The Realities of Electronic Data Interchange: How Much Competitive Advantage?

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Management in the 1990s

Massachusetts Institute of Technology
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I. INTRODUCTION

The concept of gaining competitive advantage by linking organizations with information technology has taken on an overtone of dogma in many business circles in recent years. Early academic and media attention has focused on the sexy, high-impact interorganizational systems (IOS) that clearly have provided strategic advantage for their developers. Unfortunately, the reality of developing and maintaining electronic linkages between companies is not as easy or as profitable as the optimistic preaching of IOS advocates would lead us to believe.

There is no doubt that IOS can have a major impact on organizational performance and industry structure, but as the number of electronic linkages between companies increases those advantages are going to be harder to find and hold on to. Most

of the literature to date in this field has relied on anecdotal
data to draw conclusions about the conceptual development of
interorganizational systems and their effects. To provide a
more specific look at the issues and problems confronting
organizations that implement a special class of IOS, known as
electronic data interchange (EDI) systems, this paper draws on
three detailed case studies and other insights gained from MIT's
Management in the 1990s Research Program.

Not surprisingly, our findings support some of the previous
conclusions about IOS in general, but they also raise new
questions about the real impact of EDI systems on the
organization and its competitive position. Implicit in the
early writings on EDI has been the assumption that these systems
hold great potential for providing strategic advantage. One of
our conclusions, however, is that EDI applications, rather than
being a competitive weapon, are increasingly a necessary way of
doing business as illustrated by our three cases.

Thus, the majority of firms who undertake EDI projects as a
competitive necessity must derive cost savings from these
systems to cover the investment. But these savings can only
come through the painful exercise of redesigning basic
organizational structures and work processes. Unfortunately, it

is hard to justify these very costly behavioral and organizational changes when only a small part of an organization's primary transaction volume is affected during the early stages of an EDI system. As we will see when we examine the three cases, there is logic in keeping EDI projects small at first and maintaining parallel systems. And gaining the high volume penetration of specific EDI applications needed to justify these systems has also proved difficult. Ultimately, the challenge will be to move EDI applications into high volume processing by creating new organizational structures and work processes that make the investment in this technology cost effective.

There is much to be learned from companies which have begun to use EDI technology. Nevertheless, even though other recent studies seem to support our findings (Emmelhainz, 1986), we realize there is always danger in generalizing about a new field like this, particularly from a relatively small sample. We recognize these risks, have tried to allow for them, and suggest only that the reader consider the relevance of our findings in the context of his or her own organization.

This paper is divided into seven sections. In section II, we will address the question of definitions in the evolving field of interorganizational systems. Until now, the definitions used have been general and relatively imprecise, but different classes of IOS, such as EDI, are beginning to emerge and they

need to be differentiated. Section III summarizes the case studies used to illustrate our findings. Section IV examines the impacts of EDI systems on both suppliers and buyers, and Section V identifies two critical factors that will determine the winners and losers in this emerging application area. Finally, Section VI explores strategies for EDI pilot implementation, and Section VII summarizes our conclusions.

II. DEFINITIONS: UNTANGLING A NEW TOWER OF BABEL

As in any new field, every academic researcher, journalist and vendor offers a slightly different definition of systems that are creating electronic linkages between firms. Exhibit I offers a sample of the definitions that have been put forth in recent years and clearly shows the need for a typology to classify different types of IOS. We found few distinctions have been made in regard to the different types of electronic linkages being created between companies. A more careful classification of applications labelled "interorganizational systems," "electronic data interchange," and "electronic markets" is necessary because different applications carry with them different strategic objectives and impacts, as well as unique implementation problems. When we begin to draw conclusions from empirical research, it becomes clear that our findings are not relevant for <u>all</u> interorganizational applications of information technology (IT).

EXHIBIT I

A Sample of IOS/EDI Definitions

MIS Quarterly: Interorganizational Information Sharing System is a general term referring to systems that involve resources shared between two or more organizations. (Barrett & Konsynski,1982:94)

Harvard Business Review: Interorganizational systems (IOS) are defined as automated information systems shared by two or more companies. These uses of information systems technology involve networks that transcend company boundaries. (Cash & Konsynski, 1985:134)

Fortune: They are called channel systems because they're meant to cure headaches for people in a company's distribution channels -- commercial customers and key middlemen. ...In all cases, by helping the customer solve a problem the company supplying the computer system stands to increase sales or otherwise benefit. (Petre,1985:42)

Link Resources (market research firm): "Electronic data interchange" is defined as: direct computer-to-computer exchange of standard business forms. EDI is not a system. It is a standard... EDI consists of a communications standard defining how one computer is to talk to another computer over a network, and a message standard defining the sequence and format of data which is to be exchanged.... (quoted in Callahan,1987:16)

Business Week: In a nutshell, EDI allows specially formatted documents, such as purchase orders, to be sent from one company's computer to another. (1987:80)

Malone, Yates, & Benjamin (MIT): ...new information technologies are allowing closer integration of adjacent steps on the value-added chain through the development of electronic markets and electronic hierarchies. (1986:2)

Exhibit II

	Electronic Hierarchies	Electronic Markets
Transaction Processing	**Cell 1** American Hospital Supply	**Cell 2** American Airlines Sabre System
Task Support	**Cell 3** CIGNA's Risk Info Services	**Cell 4** Planning Research Corporation's Realty System

For this reason, in Exhibit II we offer a typology of interorganizational electronic linkages. A review of several dozen systems mentioned in the literature reveals that they do one of two things: (1) routine transaction processing applications, such as order entry or invoicing, or (2) provide non-routine task support for managerial, analytic, and design functions, that contribute to decision making. On the other dimension, these systems are applied either (1) in electronic hierarchies, that is, integrating tasks and functions across a pre-determined set of organizational boundaries; or (2) in electronic markets where multiple buyers and sellers conduct business through an electronic intermediary.

Here are examples of each type of system described in Exhibit II:

<u>Transaction processing/electronic hierarchies</u> (Cell 1): The classic system in this category is American Hospital Supply, which built what was essentially an electronic order-entry system for its customers. All three of our case studies represent systems of this type, that is, they automate routine transactions between specific buyers and sellers. These are generally the systems that have been categorized as "electronic data interchange."

<u>Transaction processing/electronic markets</u> (Cell 2): The best known examples of applications in this category are airline reservation systems, such as American Airline's Sabre system.

American created an electronic marketplace that allows customers to make routine purchases (reservations) selecting from flights offered by a broad range of airlines.

Task support/electronic hierarchies (Cell 3): This class of IOS is distinguished from EDI because these applications provide support for non-routine tasks, such as sales and market analysis, and computer-aided design. For example, CIGNA Corporation's Risk Information Services enables its corporate customers to access their files on the insurer's computer to do analysis that may help reduce insurance bills. (Petre, 1985:44)

Task Support/Electronic Markets (Cell 4): Systems in this category create a marketplace for multiple buyers and sellers, trying to complete non-routine transactions or tasks. For example, Planning Research Corporation's Realty System provides an electronic network that allows real estate agents to search for listings that meet the needs of their customers. The system also provides a range of capabilities which can qualify buyers, calculate closing costs, and analyze sales.

Making distinctions between these four classes of applications is very important, although the boundaries between the four cells are not hard and fast. For the most part, terms describing electronic linkages have been used loosely by academics and practitioners alike, but failure to clarify these concepts will only add to the problems of implementation. In the context of Exhibit II, we view "interorganizational

systems," or IOS, as an umbrella term referring to applications in all four cells. We define EDI systems as those transaction processing applications found in Cell 1, although others still use the term more broadly.

Exhibit II is a static view of interorganizational systems, but what is equally important is the evolution of IOS applications over time. Some systems may bridge the categories we have offered, or evolve from one class to another, e.g. electronic hierarchy to market, as previously suggested by Malone, Yates and Benjamin (1986). Another tendency may be to add applications to an IOS so that it provides both transaction processing and task support capabilities, in either electronic markets or hierarchies. For example, American Airlines is in the process of introducing a service that will allow companies to automate their travel and entertainment (T & E) information. Building on American's Sabre reservation system, the application automatically transmits booking information to the customer's corporate headquarters with the goal of creating an electronic T & E report for each traveler. (BusinessWeek, 9/87:106) This puts American's IOS in both the electronic markets and hierarchies cells for transaction processing applications. And, when some customers begin using the new application to analyze T & E costs, the system will also fall into the task support/electronic hierarchy quadrant. This is one example of how EDI systems migrate from cell to cell over time.

Although some of our findings may be relevant to other types of interorganizational systems, the balance of this paper will focus on EDI systems that fall into Cell 1 - transaction processing/electronic hierarchies. EDI systems reflect existing patterns of buyer/seller relationships that have been supported by traditional transaction processing systems. Therefore, EDI applications are a natural outgrowth of existing ways of working and they are the most common type of IOS.

III. THREE CASE STUDIES

The three disguised case studies that provide much of the empirical data for this paper are based on interviews with executives and IS managers in the firms developing the systems. Additional interviews were done with buyers, distributors, and in one case, suppliers using the systems.

Midwest Tire, Inc. (MTI)[1]

In the last five years, this major tire manufacturer has developed EDI systems with "original equipment" customers -

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[1]   All data on Midwest Tire, Inc. in this paper are taken from "The Impacts of Electronic Integration on Buyers and Suppliers" by Daniel K. Callahan, 1987.

large automakers - and independent distributors, who sell to the replacement market, as well as suppliers. (See Exhibit III) The three types of systems are quite different, however. The original equipment market is highly competitive, given the purchasing power of major auto manufacturers and the unpredictable state of the auto industry in recent years. (The majority of Midwest Tire's sales and profits - 85 percent - come from the replacement market, served primarily by company-owned stores and independent dealers.)
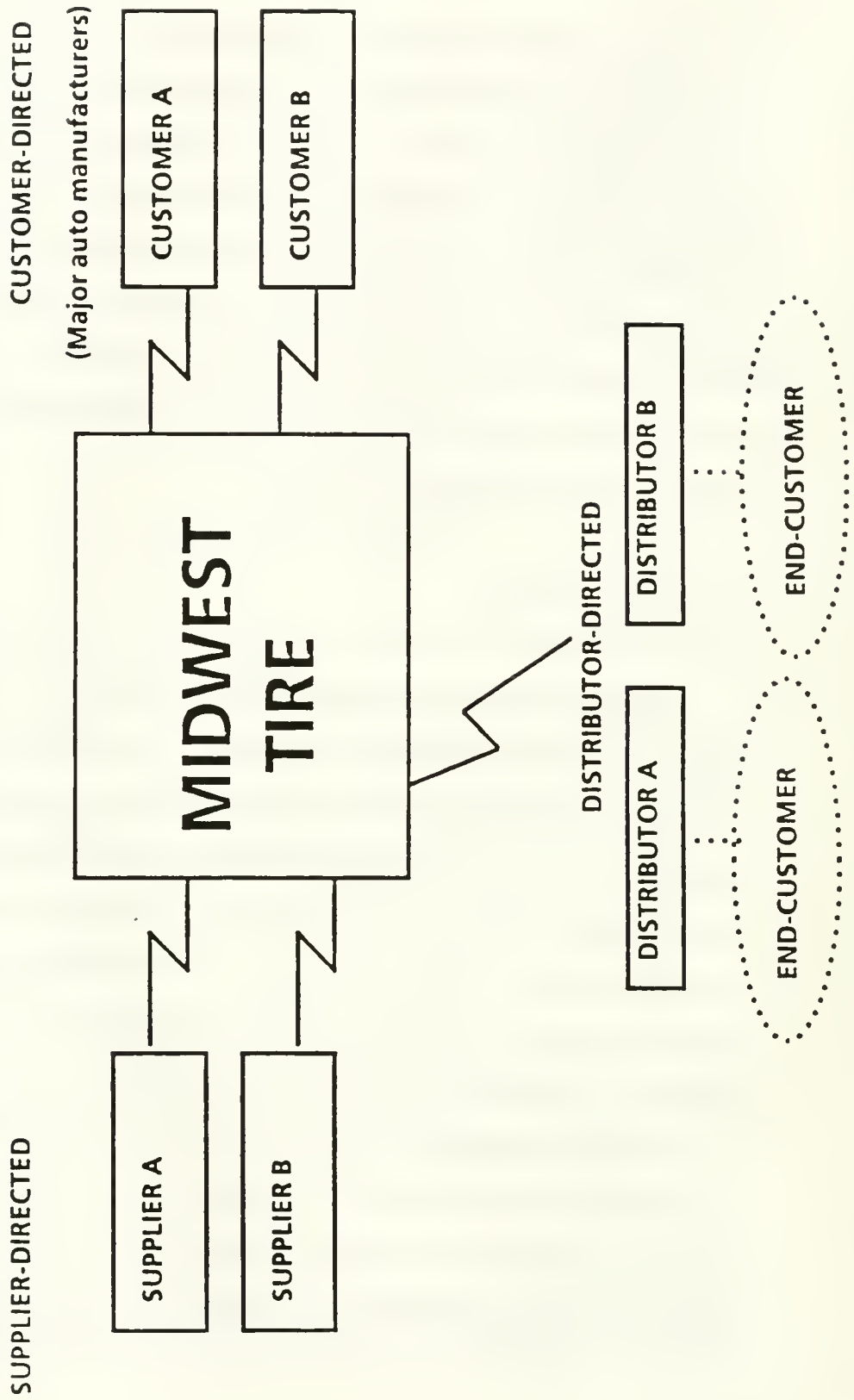
Customer-directed

Midwest Tire has established electronic linkages with at least five of its original equipment customers, but the specific functions these systems perform vary. For example, General Motors and Ford plants send information about production requirements daily and production schedules weekly to MTI via the EDI system. Midwest Tire, in turn sends ship notices to GM every two hours, Monday through Friday, and to Ford hourly between 6:30 am and 11:30 pm on weekdays.

MTI's systems linking it to Navistar and John Deere plants are somewhat different. MTI calls these customers once a day to retrieve daily production schedules. At the same time, it transports ship notices for orders sent out that day.

EXHIBIT III

Midwest Tire, Inc.
Three Forms of EDI

SUPPLIER-DIRECTED

SUPPLIER A

SUPPLIER B

MIDWEST TIRE

CUSTOMER-DIRECTED

(Major auto manufacturers)

CUSTOMER A

CUSTOMER B

DISTRIBUTOR-DIRECTED

DISTRIBUTOR A

DISTRIBUTOR B

END-CUSTOMER

END-CUSTOMER

Caterpillar also sends daily production requirements to Midwest Tire on a different network. In early 1987, at least three other auto manufacturers were in the process of implementing systems with MTI that would allow daily exchange of production information and advance ship notices.

Orders for original equipment tires currently come to MTI by computer, telephone, and teletype. Those received by computer links now represent about 50 percent of the dollar volume in original equipment sales. These EDI systems have increased information provided to Midwest Tire's product coordinators and, thus, have streamlined the process of matching customer orders with MTI's production.

Distributor-directed

In addition to a system that links Midwest Tire's company-owned stores to the firm's inventory management system, MTI has also developed an EDI application tying it to independent tire distributors. This system, still in the pilot stage at the time of the study, allows distributors to do on-line order entry, order status inquiry, and product availability checks. The major part of the transaction process that has been changed by this electronic link is the medium used to transmit orders. The computer instead of the telephone can now be used to communicate routine orders.

Supplier-directed

In the supply chain, Midwest Tire has electronic links with at least four companies. As with the systems in the customer chain, each one works differently and fulfills slightly different functions. MTI has a direct link to a major battery supplier in the large replacement market. Midwest Tire stocks batteries in its company-owned stores and is one of the manufacturer's largest customers. With the system, MTI calls the manufacturer once a day and transmits its orders. At the same time, it picks up the supplier's "confirming orders."

Each day Midwest Tire places orders electronically with other suppliers who manufacture shock absorbers and brake shoes. Unlike the link with the battery supplier, communication with these suppliers is unidirectional from MTI. In another case, a motor freight company dials up a remote printer connected to Midwest Tire's network and once a day downloads freight bills of lading information.

Office Technologies Corporation (OTC)[2]

Office Technologies Corporation manufactures a broad line of business equipment and office supplies. The firm has a large

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[2]   All data on Office Technologies Corporation in this paper are taken from "Impact of Electronic Linkages Between a Firm and Its Customers" by Shyamal Choudhury, 1987.

share of the office copier market. The OTC case study examined

four EDI systems in the Customer Services Organization of the

firm's U.S. Marketing Group. Five Customer Administration

Centers in this unit are responsible for all after-sale

administrative tasks. The centers process order entry, billing,

and credit transactions. In the long run, the EDI systems

described below are intended to replace the clerical components

of these functions. In addition, unlike the other cases we

studied, those EDI applications are all designed to become part

of a broad range of services that ultimately will enhance

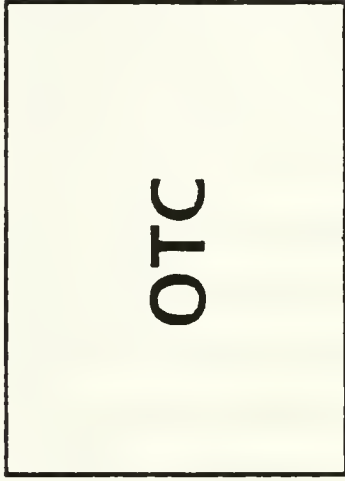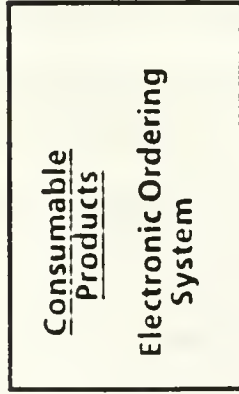customer support. (See Exhibit IV).

1. An electronic ordering system allows customers to order

a variety of OTC products and supplies. With this system the

customer sends a purchase order electronically to OTC and

receives immediate confirmation that the order has been

received. In addition, a purchase order acknowledgement is sent

to the customer electronically after the contents of the order

have been verified. Currently, OTC's receiving hardware in this

electronic link is not integrated with its computerized order

entry system, so orders received on a PC must be printed out and

rekeyed. Four technical configurations are currently being

supported by OTC because of differing hardware at the customer's

end.

2. An electronic meter data collection system facilitates

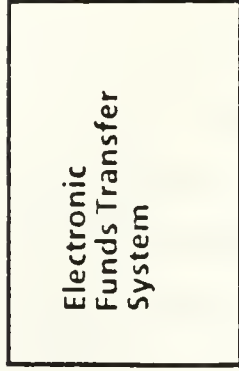the copier billing process for OTC. Each month customers must
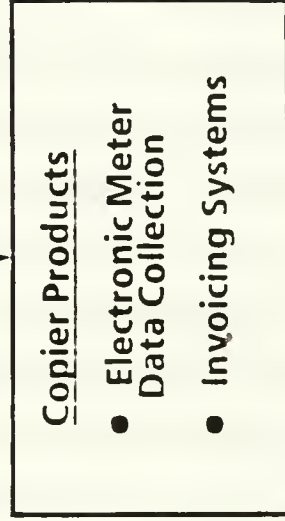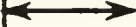
EXHIBIT IV

EDI at Office Technologies Corp.

Customer-Directed

Electronic Funds Transfer System

OTC

Customer-Directed

Copier Products
- Electronic Meter Data Collection
- Invoicing Systems

Customer-Directed

Consumable Products

Electronic Ordering System

read the meters showing the number of copies made on their machines leased from OTC. Previously, these meter reads were mailed to OTC by customers on pre-printed meter cards, so that bills could be prepared. However, about 50 percent of these hand-processed cards were not mailed or were in error, which required time consuming follow-up phone calls for OTC. But with the new system the customer collects the meter reads and transmits them electronically to an OTC computer. This eliminates the filling out and handling of meter cards. In addition, with the electronic system, receipt of the data can be confirmed and validated when it is input, thus, eliminating the error correction cycle.

3. An electronic invoicing system sends invoices from an OTC computer to a customer computer. This eliminates the need to mail printed invoices, as well as the need for customers to rekey invoices. The biggest advantage of this system is that OTC knows when an invoice has entered into the customer's computer system and therefore can forecast cash flow more precisely. Currently, however, OTC's billing system extracts a translation of the invoice and puts it on a computer tape which is mailed to the customer for direct loading onto their computer. Direct computer-to-computer upgrades will be introduced soon. Three customers are currently using this electronic invoicing system.

4. With the electronic funds transfer system, instead of mailing a check, the customer releases payment through a

computer-to-computer communication link between the customer and
its bank. The bank then debits the customer account and can
credit OTC immediately if their account is in the same bank. If
the accounts are in different banks, the electronic funds
transfer is done using the National Automated Clearing House
Agency format which is an established standard. OTC has been
receiving electronic payments this way for two years from
several large banks and a major oil company, and it is currently
involved in a pilot system with a division of General Motors.

Western Food Company[3]

Western Food Company is one of the largest manufacturers of
food and beverages in the United States. It offers a broad range
of products and has significant marketshare in many categories,
including coffee, powdered soft drinks, breakfast cereals,
frozen vegetables, and dessert lines. The primary user of EDI
systems at Western is the Distribution and Sales Service
Division (DSSD). This division is responsible for delivering
Western's "dry" grocery products from its warehouses to the
warehouses and stores of its customers. DSSD's 15 distribution

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[3]   All data on Western Food Company in this paper are
        taken from "Electronic Integration Between Firms: A
        Case Study in the Grocery Industry" by J. Thomas
        Gormley III, 1987.

centers around the country must handle the purchase order, invoice processing, and customer service for every independent and chain-owned grocery store in the U.S. The primary mission of the distribution centers is to minimize the handling, storage, transportation, and processing costs that must be charged back to the product divisions, while at the same time providing excellent service to customers.

Western is currently using EDI systems based on a Uniform Communications Standard (UCS) with 21 of its wholesale distributor customers. The systems generally are used by wholesalers to transmit purchase orders and to receive invoices, as well as purchase order acceptance/rejection messages from Western.

The major change created by Western's EDI system is that its distribution centers no longer need to be directly involved in the flow of purchase order and invoicing information. (See Exhibit V.) With the electronic link, POs are transmitted directly from the customer's computer to a mini-computer front-end at Western's headquarters, bypassing completely the distribution centers which traditionally collected POs and entered them into the firm's order processing system. A similar process is followed with invoices, which, in the ideal situation with EDI, are transmitted directly from Western's HQ into the distributor's accounts payable system. At this stage, however, most distributors still print out the electronic invoices before entering them into internal systems or processing them manually.
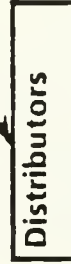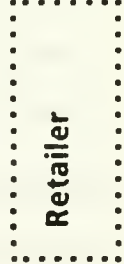
EXHIBIT V

EDI at Western Food Company

After EDI

Western HQ

POs/Invoices

Computer-to-Computer

Distributors

Retailer

Before EDI

Western Distribution Centers

Internal electronic transactions

POs
-telephone
-pickup
-mail

Invoices
-mail

Distributors

Western HQ

Retailer
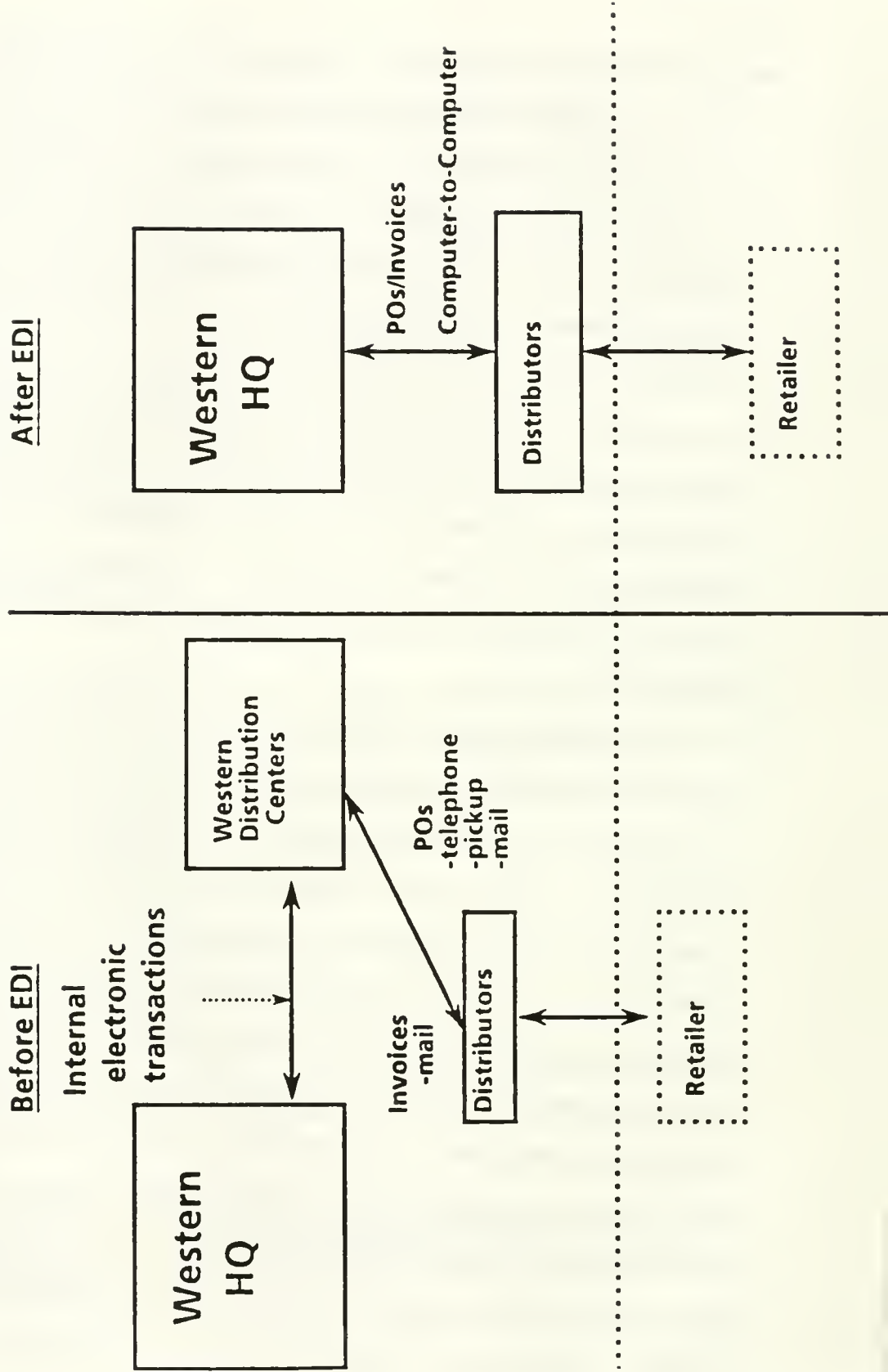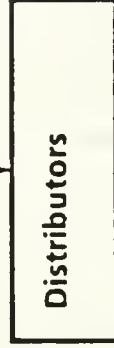
Perhaps because all three cases represent EDI applications
in mature industries or product areas, there are many more
similarities than differences in these systems. All three
companies have attempted to automate the product ordering
process in businesses where keeping costs low and providing
excellent service are both critical success factors. These
systems are also not affected by fast changing product lines or
unstable markets. The products they are selling are for the
most part high volume, relatively simple products. In keeping
with these product characteristics, the systems are inevitably
linked to long-term buyers who have relatively stable
relationships with the supplier. The buyers, for the initial
systems anyway, are all high volume customers.

In all three companies the systems are overwhelmingly buyer
or distributor-oriented, which conforms to the overall trend of
IOS reported on in the literature to date. In our sample, the
only backward-integrated, or supplier-oriented, system studied
was at Midwest Tire.

The three cases present systems in varying degrees of
maturity and sophistication. Midwest Tire's electronic links to
GM and Ford are well established, while Office Technology's
electronic invoicing system is still in the pilot stages.
Overall, the systems studied are relatively new, the standards

and related technology are still evolving, and the penetration
of the systems is limited. For example, at Midwest Tire, 50
percent of sales orders received from auto manufacturers come
via the computer. The remainder still come by telephone and
teletype. At Western Food Company, 20 percent of the firm's
total customer transactions are handled by an electronic
network. These represent some of the more mature EDI systems.

The EDI applications in these cases are performing simple,
inelegant tasks and they are not integrated, for the most part,
with the firm's internal systems. For example, in Office
Technology's electronic ordering system there is, as yet, no
electronic link between the hardware receiving purchase orders
and OTC's computerized order entry system. Orders received
through EDI must be rekeyed into the firm's internal system.
This rekeying appears to be a relatively common practice for new
EDI applications.

Finally, as we will see in the next section, the technology
used for EDI is still very unsettled and standards remain a
major factor in the spread of this type of IOS.

IV. IMPACTS OF EDI -- COMPETITIVE ADVANTAGE OR NECESSITY?

Gaining competitive advantage from EDI applications is much
more difficult than it might appear. The academic and business
press has focused overwhelmingly on the relatively few success

stories to be found in firms implementing interorganizational systems. Like lottery winners, however, these cases create unrealistic hopes for the rest of us. Although the odds are a little better than the lottery, the prospects of hitting the jackpot with an EDI application are still slim.

The desire for strategic advantage remains the most commonly espoused reason for implementing EDI systems. But of the eight different applications in the three companies studied, only one system -- MTI's distributor-oriented system -- showed the potential of providing significant competitive advantage by gaining first-mover benefits that included potentially locking out other suppliers with proprietary technology. While the other seven had the potential of reducing costs, in industries where the low cost position is important to success, the savings would not be enough to provide strategic benefits.

In reality, at least six of the EDI systems in this sample were motivated by competitive necessity. Management on the supplier's side believed the systems had to be developed as a defensive measure to stay even with the competition, although there was no evidence that the three firms were being hurt by competitor's systems. Since the two parties to EDI transactions are buyer and supplier, let us examine the impacts on each.

Impacts on Suppliers

One of the most striking aspects of the eight different
systems in our sample was how little change they had created in
the supplier's organization. Staff reductions have been few, if
any, as all three companies tried to avoid laying off workers
when the systems were first installed. Instead of reducing
headcount, the tendency has been to try to increase the
productivity of those using the systems. Implicit in this
approach is a minimal change in work processes. Gormley's study
of Western Food Company provides a typical example. He reports:

> Little organizational change has occurred in
> either Western or its customers. Each has
> maintained the same number of order entry
> personnel on its staff. None of the customer
> service coordinators or clerical workers have been
> elevated in salary or title as a result of their
> experience with [EDI], and the learning of new
> skills. It appears that such organizational change
> would be viewed negatively by managers and
> subordinates. (Gormley, 1987:153)

Along with few staff reductions, there was very little
change in the tasks performed by those using the systems. One
exception to this is the system linking Midwest Tire to its
independent distributors. This order entry application has
changed the skills needed by customer service representatives.
Because orders are now placed electronically, instead of by
telephone, there is less need for good telephone skills and
product familiarity, and more focus on reviewing information
entered by customers on the computer.

The relatively minor changes created by these EDI systems to date have resulted in only small cost savings for Midwest Tire, Office Technologies, and Western. Cost savings for suppliers will continue to be minimal as long as the penetration of EDI remains small and it is necessary to maintain parallel non-EDI systems.

In general, the short term benefits of EDI for suppliers tend to be intangible. In all three cases, the systems improved the firm's service-oriented image and enhanced its role as an industry leader in the application of technology. Because all three companies are selling in mature markets, automating its transactions gives the seller a way of at least temporarily differentiating itself from the competition, by handling sales transactions more efficiently. This advantage, however, is short-lived as other suppliers install similar electronic capabilities. In one instance, for example, Midwest Tire found that its EDI system with a truck manufacturer gave it a six to nine month advantage over other tire suppliers, until they established a similar electronic link with the customer.

In all three cases, suppliers built EDI systems out of competitive necessity, and there was no measurable gain in business volume attributable to the applications. For the supplier, EDI systems often turn out to be a cost of doing business and a way of learning about the technology. In addition, however, they also may lead to other more

sophisticated forms of IOS, such as Midwest Tire's subsequent electronic collaboration with an auto manufacturer on new tread design. This is an example of an IOS application involving task support in an electronic hierarchy, as illustrated by Cell 3 in Exhibit II.

In summary, the only way suppliers will be able to continually differentiate themselves from competitors implementing EDI systems is by adding new capabilities.

Impact on Buyers

Buyers, on the other hand, tend to gain more immediate and measurable benefits -- cost savings -- from EDI applications. These come, not because the customer has done anything innovative, but simply because of their structural position in the marketplace. Cost savings come from the buyer's ability to use more timely product ordering and shipment information to reduce inventory, as well as improving materials management and productivity. For example, when Midwest Tire established an EDI with some of its parts suppliers, the time between placing an order and delivery dropped about six days. This created an estimated one-time inventory reduction of $250,000 and an added savings of $250,000 in inventory carrying costs. In addition, better information about the status and location of products that had been ordered, e.g., when a shipment would arrive,

improved warehouse planning and personnel scheduling. Being able to schedule unloading more accurately meant less need for overtime labor and generally improved warehouse productivity.

As with suppliers, the effect of EDI on buyers' headcount appears more limited than might be expected. A recent study of EDI use by purchasing departments, however, found that organizations with the most mature systems reported reductions in personnel, while those EDI projects in the pilot or planning stages reported no decline in headcount. "This seems to indicate that reductions in personnel are not expected but may result," concludes Emmelhainz. (1986:7)

One unanticipated benefit of EDI for buyers is improved information about suppliers' operations. This can provide a significant advantage when negotiating with the supplier. For example, Callahan observed, "Midwest Tire's customer-directed systems show that, contrary to earlier 'wisdom' regarding interorganizational systems, these systems do not result in increased power of suppliers relative to buyers. Midwest Tire's customers, in fact now have more control over the company in that they have shipment information broken out by plant, size, product line and dollar-volume equivalent." (Callahan, 1987:88)

V. CRITICAL FACTORS IN EDI DEVELOPMENT

Our research indicates that two factors more than any others influence an organization's ability to develop effective EDI applications. These are (1) the existence of industry standards, and (2) the firm's ability to manage necessary changes in organizational structure and work processes.

Standards

The state of standards development is a critical variable in the evolution of EDI within individual firms and across industries. The existence of standards is not only a prerequisite for the high volume penetration of EDI which can lead to significant cost savings, but standards also change the competitive dynamics of these interorgan-izational systems because they change the rules of success. The evolution of widely-accepted EDI standards within an industry lowers the cost of entering into electronic linkages with buyers and suppliers. This makes proprietary systems, such as those developed by early EDI "winners" like American Hospital Supply and McKesson, impractical or at least much more difficult to "sell" to trading partners. In addition, standards solidify a new, larger market for vendors and encourage them to create better EDI software tools and third party networks.

Progress in standards development varies greatly from industry to industry. The evolution of standards seems to depend a great deal on industry structure, the strategies of early EDI adopters within an industry, the spirit of cooperation that exists between firms, and the strength of industry associations. Industries with strong trade associations, e.g. transportation, groceries, or where regulatory standards are imposed, e.g., banking, airlines, are most likely to be early developers of EDI standards.

Dominant buyers in manufacturing industries, such as autos, are also likely to be interested in EDI systems because of the technology's ability to support "just-in-time" inventory control. These buyers can initially impose their own standards on suppliers, but their interest in expanding penetration of the technology more quickly may lead the buyer to become a force behind standards development, as happened in the auto industry.

In industries where standards do not exist or have not yet evolved sufficiently, each EDI link requires significantly more effort on the part of buyer and seller. Midwest Tire, for example, incurred substantial development costs in creating customized document interfaces for EDI systems linking MTI to its major customers. These systems, implemented at the request of the auto manufacturers, had to be designed to suit the unique specifications of each buyer because industry standards had not yet been developed. In this case, as in others in our sample,

the party that conforms when standards do not exist is usually
the seller.

Because standards have yet to evolve in most industries, the
value-added networks (VANs), such as GEISCO and Tymnet, offer
forms translation capabilities that make it easier for companies
to translate their internal transactions into acceptable
interorganizational standards, such as ANSI X.12, a
document-messaging format standard developed by the American
National Standards Institute. These third party networks not
only reduce the cost of code and protocol conversions, they also
offer an established distribution system, or network, with low
incremental costs for linking up to additional firms.

Of course, not all companies are anxious to establish EDI
standards. For example, when suppliers see an opportunity for
"significant" competitive advantage, it is in their interest to
preempt any evolving standards and create their own proprietary
protocols. An example from our sample is Midwest Tire's attempt
to create an order entry system for independent distributors
using proprietary hardware and software in order to create
switching costs, while enhancing service, for its customers.

The existence of standards both within a particular industry
and across industries has important implications for the
potential strategic impacts of EDI systems. As the development
of intra-industry EDI standards gains momentum, customized
systems such as the one at Midwest Tire above will become

increasingly hard to "sell" to trading partners. In addition, the data show that over the long term the balance of power will continue to shift to buyers. Well-defined standards not only eliminate barriers to entry and encourage more suppliers to install EDI systems but they also remove switching costs for buyers and give them more leverage over suppliers.

Managing Change in Structure and Work Design

Ultimately, the critical factor in determining which firms derive the greatest benefits from EDI will be the ability to manage major changes in work design and organizational structure. The notion that in the long term significant internal restructuring will be necessary to reap the potential benfits of EDI was lurking in the background of all three cases. We found, however, a paradox in the EDI projects we studied and the 15 reported on by Emmelhainz.

As part of their strategy to gain organizational acceptance of the systems, developers in all three firms intentionally minimized any changes in the work processes affected by these systems. This virtually eliminated resistance to the project within the organization, but it also meant the benefits, and specifically cost savings, derived from the systems were minimal, thus, making it more difficult to justify expansion.

Of the companies studied, only developers at Office Technologies explicitly recognized the need to redesign work processes as EDI transaction volume builds up.

Organizations implementing EDI systems are faced with a dilemma. Staying in the pilot mode of operation minimizes painful organizational change but also results in increased costs of using the technology without deriving significant savings. The alternative is to go through a disruptive and uncomfortable redesign of work processes to take full advantage of EDI technology, which inherently requires fewer people doing different tasks.

Although there is no hard evidence at this stage for any of the cases investigated, it seems apparent that when EDI begins to dominate the volume of transactions, organizations will have to redesign business processes in order to remain cost and service competitive. What is less clear, however, is whether the transition to new organizational processes and structure can be facilitated in the earlier pilot stages of implementation.

VI. Strategies for Pilot Implementation

Most companies get started with EDI technology through pilot projects. The exceptions are those firms driven by dominant buyers to establish electronic linkages.

Pilots are essentially processes designed to facilitate organizational learning. It is only logical that any firm entering this applications area for the first time will do a series of pilot projects before trying to put a system into production. Indeed, the three companies in this study did extensive pilot projects to learn about the technological and organizational impacts of the systems. Ironically, in the early stages of EDI development, considerations about competitive advantage are rarely a concern. The focus is on making the technology work and managing the impacts of the application on the organization. Office Technologies, for example, ran pilots for each of its four types of EDI applications primarily to determine any obstacles to implementation, not to collect data on the pros and cons of installing such systems.

EDI pilots tend to be technologically simple. They minimize changes to existing data processing transaction systems and they can be implemented without sophisticated technology. At Office Technologies, early EDI prototypes simply involved receiving data on two PCs in ANSI X.12 format. Developers intentionally avoided more complicated technical hookups, such as interfacing the PCs with a mainframe, which could provide remote order entry or inventory checking in OTC's data bases. Except for some standards translation software, EDI developers in our sample tended to use well-established technologies and communication networks.

Another important factor in EDI pilot implementation is senior management support for the project. Except in cases where EDI is forced on a company by outside pressures, top management must understand that the implementation process takes time and is a long term competitive necessity. They must also recognize that, ultimately, to secure substantial benefits from EDI will require organizational redesign.

One of the functions of the pilot should be to provide senior management sponsors with the necessary learning and insights about the above factors to help them plan and support future EDI expansion. As a rule, however, executives seem to abdicate any control over where EDI prototypes are developed in the firm, nor do they review the strategic implications of these applications. In our case studies, the link between senior management and the EDI project, while strong at the outset, disappeared soon after the pilots were developed.

Important questions remain about the proper role for top management in shaping the organization's policy toward interorganizational systems and the allocation of resources for these systems. For example, should decisions about specific EDI applications be made far down in the organization, or should they be dictated from the top? Should the political motivations of various units in the firm who stand to gain from EDI be ignored? There is little doubt about the importance of top management's role in formulating an IOS strategy, but the level

of involvement in EDI development remains an unanswered question.

Despite optimistic assumptions about the ability of developers to expand EDI use beyond the prototype stage, significantly increasing the penetration of these systems often proves more difficult than expected. Moving EDI systems into production means confronting not only barriers imposed by a lack of standards, but also the organization's resistance to large-scale change. Top management support in this process is essential because experience indicates that the ability to implement a successful EDI pilot, while essential for learning, is no guarantee that the application can be readily expanded to a broader group of users.

VII. CONCLUSION

Until now, electronic data interchange has been viewed largely as a strategic issue whose major implementation challenge is overcoming the technical problems of creating electronic links between firms. This, however, is an oversimplification of what the technology means to organizations and what must be done to use it effectively.

As we stated at the outset, EDI represents a specific class of interorganizational systems, and the concept carries with it a unique set of strategic and implementation considerations.

Contrary to popular assumptions, the majority of EDI applications will be built out of competitive necessity, providing little, if any, competitive advantage for most users. These systems will become a cost of doing business.

To be sure, many firms enjoy a competitive advantage from EDI, however short lived. But only a rare few maintain this advantage, and when they do it is not from the technology but by instilling a mindset that focuses on customer value and then supports a process that continually innovates and adds features valuable to the customer.

The existence of standards will continue to be the fundamental factor in how fast EDI spreads in an industry. In the end, two determinants of this spread will be (1) industries with strong trade associations which create standards, and (2) industries where a few major buyers are able to force suppliers to establish electronic linkages. As standards become more widespread over time, more of the benefits of EDI will go to buyers, who will find these systems shifting the strategic balance of power in their favor. Thus, buyers will be the dominant force behind the growth of EDI, while suppliers will push it only when they see some way of diffentiating themselves.

The most significant and, heretofore, most overlooked factor in determining the effective use of EDI is the organization's ability to manage the changes in structure and work processes that must attend the implementation of this technology. Laying

EDI systems on top of existing work processes trivializes the potential of these interorganizational systems. To assure effective use of the technology, organizational redesign must become synonymous with EDI development. The managers who understand this will be most likely to succeed in an environment where EDI becomes a way of doing business.

Those who do gain significant competitive advantage from EDI will do so by learning how to integrate the technology effectively into their organizations in such a way that they can continually add valuable new capabilities to the system, while deriving cost savings from increased productivity and decreased overhead made possible by EDI. In the early stages, most of this learning will come by implementing pilot projects, but competing with EDI is not simply a matter of investing in the technology. EDI development is a process that takes time and patience, and those who start first have the best chance of staying ahead of the competition if they recognize that EDI involves a continuous process of change. There is no end to organizational change in this era of rapidly evolving information technology.

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