the theft of passwords from an Internet Service Provider in 1993 (Bhimani, 1996) as well as the successful decryption of supposedly secure messages sent from Netscape Communications Corp.'s browser in 1995 (Wildstrom, 1995). More recently, rapid progress has been made in terms of encryption technology, however, helping to speed the adoption of EDI through the Internet. Premenos' Corporation's Templar product, for example, makes use of public key cryptographic technology to provide secure EDI services. PEM/MIME, an Internet standard for secure mail available from Trusted Information Systems Inc., is also a viable option. Although these products help rectify the security situation, the ability to *convince* corporate customers of the invulnerability of encrypted EDI documents over the Internet appears to be still some time away. This is in stark contrast to the extensive perceived security that VANs provide along with their other services.

The second drawback of EDI Internet use is that customer service on the Internet is practically non-existent. Using the Internet, there is no audit trail to determine the source of transmission problems. Again, this contrasts largely with the vast quantity of services and assistance offered through VANs which include the ability to track and monitor data.

Clearly, although still in its infancy, the Internet appears to be far more cost-effective than most value-added networks for conducting large volumes of EDI transactions. This is especially true when companies want to transmit large binary files such as engineering drawings. However, VAN EDI users are reluctant to readily adopt the Internet as a transmission medium due to a *perceived* lack of security. With products available such as Premenos' Templar which incorporate the latest security technology, more companies will likely begin to adopt the Internet for EDI transactions in the future. As a consequence, it will certainly be interesting to observe the new strategies VANs will employ to remain competitive.

7.4 Global EDI Infrastructure

While the flow of EDI transactions between Canada and the U.S. is currently unequaled in the world, EDI is quickly gaining converts and users at an unparalleled rate in many of the other major global trading nations including the European Economic Community, Eastern Europe, countries in the Pacific Rim, Australia and New Zealand (EDI Council of Canada, 1996). Use of EDI can assist the free movement of goods, capital and labor across borders because it allows business partners to exchange information quickly and eliminate misinterpretation due to language or cultural differences. EDI has, in fact, very much become a reality of doing business both domestically and externally as we move toward a true global economy.

7.4.1 European Community

European organizations are adopting full Electronic Commerce including EDI and such technologies as e-mail, e-fax, file transfer and on-line access at an accelerated rate (Sharda, 1996). In addition, a number of value-added networks have recently been launched in Europe to meet the growing demand for EDI services. In fact, some estimates indicate that EDI expenditures in Europe are growing at an annual compound rate of 21%, and that the number of European users could reach 300,000 by the year 2000 (Dearing, 1995).

As part of the move to a single market, the European Community recently launched several initiatives to create a cooperative and coordinated business environment throughout the continent. The initiative included 2 EDI projects, TRADACOMS and ODETTE, in an effort to reduce expenses

and remain competitive with Japan (Sharda, 1996). The EC also undertook the development of the Trade Electronic Data Interchange System (TEDIS) Programme in 1988 to coordinate EDI activities within the EC (Sharda, 1996).

- **The TEDIS Programme**

  The TEDIS programme works to coordinate the efforts of the various European user groups and organizations involved in EDI activities in the various industry sectors by offering them logistic support and financial assistance. TEDIS also works closely with the EDIFACT Board for Western Europe. The objectives of the TEDIS programme are stated as follows (Tallim, 1993):

  - To avoid the proliferation of closed EDI systems and the widespread incompatibility that this entails
  - To promote the creation and establishment of trade EDI systems which meet the needs of users, particularly small to medium sized enterprises
  - To increase the awareness of the European telematic equipment and services industry to meet these user requirements
  - To support the use of common standards such as ISO 7372 (the Trade Data Elements Directory) and ISO 9735 (the EDIFACT message syntax)

  To meet these objectives, the programme coordinates activities in different industry sectors and encourages the formation of user groups, pilot projects and work on message standards (Peeters, 1988). As part of its technical support activities, TEDIS maintains a database of standard message types, segments, code-sets and data elements in current use so that potential users can apply messages that have already been developed by the various sectors. The TEDIS programme also works to coordinate issues of common interest across the sectors such as telecommunications issues, security issues, legal aspects and software provision. Currently in its second phase, 29 contracts have recently been awarded under the TEDIS programme for a variety of EDI initiatives and pilot projects (Tallim, 1993). Clearly, this initiative appears to provide a firm base for the development of EDI within the European Community.

7.4.2 EDI World Institute

The EDI World Institute is a non-profit organization founded in April 1992 that is dedicated to the rapid development and use of EDI in business worldwide (Tallim, 1993). The institute's founding

meeting was attended by representatives from Australia, Austria, Canada, Hong Kong, Indonesia, Italy, Japan, Korea, the Netherlands, Slovenia, Taiwan, United Kingdom and the United States.

According to Tallim (1993), the EDI World Institute's mandate includes efforts to:

- Accelerate the diffusion and acceptance of EDI throughout the world economy by identifying the means and methods to expand its use and enhance its value to all users
- Establish linkages with business, EDI associations, industry associations, government agencies, international organizations, and universities in a cooperative effort to promote and realize the benefits of EDI
- Support implementation initiatives in EDI, in international business, world trade and the public sector

The primary thrust of the Institute is to support research, implementation activities, information and education services. While the EDI World Institute works to support and promote the use of international standards, the Institute does not participate in the formal EDI standards development process.

Membership in the EDI World Institute is open to national EDI associations and councils, private companies involved in world trade, government and industry organizations involved in the implementation of EDI, as well as research and academic institutions.

It is hoped that the EDI World Institute will provide the coordination necessary to cope with the problems inherent in the development and use of EDI on a global scale (Lortie, 1993).

8.0 SOFTWARE

Selecting the proper software for an organization's needs and requirements is one of the most important decisions that will be made in the EDI implementation process. There are several types of EDI software that operate on specific platforms and have varying capabilities. EDI software capabilities range from processing low volume transactions on a stand-alone microcomputer to the full range of high volume processing and computing capabilities designed for mainframes. Some software allows users to design and maintain electronic forms that replicate paper business documents. Others provide security controls such as limiting access and protecting corporate information with passwords and data encryption. In general, however, EDI software will send, receive, translate, and archive data to be used by other company applications. Typically, one organization's software does not have to match its trading partner's software, although there are exceptions. EDI software can be developed in-house or purchased from a number of commercial software vendors. Depending upon the hardware configuration and the capabilities required of the software, software costs can range from a few hundred dollars for microcomputers to thousands of dollars for mainframe computers (Hinge, 1988).

Figure 5 illustrates a close-up of the internal software information systems of two EDI-linked trading partners. According to Hinge (1988), to send/receive EDI documents and use the EDI data most effectively, the internal software information system must contain the following components:

- **Application**

This is the business function in which information is either generated or needed. Order entry and accounts payable systems are examples of applications. The application may be paper-based, computerized, or a combination of the two.

- **Application-Translator Link/Interface**

This component links information flow between the application and the document translator. Where the application is computerized, this link may be a "flat file," wherein the data is arranged in some defined format. In the case of a paper-based application, keyboard data

entry obtains information from the application to the translator, and a printer obtains information from the translator to application.

- **Document Translator**

  For outgoing data, this component reformats the computerized data into some EDI standard such as X.12 or EDIFACT; for incoming data, it reformats the incoming EDI data into the format required by the internal application. The former process is denoted as "document generation", the latter "document interpretation".

- **Communications**

  This component provides the capabilities to send and receive electronic documents. Typically, this will consist of some type of communications software (which contains an appropriate protocol) to link with hardware such as a modem.

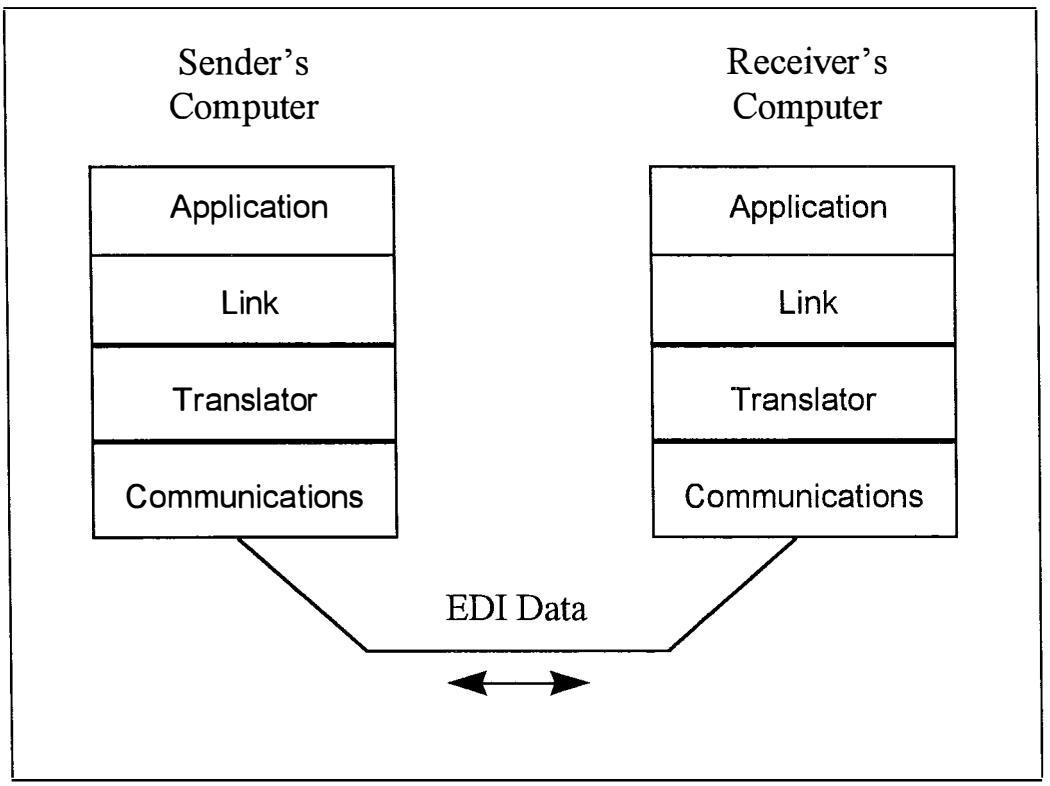

Figure 5: Internal Software Information Systems For EDI

Source: Hinge (1988)

EDI software is available from some 40 different companies, with off-the-shelf packages existing for microcomputers, minicomputers, and mainframes. While all EDI software packages contain the translator component described above, the availability of a communications or an application link varies from product to product.

Table 4 on the following page details the advantages/disadvantages and price ranges of EDI software for each computer level.

Table 4: Advantages/disadvantages and price ranges of EDI software

Source: Hinge (1988)

HARDWARE LEVEL	ADVANTAGES	DISADVANTAGES	SOFTWARE PRICE RANGE (1988 $US)
Microcomputer	• Relatively inexpensive • User friendly operation • Easy start-up • Portable to user location • Many microcomputer software products exist	• Data entry is slow and error-prone • Cannot handle large data volumes • Limited support of transmission protocols • Integration with applications is limited	$700-$3,500
Minicomputer	• Maximum EDI benefits attainable • Can support multiple transmission protocols • Can handle large volumes of EDI data quickly • Eliminates key entry of data by integration with application • Computing environment is multitasking; machine is not dedicated to EDI • Medium cost range	• Requires experienced operation and maintenance • May require extensive integration development work	$5,500-$20,000
Mainframe	• Maximum EDI benefits attainable • Can support multiple transmission protocols • Can handle large volumes of EDI data quickly • Eliminates keyboard entry of data • Computing environment is multitasking	• Requires experienced operation and maintenance • May require extensive integration development work	$9,500-$35,000

As EDI acceptance and usage grows, the costs for such software will likely drop. Already, Premenos sells its advanced Templar EDI client for Windows platforms for under US$500 (Premenos Corp., 1996). Selecting the proper software to meet organization-specific needs and requirements can make EDI implementation either a time-consuming burden or a relatively painless

process. Most EDI software vendors are a source of implementation expertise because of their EDI knowledge and experience. While there are several software packages from which to choose, there are three main categories of EDI software (Sharda, 1996):

- Stand Alone PC software
- Integrated EDI software
- EDI Server/Gateway software

Each of these software types will now be discussed.

8.1 Stand Alone EDI Software

Operating stand alone EDI software leverages some of the benefits of EDI and spares the time and expense involved in integrating the software with other company applications (Tallim, 1993). This arrangement is referred to as stand alone EDI because the EDI activity "stands alone" from all other computer activity and applications within the organization. In a stand alone system, manual input at a PC is used to generate an EDI transaction. The stand alone translation software provides screens for data entry, translates this information into a standard format such as X.12, and handles communication interfaces to trading partners or third-party networks. The software also receives EDI messages from trading partners in a standard format and translates the data to the company's application format. Because this type of EDI system is not connected with other applications, organizations may engage in EDI while continuing with a traditional paper-based system as well. Thus, only the means of communicating with trading partners has changed; internal operations can continue as they always have.

This type of EDI software is often an attractive option for small organizations that have been given an EDI mandate from a larger company, for companies that do not have a great deal of in-house technical expertise, or for small businesses that have few trading partners. Stand alone EDI can be implemented relatively quickly and inexpensively. For example, stand alone systems, including software and a personal computer, can be purchased for under $4,000 (Sharda, 1996). Additionally, the system can be installed and fully operative within a matter of days. In summary, the advantages of stand alone EDI software include quick and relatively easy implementation, lower costs, and a wider variety of user-friendly software packages from which to choose.

While stand alone EDI provides some of the advantages of EDI as mentioned earlier, there are several drawbacks to this type of system as well. Stand alone EDI allows trading partners to engage in the computer-to-computer electronic interchange of business data, but because the application is not integrated with others in the company, manual data input and transfer are always required. Whenever information is transferred manually from one source to another, there is a chance for error. Second, stand alone software has a much slower processing speed and limited volume capability than other software options. Finally, and perhaps most importantly, stand alone EDI does not reap many of the benefits that have caused organizations worldwide to engage in commerce through EDI. All activity in a stand alone system must be re-keyed between the EDI system and internal operations. Therefore, the major disadvantages of this option are lack of integration with existing application software and the need for manual data re-entry. A more integrated approach to EDI, for many organizations, may be a better option.

8.2 Integrated EDI Software

Integrated EDI software provides the same translation and communication interfaces and capabilities as stand alone PC EDI software, but includes the ability to integrate with existing company software (Tallim, 1993). In fact, many stand alone software packages have add-on modules to support a transition to integrated EDI. The integrated EDI software option, although slightly more expensive and complex, resolves many of the disadvantages inherent to stand alone systems and typically runs in both the PC (DOS/Windows) and UNIX operating system environments. Integrated EDI software is the key to realizing many of the long-term benefits of EDI since it is able to process greater volumes of transactions at greater speeds.

EDI integration is accomplished in two ways. The first method is through what is known as "flat file input", while the other is through a process called "mapping". Using flat file input integration, EDI software accepts data from existing company applications that have first been transferred to a file that meets the format criteria of the EDI software. If this transfer process is not immediately possible, some programming expertise may be necessary. Integration through flat file input, however, may make subsequent changes in trading partners difficult to implement. Additionally, not all integrated EDI software packages will match accounting and order-entry applications.

Integration through mapping allows organizations to specify a link between business documents sent to trading partners and the data layout of application software. Once the link has been established, the data exchange is automatic. Unlike flat file input, future changes by trading partners can be implemented easily with mapping integration. Also, existing "maps" can be copied and altered to support new EDI transactions. Therefore, this method of integration is preferable to flat file input (Sharda, 1996).

In summary, integrated EDI software eliminates many of the disadvantages associated with stand alone software. Because EDI is integrated with existing company applications in this option, there is no need for manual data re-entry. This reduces the opportunity for error, saves time, reduces costs associated with paper-based processes, and frees up data entry clerks for jobs in which they can better serve the customer. However, this type of system is also more expensive to purchase and deploy, and more complex to install, test, and modify.

8.3 Server/Gateway EDI Software

If an organization operates on mainframes or has numerous trading partners requiring high volumes of EDI activity, server/gateway EDI software is most likely the optimal communications option. This software supports business applications on one or more mainframes and has all the features of integrated EDI software plus data transfer, routing, timing mechanisms, electronic mail-boxing, and restart/recovery options. Server/gateway EDI software requires a longer implementation period, more in-house technical EDI expertise, and is significantly more expensive than either stand alone or integrated EDI software.

9.0 HARDWARE

As previously stated, EDI systems may be implemented on microcomputers, minicomputers, or mainframes. Client/server networks are also prime candidates for EDI systems. EDI may be implemented on any of these platforms provided it meets the company's requirements and does not limit growth opportunities. To ensure these requirements are met, Tallim (1993) recommends that a company:

- Analyze existing hardware
- Analyze expansion potential of existing hardware
- Analyze existing software
- Determine what role EDI will play
- Estimate EDI volume
- Allow for trading partner communication requirements
- Cost out each reasonably possible solution

After this analysis, the company can decide on whether to implement a microcomputer, minicomputer, or mainframe approach.

10.0 Implementation Considerations And Issues

Before an organization embarks on implementing an EDI system, there are numerous factors which must first be addressed. These elements include determining the readiness of the company to implement EDI, becoming informed about the technology, as well as examining economic, legal, auditing, and security issues. The following sections will address these topics and will conclude with a suggested implementation roadmap.

10.1 Determining EDI Readiness

The first step in implementing an EDI system is to select a suitable business champion who will spearhead the effort. This champion should be in a sufficiently high management position who has both authority and a broad perspective of the organization's needs and goals. Indeed, the probability of successful EDI implementation increases directly with the level of management committed to the project (Tallim, 1993). The manager who champions EDI must first evaluate whether EDI makes sense for the company as a whole. According to Hinge (1988), a fertile business environment for EDI is characterized by:

- A large volume of recurring transactions
- The need for timely transaction processing
- Products/services described by a code value
- Transactions associated with large amounts of paperwork
- The need for careful data tracking and reporting
- A highly cost-competitive market environment
- Centralized data processing or distributed data processing with standardized applications

In practical terms, EDI readiness varies with the level of benefits the company ultimately wishes to achieve from EDI integration and the current level of computing systems. To attain the maximum benefits from EDI, information must flow readily from the computerized application of the sender to the computerized application of the receiver without human intervention. Many companies' information systems have been designed around interactive data entry; hence, they may not be ready to handle the batch information flow of EDI data. Preparing information systems for EDI is by no means an instantaneous occurrence. The effort takes planning, commitment, and cooperation among functional business managers as well as systems support personnel.

In determining its readiness for EDI, a company often takes the opportunity to reevaluate its internal business procedures. Hinge (1988) believes the decision will be one of three:

- To enhance existing systems
- To install new systems
- To redirect the flow of data prior to implementing EDI

Should the company have only minimal existing information systems, the EDI champion may consider implementing a small-scale EDI program (on a microcomputer, for example) to illustrate the benefits and build a case for program expansion.

Sometimes, however, a situation arises where the pressure for implementing EDI is directed from a strong customer. In this case, the need to remain a viable supplier supercedes any concerns over readiness. The relatively small purchase of a microcomputer and some minimal software would be sufficient to enable the supplier to deal electronically with the customer while planning on enhancing or developing systems in the future.

Clearly, the EDI champion will be faced with a number of challenges. In order to better prepare for an analysis of EDI implementation, the champion should first embark upon becoming aware of the issues, benefits, and pitfalls concerning EDI (Tallim, 1993).

10.2 Increasing EDI Knowledge And Awareness

It is imperative that the EDI champion first gain an understanding of the technology. This is necessary in order to learn the technical terms necessary for efficient communication, and to begin developing a strategy for meeting a trading partner's requirements. The EDI champion has a number of options concerning improving his or her knowledge about EDI.

Besides traditional periodicals and books, a strong source of information about EDI may be obtained through the World Wide Web. The Internet has been growing at an amazing rate over the last year. According to Tallim (1993), there are 12 mailing lists on the Internet which are devoted to various EDI-related topics. These lists serve as a forum where members can post questions which are

answered by other members. Many of the lists focus on a very specific area of EDI such as the development of a single standard. However, the general-purpose discussion list can be a valuable source of information for first-time EDI users. Here, a newcomer can pose an implementation question which will normally be answered by several experienced EDI users.

A second method is to contact and/or join industry organizations. The Electronic Data Interchange Council of Canada was incorporated in mid-1985 by the eight trade associations that sponsored the first EDI pilot program in Canada (EDI Council of Canada, 1996). The EDI Council is effectively the voice of EDI for industry, business and government in Canada, and currently has more than 600 members. The EDI Council has five specific objectives, not the least of which is to promote the use of a common standard for the electronic transmission of business data in Canada. According to the EDI Council (1996), other objectives include:

- Enhancing and maintaining the EDI message standard.
- Dealing with other standards groups and with domestic and international governments where the EDI Council will serve as the voice for Canadian industry on EDI.
- Assisting members in the implementation and use of the standards through events such as orientation seminars, education programs for new and existing users, user meetings, establishing special industry sector task force groups, and providing day-to-day support.
- Ensuring the EDI Council, its board, committees and staff work in the best interests of users and is not unduly influenced by technology and/or suppliers.

Accordingly, the EDI Council of Canada regularly provides a two-day education seminar that provides corporate staff with guidelines to assist them in taking the first step toward successfully co-ordinating and implementing EDI.

Thirdly, the champion should contact current or potential trading partners to determine the EDI systems currently in place, and to discuss issues which may assist in the EDI transition process or remove obstacles to its implementation.

10.3 Cost Implications

One of the major problems an EDI champion will likely encounter is justifying the implementation of EDI for management purposes (Hinge, 1988). The cost of implementing EDI truly depends on each individual company, taking into account its size, complexity of operation, and number of suppliers,

dealers, and customers. A study of recent EDI implementations has shown that a typical company can implement an EDI system in as few as four weeks or as long as six months (EDI Council of Canada, 1996). Small Canadian companies presently without a computer can now purchase a turnkey microcomputer system and all the required software programs for a starting price of $4,000 (Sharda, 1996). However, midsize to large organizations are typically faced with very large investments of effort and capital to implement an EDI solution. In addition to this high initial investment, EDI requires ongoing maintenance and enhancements. According to Kumar (1996), costs can be generally broken up into four main categories as shown in Table 5.

Table 5: Major Cost Categories Associated With EDI Implementation

Source: Kumar (1996)

TYPE OF COST	COMMENT
Hardware Costs	Microcomputer, minicomputer, or mainframe
Software Costs	EDI software and any other application development required to integrate EDI with other applications
Telecommunications Costs	Accessing and using a value-added network
Training Costs	Training employees to change their existing work practices

A recent study directed by Coopers & Lybrand (EDI Council of Canada, 1996) found the primary costs of EDI implementation, in decreasing order, to be:

1. Installing, implementing, and interfacing EDI with the in-house information system
2. Time and effort required to coordinate EDI implementation with trading partners
3. Internal implementation costs, particularly organizational and training expenses
4. Network communication charges

One method an EDI champion may employ to justify implementing an EDI system is to use a cost/benefit analysis as described below.

10.3.1 Cost/Benefit Analysis

The cost/benefit equation used in evaluating the potential payoff of an EDI investment weighs market factors and potential benefits from EDI against the costs of implementing and maintaining an EDI system. This system can be expressed as:

Market Factors + Potential Benefits > Setup Costs + Operational Costs

Each of these aspects will now be discussed in greater depth.

- **Market factors**

  Market factors refer to the environment external to a company. Market factors that contribute strongly to the decision to employ EDI include:

  - Existence of a highly competitive market where EDI can provide much-needed competitive advantage through:
  - High customer responsiveness
  - Service distinction
  - Product cost/lead time reduction
  - Pressure from a major customer to accept orders electronically or seek business elsewhere
  - Industry-wide EDI activity makes it beneficial to be a front runner in the industry, while reducing the chances of an EDI competitive disadvantage later

  While difficult to quantify, market factors play a major role in companies' decisions to implement EDI. As discussed in Section 2.4 of this report, even in companies where the short-term costs of EDI outweigh the benefits, the existence of EDI pressure from the market may well be enough to justify the investment.

- **Potential Savings**

  As reviewed in Section 3.0, direct benefits of EDI are fairly easy to quantify. They include:

  - Eliminating labor and material costs associated with printing, mailing, and handling envelopes for paper-based transactions
  - Reducing telephone costs
  - Eliminating clerical costs associated with key-entry of data

  Indirect benefits of EDI (i.e. those that accrue from more efficient use of information resources and improved business procedures) are more difficult to quantify. They include:

  - Decreased required safety stock resulting from shortening the order cycle
  - Decreased labor, freight, and material costs resulting from fewer material returns
  - Improved cash flow resulting from reduced inventory and more timely invoicing and payment
  - Improved customer service resulting from more accurate and timely information
  - Improved sales/purchasing productivity resulting from reduced paperwork requirements

- Improved business efficiency resulting from the flow of more complete, timely, and accurate information

Tracking indirect benefits, like improved customer service, often depends on the existence of some internal systems or programs such as JIT, excellence, or quality programs (Tallim, 1993). Companies that do not have such programs will have to use some ingenuity in quantifying these benefits.

The benefits derived from EDI are proportional to both the extent to which EDI is integrated with internal applications and the volume of business transacted electronically. As companies begin in EDI, volumes are low and integration is in the initial stages, if begun at all. Hence, in reality, during the initial stages of EDI implementation, the direct benefits are small and the indirect savings are virtually nonexistent.

However, as the volume of EDI activity increases and the company establishes internal systems to achieve continuous information flow, both the direct and indirect benefits of EDI increase. In the long term, indirect benefits will be substantially greater than direct benefits. This should help give a ballpark value of indirect savings for cost/benefit analysis, even if exact values cannot be found. It is estimated that EDI implementation has an average pay-back period of three years (Tallim, 1993).

- **Setup Costs**

Setup costs refer to one-time, up-front expenditures required to implement EDI, such as:

- Development, purchase, or lease of communications hardware and protocol software
- Development, purchase, or lease of computer hardware, application link software, and translation software
- Person-days of effort to reevaluate current business information systems and to design for the EDI data flow
- Person-days of effort spent in steering group meetings, in implementation meetings, meetings with trading partners, industry group meetings, or at standards organization meetings
- Education, setup, and training costs

Setup costs can be substantial, especially if viewed from within only one or two functional business areas. Commitment to EDI from the corporate level will facilitate cooperation among several functional areas, reducing the burden of setup costs for each area.

- **Operational Costs**

  Operational costs refer to the ongoing costs of communications and the hardware and software maintenance needed to transmit and receive data electronically. Third-party EDI network charges form the major portion of EDI operational costs.

10.3.2 Evaluating The Cost/Benefit Analysis

In evaluating the cost/benefit equation, the EDI champion must keep the following in mind (Hinge, 1988):

- Each functional business area has to evaluate the cost/benefit equation separately, since costs and benefits will differ in each area
- Market factors should be weighted very heavily
- Setup costs, operational costs, and potential benefits should be amortized over time; EDI is a long term strategy
- EDI data volumes, benefits, and operational costs will increase over time

10.4 Legal Considerations

A number of legal issues are unique to EDI and should be addressed in contract negotiations.

10.4.1 Contractual Obligations

EDI transactions are binding contractual agreements. Contracts have three fundamental elements:

1. Offer
2. Acceptance
3. Consideration

In the United States, the Uniform Commercial Code (UCC) defines rules such as what constitutes a contract, what is evidence, and what is a signature. A contract for the sale of goods, according to the UCC, is not enforceable unless there is sufficient written signed proof of the business expectations. Anyone intending to use EDI documents as admissible evidence of a contractual relationship needs to prove both content authenticity and transmission authenticity.

Also, current contracts with VANs and software providers typically leave the user bearing much of the risk of electronic communications. These include loss or alteration of data during transmission and any business losses that may result.

10.4.2 Trading Partner Agreements

With documents being sent electronically, contract terms and conditions will no longer be sent to trading partners with each transaction. Often, a standard Trading Partner Agreement (TPA) is prepared and signed once, and is considered valid for all EDI transactions. Trading Partner Agreements are formal legal documents used to define terms and conditions under which information is exchanged between two companies via EDI. According to Tallim (1993), such agreements typically address:

- Payment terms
- Liability - who is responsible for a transmission error?
- The need for transaction acknowledgment
- Communication charges - who pays the data transmission bill?

10.5 Auditing Considerations

A company's use of EDI will have a profound effect on auditing activities. With this issue in mind, the information system can be designed to account for the changes brought on by EDI. As companies transact business computer to computer, much of the traditional hard copy audit trail has been replaced by electronic storage. A rule of thumb is to keep the extent of detail in electronic and other records that would provide sufficient documentation in hard-copy form (Hinge, 1988). Because of the minimization of paper documents in an EDI system, Hinge (1988) recommends that companies maintain a specific audit trail database, date/time stamp all activities and all attempts to access the information system, incorporate data "reasonableness" checks, create safeguards parallel to those of paper systems, and automate the payment validation process.

10.6 Security Implications

With the expansion of Electronic Commerce and EDI into business-critical and highly sensitive data areas comes the perception of security risks. Business communication, such as purchase orders, commonly involves entering into legally binding commitments, and is often sensitive to unauthorized

disclosure. Businesses must therefore have confidence that their EDI system will reliably and securely deliver their transactions. As a result, issues such as authentication, data integrity, privacy, access control and non-repudiation become a concern.

In addition to system-access security measures such as passwords and electronic signatures, there exist two methods for disguising EDI data for secure electronic data transfer between companies:

1) **Encryption**

Encryption acts to ensure data confidentiality and involves the process of converting a normal message into a garbled form that cannot be read until it is converted back to readable text again. Quite often, VANs offer data encryption services. In addition, 3rd-party encryption products that use sophisticated public and private key schemes are becoming available to enable only appropriate trading partners to access data.

2) **Authentication**

Authentication ensures that the data sent has not been tampered with while en-route to the receiver; in essence, it ensures data integrity. Checks can automatically be conducted to ensure:

- Proof of content received: This enables the originator of an EDI message to verify that the message content received by the recipient was the same as the message content as originated.
- Non-repudiation of content received: This provides the originator of the EDI message with proof that the message content received was the same as the message content originated. This protects against any attempt by the recipient to falsely deny the content of the message received.

Both encryption and authentication processes add expense. As a result, the EDI champion must consider whether the nature of the transmitted data is worth the extra security effort. For electronic payments or government correspondence, the extra security may be warranted. In the case of documents previously sent via a postal service, the EDI-user may well question whether data encryption or authentication is necessary.

Those who need a high degree of security in Electronic Commerce have generally resolved the risks by delivering EDI transactions over VANs. To prevent data loss, VANs keep transaction logs and back-up copies of data sent and received. To prevent data modification, VANS also typically provide or permit use of communications software that detect data modification. To prevent unauthorized reading, user identification and password protection are required to gain access to the VAN for sending or receiving messages.

However, third-party EDI network services create a number of security issues that should be considered prior to signing a VAN service contract:

- VANs keep backup files of data sent through the network; how secure are these?
- VANs can read data as it flows through their networks
- "Compliance checking" (a service offered by VANs to check compliance of data sent with an accepted EDI standard) requires the VAN to look at the data

Another perspective on security comes from the growing use of the Internet for EDI purposes. As mentioned in Section 7.3, security concerns have typically limited the use of the Internet for EDI transactions. However, numerous organizations are working together to develop protection schemes to guard against data tampering. Examples of such schemes include firewalls as well as mutual authentication, whereby the connecting computers can verify each other's identities.

10.7 Implementation Steps

Various sources present different plans for implementing an EDI system. The following list attempts to consolidate these different perspectives and provide a framework for a successful EDI implementation strategy.

- Select an EDI champion, preferably at the executive level
- Conduct an analysis to determine if a reasonable EDI opportunity exists and attempt to identify potential EDI applications
- Obtain senior management support
- Select an EDI task force
    - Appoint a team to establish EDI policies and procedures
- Become knowledgeable
    - Survey trading partners to determine EDI capabilities and interests
    - Join industry organizations

- Develop an implementation plan
    - Create an EDI mission statement
    - Select and prioritize trading partners and transaction sets
    - Evaluate providers of EDI services and products
- Develop a trading partner agreement
- Establish a pilot program

11.0 CONCLUSION

The past few years have seen a great deal of interest and activity in EDI. From its industry-specific origins in the 1960's, EDI has evolved into a framework for international business communications that is rapidly gaining acceptance throughout the business community. Major advances include efforts to merge the existing ANSI X.12 and UN/EDIFACT standards to form an internationally accepted standard format, as well as expanding the functionality of the Internet to support rapid, reliable, and secure EDI transactions.

However, EDI can be only one component in a company's overall effort to improve quality, cost, delivery, and service; EDI makes no sense as an objective in and of itself. Hence, benefits attributed to EDI are really the results of programs like JIT, Total Quality Management, strategic partnering, and customer service that have been made more effective through the use of EDI.

There is no doubt that EDI will be the way of the future, particularly given the current trend toward a global economy and doing business in international markets where it is essential that partners "speak the same language" in order to communicate. Employed properly, EDI can allow a company to manage costs, reduce transaction times, and improve customer satisfaction, effectively providing a strong basis to compete on a global scale.

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APPENDICES

Appendix I: Glossary Of EDI Terminology

ASC X.12 - the ANSI accredited standards committee charged with developing EDI standards for use in the United States.

American National Standards Institute (ANSI) - parent organization of X.12.

Data element - the basic unit of information in an EDI standard which contain a set of values that represent a singular fact.

Data segment - a pre-defined set of functionally related data elements which are identified by their sequential position within the transaction set.

Data Interchange Association (DISA) - group which provides the secretariat for ASC X.12. They are also responsible for publishing and distributing the X.12 standards.

Electronic Data Interchange (EDI) - the intercompany computer-to-computer transmission of business data in a standard format.

Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) - an EDI standard for international use developed by the United Nations

Electronic Funds Transfer (EFT)

Evaluated Receipt Settlement (ERS)

Functional group - one or more transaction sets of similar type sent in one transmission.

Header - control structure that indicates the start of an entity to be transmitted

Mapping - the process of identifying the standard data elements' relationship to application data elements.

Network - a group of terminals, computers, and other equipment that use communication channels to share data.

SITPRO - Simplification of Trade Procedures Board

Syntax - the rules for the construction of standards

Trade Data Interchange (TDI)

Trade Electronic Data Interchange Systems (TEDIS) - programme set up by the CEC to promote awareness of EDI in Europe.

Trading Partner Agreements (TPAs)

Transaction set - electronic transmission of a single document such as a purchase order or invoice between one computer and another. The data included in a transaction set or message will convey the same information as a conventional printed document.

Translation software - transforms data into a format that can be read by an otherwise incompatible system or network at either end of a transmission.

Transportation Data Coordinating Committee (TDCC).

X.12 - ANSI standard for inter-industry electronic interchange of business transactions.

Value-Added Network (VAN) - third-party service providers which offer enhancements to basic network services.

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