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May 1990

CISR WP No. 206  
Sloan WP No. 3151-90

## Center for Information Systems Research

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## ABSTRACT

Business executives and systems professionals are frequently confronted with suggestions to use information technology strategically. While this advice has had a number of positive effects, including broadening the thinking about how IT can be used, it has at the same time failed to suggest the significant difficulties in actually implementing these systems.

This paper highlights a dozen significant barriers to the successful definition, development and maintenance of strategic information systems (SISs). These problems are illustrated with actual examples gleaned from an extensive review of the business press and from confidential interviews with managers who have attempted to develop SISs. A risk matrix is provided to assist managers in determining their relative exposure to these pitfalls.

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## I. INTRODUCTION

Business executives and systems professionals are increasingly confronted with suggestions to use information technology strategically. At least a dozen articles have appeared in such journals as the MIS Quarterly, Harvard Business Review and Sloan Management Review proposing strategic information systems (SISs). This stream of articles has had two salutary effects. The first is that it has increased many firms' awareness of ISs' strategic potential. This movement from narrowly viewing IT as only appropriate for automating back office functions to a broader conception of IT's applicability has been of benefit. Second, it has relieved the necessity for cost/benefit style justification of many investments in IT where such justification may have been inappropriate [Vita88].

However, for all these positive effects, there is growing recognition that the current writings on SIS have been extremely one-sided. The articles encouraging firms to "get on board the SIS movement" have rightly pointed to a Trinity of legitimate successes: Merrill Lynch's Cash Management Account (CMA), American Hospital Supply's (AHS) ASAP order entry system, and the American Airlines SABRE reservation system. However, these articles have generally not addressed the significant barriers to conceiving, developing and implementing SISs and the inherent risk of failure.<sup>1</sup>

For example, the August 1984 issue of Fortune, in an article on Federal Express's Zapmail and MCI's MCIMail, stated, "Wall Street's analysts generally agree that each company will turn a profit in electronic mail by 1986 and that each service will be grossing over \$1 billion a year by the early 1990s" [Loui84]. Since then, Zapmail has been discontinued amidst approximately \$350 million in losses and MCIMail has fallen far short of the initial optimistic predictions. In light of experiences such as these, managers need to look very closely at any SIS proposal.

It is the thesis of this paper that *there exist significant systems development challenges that present risks or even barriers to some organizations' attempts to use information technology strategically, and that executives and systems developers who are considering an SIS development must carefully plan so as to avoid these pitfalls in order to increase the likelihood of a successful SIS.* This paper outlines a dozen significant problems in realizing a SIS, and provides examples of unsuccessful SIS attempts gleaned from an extensive review of the business and systems press and

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<sup>1</sup>One exception to this is McFarlan's foreshadowing of a "flip side" to the promises of SISs. See [McFa84], p. 99.

confidential interviews with individuals involved in SISs attempts. It is shown that the paucity of SIS success stories is not merely a lag between the proposal of such ideas in journal articles and their implementation in the real world. Rather, it is because SISs investments are only appropriate for those organizations that can overcome the numerous hurdles that have stopped other organizations. Clearly, building a successful SIS is a desirable goal. However, the question managers must ask themselves is, "How will this be accomplished?"

## II. PROBLEM APPROACH

Answering the question of why there are not more successful examples of SISs is a much more difficult assignment than finding the successes, for two reasons. The first is that much of the data, mostly in the form of institutional evidence, is in the hands of firms who would prefer to keep private any evidence that might indicate less than total success. Second, it will be argued that a number of prerequisites must be met before an SIS idea can even make it through the conceptualization stage, and therefore an additional task is to try to identify evidence for systems that were not even attempted.

These are somewhat daunting tasks, and the results that follow were based on two main approaches. The first was a thorough review of business and systems journals for a recent two year period (some 645 issues), looking for evidence of firms' experiences with SISs<sup>2</sup>. The second was a series of confidential interviews with individuals in eight firms representing a spectrum of American business. These interviews should be considered a convenience sample and are presented as illustrative rather than a statistically representative sample of some underlying population.

An important issue that arises in the context of doing this type of work is what constitutes an SIS? Many of the most widely cited works in this area provide only examples rather than actual definitions. One exception to this is the book by Wiseman [Wise85]. His definition is: "...information systems used to support or shape the competitive strategy of the organization." This definition is relatively broad, a view that is consistent with that adopted in this paper. Along with adhering to this definition, all of the examples used in this paper reflect a view of strategy first proposed by Ansoff in his "growth vector" matrix, shown in Figure 1.

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<sup>2</sup>See [Sosa88] for a complete list of sources.

	Product		
Mission		Present	New
	Present	“Market penetration” (early AHS ASAP)	“Product Development” (ML’s CMA)
	New	“Market development” (SABRE, APOLLO)	“Diversification” (USA Today)

**Figure 1. Ansoff growth vector matrix [Anso65, p. 109]**

Perhaps the best way to illustrate Ansoff’s framework is through classification of the standard SIS success stories. By *market penetration*, Ansoff suggests strategic moves that increase market share among existing markets with the existing product [Anso65]. The original AHS electronic order system, by making it easier for hospitals to order ever increasing amounts of their supplies though ASAP is therefore an example of this type of strategy. *Market development* is where “new missions are sought for the firm’s products”. The use of airline reservation data by American and United to perform analysis of competitors’ routes to determine which markets to expand into is an example in the market development cell. Product development occurs when new products are introduced into existing markets to replace current ones. Merrill Lynch’s CMA was a new financial services product that successfully lured deposits away from a variety of existing sources. Finally, diversification is growth into a new market with a new product. Benjamin, et al. cite Gannett newspapers’ USA TODAY as an example of information technology’s power to create a new product, a national general interest newspaper [Benj84]<sup>3</sup>.

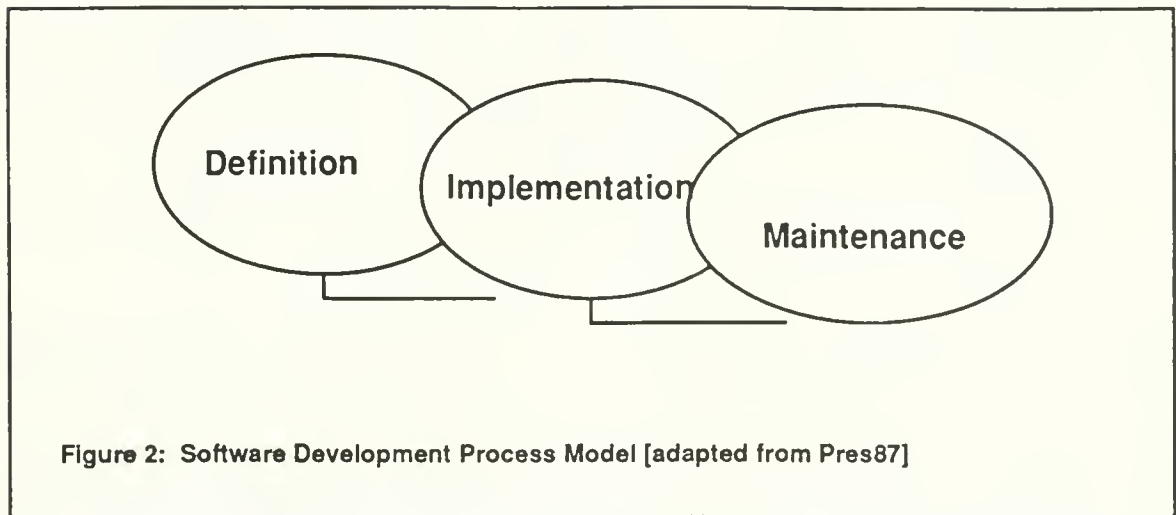
Similarly, all of the less than successful examples in this paper are also illustrative of strategic attempts in at least one of the four Ansoff quadrants.<sup>4</sup> However, given that this paper’s focus is not the generation of ideas for SISs, but rather the challenges faced in their *systems development*, the remainder of the paper is organized around a systems development life cycle model, as shown in Figure 2. The particular illustration shown in the figure is from Pressman’s classic software engineering text, although this so-called “waterfall model” has been a long accepted view of the development of systems [Press87]. Therefore, the outline of Section III of this paper is divided

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<sup>3</sup>Interestingly, the early enthusiasm for USA Today has dimmed somewhat. As of the end of 1989 the paper, launched in 1982, has yet to have a single profitable year. This is in contrast to the typical expectation of a three or four year investment period [Metz89, Beck89].

<sup>4</sup>The appropriate quadrant is named at the system’s first occurrence in the text. Readers should note that the use of the Ansoff model and the significant reliance on publicly available data may tend to place more emphasis on “external” types of SISs than the “internal” types. Interested readers are referred to [Brun87] for details on these “internal” systems.

into three sections, A through C, corresponding to definition, development, and maintenance respectively.



### III. DISCUSSION OF RESULTS

From the business press review and from interviews with leaders in the SISs area, it appears that the potential pitfalls faced when working with strategic information systems can be classified into three steps of the strategic information systems creation process. These are:

- A. Definition phase - identification of feasible opportunities for strategic advantage is difficult,
- B. Implementation phase - given an idea, strategic systems are often difficult to implement, and
- C. Maintenance phase - even if implementation is successful and the system is strategic, continued success can be very costly.

Examples of pitfalls within each of the three areas that have proven to be obstacles for organizations' successful creation of SISs are presented in the following three sections.

#### A. Feasible opportunities identification is difficult

In order to identify a feasible opportunity to obtain strategic advantage through SISs, the following minimum criteria should be satisfied. systems must: 1) be conceived, 2) be technically feasible, 3) be fundable by the organization, and 4) have a market. The following sections show how failing to meet just one criterion creates a major impediment to the development of SISs.

### *A.1. Conception of ideas for SISs requires teamwork*

As noted by Wiseman, the development of an SIS often begins with a visionary idea [Wise85, p.9]. However, such ideas may be difficult to conceive. The business press has not highlighted problems in this area because, obviously, non-conceived ideas are not evident. However, interviews with industry leaders indicate four common barriers: a) a non-supportive corporate environment, b) a lack of leadership, c) a lack of vision and d) difficulties in intra-firm communication, that can all act to inhibit the generation of SISs ideas. A conducive and appropriate environment is needed to allow staff to conceptualize SISs. An executive at a financial services company interviewed for this research (all references to unidentified organizations are based upon confidential interviews completed for this study) commented on how the organizations' leader did not want systems people telling the business people how to run their businesses better because they might come up with an idea to spend money. The leader did not want to spend money on "pie-in-the-sky stuff." The executive remarked, "This is a depressing statement for someone interested in thinking of ways to help."

The generation of SISs ideas often requires that individuals in line rather than staff positions show initiative. A manager at a public utility stated, "The challenge in the conceptualization is that users expect the systems people to come up with the systems recommendations." The manager also said, "Systems people do not know the business-end, so coming up with the ideas is tough. Not knowing the business-end makes it difficult to think of potential benefits."

The manager's comments coincide with Rockart's recent research and study of 15 companies [Rock87]. Rockart clearly shows that there is a pattern of emerging line responsibility where systems conceptualization is driven by business persons, not by IS personnel. One of Rockart's key points is the importance and essentiality of an active partnership between the line and the systems group. the increasing complexity of the work, coupled with increasing line involvement demands that the corporate environment support the required interaction if success is to be achieved.

An executive of a consumer goods manufacturer provided an example that supports Rockart's results. He remarked, "Creating the environment between the sponsor and the information systems group for participation and enthusiasm in a recent project was the biggest difficulty. There is a lack of a mutual conceptual understanding between the business unit and the MIS group."

A conducive environment alone does not, however, solve the dilemma. The supporting environment must be coupled with visionary individuals. An executive of a consumer goods manufacturer stated that “To develop SISs we need people with vision; dreamers who could step beyond the current limits of technology.” This first hurdle is very difficult to clear and is one where many firms fail.

A senior manager at a manufacturing firm said that the translation of skills between the individuals working on SISs is a hindrance. He remarked, “The people with business needs must be able to translate them into a system, and the people with technical knowledge need to translate that knowledge into a business opportunity.” A member of the company from the business side remarked that his biggest problem was to “get some technical direction to get the job done right.” He had come up with an idea for a strategic system but did not have the background to implement it. Some components of the original system-concept were left out because the users did not have the technical expertise to use them.

A senior manager of a construction company remarked that the lack of dual expertise causes some IS difficulties. The manager stated, “Systems that are developed out of the organization’s business-end tend to be faulty. This problem would be eliminated if the business individuals possessed some information technology skills.”

In summary, many barriers exist that prevent even the conception of SISs ideas. Firms should strive to provide a supportive environment that acts to encourage the generation of creative systems ideas. The importance of an active partnership between line managers and IS staff in order to develop these ideas should not be underestimated. In addition, an environment that supports limited experimentation and tolerates the inevitable results shortfalls and even minor outright failures is critical in providing the room that visionary individuals need to exercise their plans.

#### *A.2 Current technical infeasibility can limit innovation*

In SIS conceptualization, technology is often thought of as a driver, providing the inspiration for new ideas. However, the technology to make ideas work as conceptualized must be currently available for the company to benefit. Without the proper technology available for use, even the best SIS idea can not be brought to fruition.

For example, in the 1970’s a few companies tried to allow customers to pay bills by dialing digits on a telephone, an example of an Ansoff product development-type initiative. The bill paying



phone systems were hard-to-use and error prone, as the standard telephone is a very limited input medium. Although the concept of paying from home seem attractive, the technical difficulties of the systems limited the pay-by-phone method to only 6% of the bill-paying options as late as 1987 [Pay-87]. Similarly, home banking has not been widely accepted, in part due to the lack of home PCs [DeJe88].

In early 1984 Shearson American Express had the idea of applying artificial intelligence to the task of interest rate swapping, another product development initiative [Ross88]. Unfortunately, the LISP machines that were required to provide sufficient processing speed then cost approximately \$100K piece, and therefore a less satisfactory personal computer version was developed. The lack of performance of the PC technology was one factor in this system's eventual failure.

Equitable Life Assurance Society Inc. regards the lack of high-quality computer-graphics as a key limitation of Knight-Rider's Viewtron service, an early videotex offering that is discussed in greater depth later in this paper. The screens that the in-house developed software could create were "dull as toast", according to James Johnson, Equitable's chief MIS strategist [Stix86].

Conceivably the above ideas might have been successful. However, because the technology currently available was not sufficient to support them, they were doomed to be ideas before their time. Additionally, it is easy to imagine that other ideas never publicly surfaced due to technical limitations.

### *A.3. SISs are expensive*

Attempts to use strategic information systems, whether they become successful or not, typically require large investments. Of course, finding examples of SISs that were not attempted due to inadequate funds is extremely difficult, but there is some evidence.

According to the Equitable Life Assurance Society Inc., the company could not afford the \$15 million required to develop its own electronic insurance marketing system [Stix86]. Instead of spending the money to develop a system, it paid between \$.5 and \$1.0 million to join Knight-Ridder's Viewtron videotex service. Unfortunately for Equitable, Viewtron ceased operation in March, 1986.

A manufacturing firm reports that strategic systems employing leading edge technology are not aggressively pursued because the division's funds are eaten up by software maintenance. The

controller commented, “The company needs to bring back some good ideas and work with them (if funds become available).”

While the data for unaffordable systems is difficult to obtain, there is much evidence that consequential SISs are expensive. The cost of supporting an SIS concept can be enormously burdensome, even for a large firm. Citicorp spent \$3.25 billion on hardware, software, and personnel between 1979 and 1984 to develop the Global Transaction Network [Harr86]. Sears and IBM have invested \$450 million on an interactive videotex service to provide information, entertainment home-shopping and banking [Bair87]. Federal Express lost approximately \$350 million from two years of operating its failed Zapmail facsimile information transmission service [Brod88a, Fous87. Also, see the discussion on Zapmail below]. United Airlines Inc. spent \$250 million to build its Apollo airline, hotel, and car rental reservation system [ben-86b]. Additionally, United will have spent \$120 million building a reservation system for a European partner [Whee87].

In order to place the previous expense figures in some perspective, it may help to recall that the 1987 mean profit for Forbes 500 companies was \$128 million [Intr88]. given these figures, it is clear that some types of high potential SISs may be beyond the reach of all but a few industry giants, even if the idea is likely to be successful. Of course, in the following sections it will be suggested that success is very difficult to achieve, thereby raising the SIS ante.

#### *A.4 External SISs still require customers*

Even after an organization has conceived an affordable, technically feasible SIS idea, it must have a market in order to be successful. Several very expensive and technically feasible attempts to obtain competitive advantage using IT failed because of market problems. Four well-documented failed attempts are: electronic transmission services, shop-at-home, on-line mortgage services, and debit cards.

##### *A.4.a) Electronic transmission services*

Federal Express Corp. an acknowledged user of strategic information technology in the package delivery industry. After 5 years of planning, Federal Express launched a 2-hour facsimile transmission service in July, 1984 [ben-86a, Hell87, Port85]. The service, Zapmail, was based on non-standard but high quality fax technology and was positioned as a high-end product relative to Federal’s overnight delivery service. The company lost approximately \$350 million dollars and

eliminated the service in March, 1986. This attempt at diversification never reached the 20,000 transmission-per-day volume that was necessary to break even, even though the retail transmission price was reduced from \$36 to \$25. One reason for Zapmail's market problems may have been a growing installed base of increasingly affordable fax machines [Hell87].

#### A.4.b) Shop-at-home services

Another example of an implementation of an Ansoff diversification strategy are videotex services that allow firms to offer interactive information and services through computers and can provide home-shopping, home banking, travel information and reservations. Wildly optimistic projections about the potential market for videotex were made (e.g., as recently as 1983 a prediction was made that sales in 1987 would be \$7 billion; actual sales were less than 2% of this forecast [Brod88]). However, to date consumers have resisted the costly videotex electronic information services concept. Knight-Ridder Newspapers Inc., the pioneer of the videotex market, was able to obtain only 20,000 subscribers and left the business in March, 1986 after losing more than \$50 million [Baum88]. Times Mirror Co., another industry pioneer, was also forced out because of the poor market. Consumer resistance to the complex technology, and the high cost of operating a terminal have been cited as the main reasons for the videotex failures. The low number of households with PCs has also been a problem [Bair87].

IBM, Sears, and CBS created a videotex company called Trintex in 1984. The market's poor showing caused CBS to "bail out" of the joint venture on November 14, 1986 after spending \$20 million and expecting to spend at least \$80 million more [Baum88]. Other sources estimate that between \$300 and \$500 million have been invested in total [DeJe88]. Trintex had predicted a 10 million household subscriber base over the next 10 years. However, by March, 1988 the company still had not delivered its service. Apparently, Trintex is very concerned that the low number of modem-equipped home computers will cause it to fail just as previous services have and, in an effort to increase the potential for market success, Trintex announced an alliance with Hayes Microcomputer Products, Inc. to offer a modem-software package [Robe88]. The collaboration is an effort to increase the number of home computers with the modems, and therefore increase its chance for success.<sup>5</sup>

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<sup>5</sup>Note that these early videotex disappointments are not isolated incidents. Grover and Sabherwal, in a forthcoming article in the Journal of Systems Management, also cite the British Post Office's PRESTEL system and Keycom's Vidotex offering in Chicago as services that failed meet initial expectations [see Grov89,p.7]. Most recently, Business Week has noted the \$106M failure of J.C. Penney's Telaction system [Bren89].

Another example is a New York bank that has spent over \$10 million developing a new product, a home banking system [Bonn87]. So far, the system has attracted fewer than 20,000 users. Nationwide it is estimated that fewer than 100,000 people and small businesses use home banking services, a number smaller than that likely to be required to make these services economically justifiable to the banks [Zinn88].<sup>6</sup>

#### A.4.c) Mortgage services

Both Wiseman and Ives and Learmonth specifically cite Shelternet, a market development system that allows potential home buyers to search for the best mortgage rates and apply for a mortgage, as an SIS [Wise85, pp. 126-127; Ives84]. However, Shelternet, developed by First Boston Capital Group, did not become popular with home buyers or real estate brokers and therefore never found its proposed market. According to a senior VP at the Furash & Co. management consulting firm, the system ignored the criticality of face-to-face contact between the customer and loan processor. At least other mortgage networks have been either discontinued or reduced to providing only rudimentary information, according to a September 1986 survey by the Washington Post [Rifk88].

#### A.4.d) Debit cards

The Electronic Funds Transfer Association has completed a study, based on surveys of U.S. retailers in the gasoline, grocery, airline and fast-food industries, on the use of the new debit card product development systems for point of sale (POS) transactions [Ste188e]. The study reveals that debit cards are not being readily accepted by American consumers. Consumers fear that debit cards will create "irreversible errors" in personal financial information through electronic transactions, and that unauthorized access to bank-account data will occur. Additionally, the loss of "float" from using debit rather than credit cards is unattractive. Retailers expect POS debit-card use to increase the average amount spent on purchases, however, they are hesitant to install terminals without widespread acceptance of POS. Perhaps the best summary of the debit card market is from Stephen Cole, who, in an interview with MIS Week, noted that "There is not one institution in the country making a profit out of debit cards." [Iida89]

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<sup>6</sup>Most recently, Chemical Bank and AT&T have abandoned their home banking product, at an estimated cost of \$70M in writeoffs [Clem90].

## B. SISs are complex to develop

Achieving a fundable, technically feasible, and marketable SIS concept moves an organization only partly towards success. The examination of the literature on successful SISs suggest that systems often involve one or more of the following attributes: 1) telecommunications, 2) reliance on multiple-vendors, 3) inter-organizational cooperation, and 4) “bleeding edge” technology. These areas, either separately or combined, can provide sufficient difficulty during the development and implementation process to make an SIS idea unsuccessful.

### *B.1 Telecommunications can dramatically increase system complexity in today's environment*

The inclusion of telecommunications into an SIS dramatically increases that system's complexity in today's environment. Problems currently stemming from this complexity can be categorized into two areas: equipment problems and staffing problems.

The proliferation of different varieties of equipment, and their proprietary protocols make it difficult to create and monitor a network effectively. Equipment can come from local telephone companies, satellite suppliers, microwave vendors, local-area networking companies and value-added network operators. Moreover, the equipment may handle analog and digital links as well as intermixed voice, data, and video signals. Compounding this complexity is the diversity and large number of service and equipment providers [Davi87].

One extreme example of equipment problems were those faced by Federal Express Corp, which was forced to stop its Zapmail electronic document transmission service after being plagued with telecommunications equipment difficulties [ben- 86a]. The telephone lines performed extremely poorly; they were slow and noisy, creating the need to re-transmit many of the packets. These problems caused Federal Express to incur very large additional costs. The company then installed satellite transmission facilities at customer sites and installed rewritten software and more mainframe switching stations around the country. The company also had to request a communications satellite. The FCC approved a satellite launch, but the Challenger space shuttle disaster caused the cost of satellites to skyrocket and their launching to be delayed. All of these problems contributed to Zapmail's failure, causing an approximately \$350 million loss for Federal Express [Brod88a].

The complexities of working with telecommunications equipment are made even more challenging by the current tremendous shortage of people who can provide a mix of strong technical and

business skills [Keen86]. As firms continue to recognize the importance of telecommunications to their business strategies, they are willing to pay whatever is needed to get these people.

However, even large firms that might be willing and able to pay the large salaries required have difficulty in attracting key people. For example, Westinghouse Electric Corp. and Northern Business Information (NBI) in New York have both reported difficulties in hiring trained staff [Stam87]. In an effort to make use of the Internal Revenue Service's electronic income tax-return filing program, Tax Masters Inc. had hoped to offer a new product, a telecommunications channel between independent tax preparers and the IRS. According to the president of Tax Masters, the company may go out of business because his staff could not handle all of the technical issues involved with communications between Tax Master's and its customers' computers. [Stein88f]

Of course, it can be argued that many of the problems cited here relative to telecommunications are temporary; that after the industry adjusts to deregulation and the labor market adjusts to the shortage, these problems will diminish. These contentions are no doubt true in the long term. However, they are scarce comfort to a firm trying to implement an SIS today. Also, the problems of telecommunications are symptomatic of any leading edge technology, and firms should expect similar difficulties in the future in other rapidly changing areas of technology.

### *B.2 The hazards of vendor-driven systems*

Developers of nearly any type of information system are typically reliant upon vendors of one sort or another for parts of the system. But, these vendor-related problems are magnified by the scale of most SISs efforts, and are compounded by the typical presence of multiple vendors on large projects.

An example of a technology supplying vendor preventing a successful SIS is provided by an executive at a consumer goods manufacturing company. A software vendor indicated that their products could handle the performance needs of a very large and complex market penetration system that was being developed. However, the software did not perform to expectations. The executive stated, "When the vendor's product expert was called in to examine the situation he remarked that he had never seen such an ambitious attempt to use the software and, that if we figured out a solution, to please let him know." According to a recent article in Datamation, American Airlines and United Airlines, both sophisticated users of IBM equipment, have been forced to create solutions on their own because IBM is reportedly too slow to come up with key parts of announced architecture [Moad88]. A consumer goods company is having difficulty

finishing a system because certain sections of needed software have not been completed by a vendor. Additionally, questions concerning communications capability between two different mini-computer models keep arising. The company has to verify the communications capabilities that the vendor promises whenever a question occurs. The verification process keeps slowing up the project. All of these examples show that there are large risks in relying upon the timely availability of vendor products and services.

The need to use equipment from multiple vendors can make the development of SISs extremely difficult, as products from different vendors are often incompatible and the presence of multiple vendors makes diagnosis of systems problems very complex. For example, Merrill Lynch & Co.'s market penetration system requires the maintenance and monitoring of telecommunications links between 600-plus brokerage locations around the world, without which they cannot do business. However, it is very difficult to identify which links are down when problems occur, and to determine the corresponding traffic load. Merrill Lynch buys network equipment from 30 vendors and each piece has its own method of tracking equipment performance. When equipment fails, Merrill Lynch must first identify and locate a failure (often a difficult process) before contacting the vendor [Guyo88].

The problems with using products from different vendors is preventing Big Eight accounting firms from successfully implementing strategic market penetration systems to prevent the loss of audit customers who are in search of lower accounting fees. During 1987 approximately 1000 companies switched accounting firms to lower auditing costs. To prevent the loss of a customer to a competitor, Big Eight firms try to reduce audit costs by integrating their hardware and software with the clients' systems. However, clients operate in different industries, and use different applications with different software and hardware. The multitude of equipment and software is preventing the Big Eight firms from standardizing on a system that will allow them to keep costs lower than those of competing firms [Berm88b].

### *B.3 Inter-organizational systems require inter-organizational cooperation*

One of the clear themes in the SIS literature is the large role played by inter-organizational systems (IOSs) [Barr82, Cash85]. However, SISs ideas that require multiple-company efforts often fail because of the difficulties involved when usually autonomous organizations attempt to work together. For example, lack of inter-organizational cooperation is one factor preventing point of sale (POS) debit systems from being successfully implemented by retailers [Perr88]. Retailers see POS as a way to become more competitive in three mature industries: the supermarket, gasoline-

station, and fast-food chain. However, there is a dispute between the retailers, banks, and switching companies over who will be responsible for system operating expenses.

There is a more serious conflict between debit-type POS charges and credit-card charges. POS is presently available only in business that either have never accepted credit cards or have begun to discourage their use. POS will eventually compete with credit cards and cash, and banks that issue credit cards are worried that they will lose credit-card income (the percentage of total transactions charged retailers). Banks want to charge for POS transactions, but retailers do not want to pay large fees for a cash substitute. Unless the organizations involved can work out the issues, POS will not be successfully implemented by retailers.

A specific SIS example cited by Ives and Learmonth is a retail gasoline POS system [Ives84]. But more recently it has been reported that oil companies have begun facing inter-organizational challenges in their dealings with banks to set up successful POS systems at gasoline-stations [Hind87]. The banking industry has not agreed on standards for connecting ATMs. According to the president of the New York Cash Exchange (NYCE), the ATM connections were based on a model of the banking industry that may not be applicable to the oil industry and debit cards. Oil companies are challenged with writing special software interfaces to connect to different ATM networks. The NYCE president also reports that there are differences between the industries on whether banks or oil companies should pay each other for a transaction, as well as each party's perception of who gains the most value from inter-connection. A Mobil Corp. official stated that their program has done well in regions where banks promote the ability for customers to use ATM cards for gas purchases. However, Mobil has been disappointed by acceptance levels in other regions [Hind87].

PCS Inc., an insurance claims processor, is attempting to establish communications links between itself and pharmacies throughout the country in order to extend its market penetration [Stein88a]. However, without pharmacy cooperation the system will never be a strategic success. The biggest challenge is convincing the pharmacists, who are neither PCS customers nor suppliers, that they will benefit from the system. Pharmacists that already have a system would double their data-entry by installing the PCS system. The large chains would need to adapt their central in-house system to permit communications with PCS. PCS has been processing claims for 19 years but feels that their growth and survival is dependent on the on-line pharmacy link plan, and that the link plan is dependent on pharmacy cooperation.



#### *B.4. The “leading edge” may be the “bleeding edge”*

The use of SISs often requires working with the latest, most advanced hardware and software technology. In fact, it can be argued that it is new technology that often provides the source for SIS ideas. However, attempting to work with the “bleeding edge” of technology has proven difficult for several companies and the Shearson American Express KnowledgeBase system cited earlier is a good example of a failure related to the use of a new technology, in this case, expert systems [Kosl88].

Another product development example may be BankAmerica Corp. (BA) ending its efforts to implement an ambitious strategic trust accounting system product, MasterNet [Ludl88]. MasterNet had a unique goal to combine two separate systems through a common delivery vehicle. It required previously non-existent hardware and software capabilities involving a multitude of vendors, most especially a custom database management system [Ande88a]. Telecommunications issues also played a role, as asynchronous and synchronous protocols had never been used simultaneously by the bank [Ande88b]. This SIS setback caused the loss of 100 institutional clients and \$4 billion in assets [Fran88]. According to a former employee, MasterNet failed to maintain current data and fell months behind in generating statements. The difficulties were caused by slow run and response times, communications problems and troublesome disk-drives. Moreover, the difficulties may have caused BankAmerica to violate banking laws, as it did not inform customers that it was unable to keep current records of securities transactions as the result of a system conversion. The bank is believed to be being investigated by the U.S. Comptroller of the Currency [Steil88c], and has set aside \$60 million to cover monetary losses arising from MasterNet [Port88].

#### **C. Maintaining and adapting SISs requires constant management**

Even after an SIS idea has been created, and the system has been successfully developed and implemented, the success of the system can be costly for the organization [Vita86]. Strategic systems can: 1) be copied by competitors, 2) create oversubscription, 3) be expensive to maintain and/or enhance, and 4) create high exit barriers. Of course, there are currently only a few systems that have reached this phase, and therefore there are relatively few current examples of these types of problems. However, the examples that follow are likely to be representative of problems that are predicted to befall other SISs attempts in the future.

### *C.1. Competitive copying*

Strategic systems are unlikely to maintain a company's competitive advantage if they are copied. Competitors eliminate the advantage by developing their own system in-house or by purchasing a similar system. Automated Teller Machines (ATMs) provided a few banks with a competitive advantage through market development for a short time [Clem86b]. The advantage ended when small banks responded by joining their networks to form consortia. For example, BayBanks Systems Inc., of Boston, launched their XPress 24 system in approximately 1978 [Hell87b]. In last 1987 BayBanks' ATM network included about 850 machines, 650 of which are owned by BayBanks and the balance by more than 70 smaller banks. BayBanks marketed its retail banking services aggressively by featuring their vast ATM network. The response from the other Boston-area banks, none of which had network capacity to match the size of BayBanks', was to join forces with several Connecticut banks in a collectively-owned rival network called Yankee 24. Clemons and Kimbrough report that most industry observers acknowledge that the universal adoption of ATMs has benefited the substantial portion of retail customers who use them. However, since ATMs are offered by almost all banks, the machines provide neither margin nor market share advantage and have become, in Clemons and Kimbrough's terminology, mere "strategic necessities", and do not offer strategic advantage [Clem87].

United Parcel Service (UPS), aggressively pursuing Federal Express' overnight delivery market, is using technology to provide the same level of services that Federal Express offers [Reib88]. These service features include on-call pick-up and continuous tracking of packages. Additionally, UPS is trying to compete with Federal by installing computers in its trucks [Fous87]. At a cost of \$15 million, UPS purchased a company that makes vehicle tracking systems [Colo87]. The tracking systems will allow dispatchers to locate vehicles on electronic maps, thereby allowing UPS to determine the exact location of its 60,00 trucks, and provide customers with better pick-up service.

### *C.2. Oversubscription*

Sometimes, an SIS can be seemingly "too successful" in that inability of an SIS to meet unanticipated demand can cause unexpected expenditures, wipe out potential benefits and possibly cause the system or even the firm to fail. H&R Block Inc.'s electronic tax filing system, Rapid Refund, created a tremendous demand that completely overwhelmed the company's data-processing facilities, creating embarrassing delays [Stein88d]. This new product development promised tax refund checks just one day after a customer filed tax forms. H&R temporarily

stopped advertising the service and had to increase computing capabilities by 50%, thereby incurring large expenses. Additionally, H&R has not been able to provide the initially promised 1 day turn-around.

TaxMasters Inc's strategic attempt to become a telecommunications channel between small tax preparers and the IRS's electronic income-tax return filing program became an "unexpected headache" for the company's staff [Ste188f]. A huge increase in the number of customers wanting to submit tax-returns electronically and their request for technical assistance was too great a load for the staff. According to the president of Tax Masters, the company will either go out of business or will get out of performing data communications for small tax preparers.

### *C.3. Expensive to maintain/enhance*

The expense of maintaining and enhancing installed systems can be very costly. As competitors begin to copy successful systems, originators are pressured to maintain their advantage. Therefore, they are burdened with the expense of continuously improving their systems and offering more features.

It is estimated that United Airlines Inc. will have spent \$1 billion between 1986 and 1991 to replace the Apollo Business System, an office automation package for travel agents [ben-86b]. The new system, the Enterprise Agency Management System, is needed because the old system grew haphazardly and is therefore difficult to maintain.

Citicorp has implemented a separate division, the Information Bank, to continuously develop and market new technology based products [Cult87]. The Information Bank is viewed as a long term venture, and in 1986 it lost \$34 million, according to Forbes.

### *C.4. High exit barriers*

The very large expenses associated with strategic systems (see section IV.A.2) can create high exit barriers. Firms may invest such a great amount of money that exiting from the industry may be devastating. For example, Federal Express' Zapmail failure has forced the company to market international X.25 networking services at "exceptionally low rates" [Ste188b]. The service will be provided through the Federal Express International Transmission Corporation subsidiary using the data lines that were intended to support international Zapmail transmission.

## D. Results Summary

From the many examples presented in this section it is clear that developing successful SISs requires careful planning to avoid the problems faced by other firms. By returning to the Ansoff matrix, it is also clear that these problems can strike systems designed in any of the four quadrants (see Figure 3). While the diversification strategy systems may be the most visible due to the high degree of the publicity surrounding their inception, even systems in the less widely publicized market penetration category can pose stumbling blocks.

Product	Present	New
Mission	<p>Audit systems Pharmacy insurance</p>	<p>Pay-by-phone Interest rate swapper POS debit cards Electronic tax returns MasterNet</p>
<p>Present</p>	<p>Shelternet ATMs</p>	<p>Early videotex Zapmail MCIMail</p>
<p>New</p>		

Figure 3. Growth vector matrix of example systems

## IV. SIS RISK EVALUATION

### A. Introduction

This research has shown that the conception, development, and implementation of strategic information systems is much more difficult than previous literature might have indicated. Over a dozen potential pitfalls that make the SIS creation process extremely complex have been identified and supported with industry examples.

Of course, it is important not to confuse the examples with the underlying problems. Current difficulties in telecommunications will no doubt be mitigated in the near future. And videotex, a failure in its first incarnation, may yet be successful [Hann87]. However, the underlying theme,

that working with new technology is expensive and risky, still remains. The 1990s will no doubt provide different but analogous examples of leading edge failures.

The preceding sections of this paper have described over a dozen pitfalls that can imperil the success of an SIS. While being a fairly comprehensive list, at least so far as it is based on the actual systems experiences reported in the business press and through confidential interviews, it is a rather lengthy list, unsuitable for advice to practicing managers. Ordinarily, such lists are ordered in some way, perhaps by relative importance of the problems. In this case, however, that is not strictly appropriate. As each of the problems has the potential of causing the failure of an SIS, they are all important.

However, there is a way for managers to concentrate their energies on those problems that they are most likely to face. Figure 4 contains an SIS Failure Risk Matrix, which highlights the pitfalls that are likely to hinder firms that possess particular characteristics *relative to their competitors*. In this matrix, firms are characterized along three relative dimensions. A manager should assess his or her firm's relative position along each of the following dimensions:

- *Monetary Resources*. Does the firm have access to the capital that will be required to embark upon and successfully complete an SIS project? If the firm is relatively poor vis-a-vis possible competitors, then the chances of it falling victim to some problems are relatively higher.
- *Technological sophistication*. Relative to the competition is the manager's firm a technology innovator, or a relatively late adopter? Firms that do not possess high quality technical talent and experience will run a greater risk of certain pitfalls.

FIRM RELATIVE TO COMPETITORS			
PITFALLS	AVAILABLE FUNDING FOR SISs RELATIVELY LIMITED	TECHNOLOGICAL SOPHISTICATION RELATIVE TO OTHERS LOW	ORGANIZATIONAL FLEXIBILITY FOR ADAPTATION RELATIVELY LOW
Conception	L	M	H
Technical Infeasibility	L	H	L
Funding	H	L	L
Market Creation	M	L	M
Telecommunications	M	H	L
Vendors	M	M	L
IOS	L	L	H
Leading Edge	M	H	L
Comp. Copying	M	M	L
Oversubscription	M	L	H
Maintenance	H	L	L
Exit Barriers	H	L	M

**Table 4: SIS Failure Risk Matrix**  
(Key: L = Low risk, M = Medium risk, H = High risk)

• *Organizational Flexibility.* Is the firm one that can adapt quickly and easily to change, or is it hidebound to traditions that make it relatively inflexible. Even with all the required money and technology, firms that cannot adapt to changing markets and customer requirements will be hard pressed to deliver a successful SIS.

In the sections that follow, the Bank of America MasterNet project is used as a mini-case study to illustrate the use of the SIS failure risk matrix.

## B. Monetary Resources

While no organization is likely to claim that it has excess slack in terms of monetary resources, clearly some firms are working under tighter constraints than others. For example, firms in certain commodity-type industries may be subject to very low margins on goods or services sold.

How does a firm recognize whether it scores high or low on this scale, relative to other firms? While it is beyond the scope of this paper to develop an exact metric, the following questions may give some insight into the problem. How do the budgeted expenses for the proposed SIS compare to the firm's other IT expenditures? How do they compare to the firm's annual revenues? Very large projects obviously pose more risk. What would be the financial impact of a complete project

failure, including both the sunk project costs and any market exit-related expenses? What would the impact of such losses be to the firm's reserves? SIS projects with potential balance sheet level impacts should be scrutinized extra carefully. In general, in recent history how well has the firm been able to weather severe financial shocks, such as large disruptions to its cash flow? Such history may be a good guide to the likely impact of an SIS failure.

While much of the focus of the MasterNet failure has been on the technical problems, financial conditions may have hastened the system's decline. B of A reported severe losses in 1986 and made numerous staff cutbacks that inhibited progress on the trust accounting system both directly (through staffing cuts) and indirectly (through loss of morale and longer working hours) [Fran88; Ande88a and 88b].

Firms that score relatively poorly on the monetary resource dimension are at relatively greater risk of a) not being able to fund the SIS venture, b) not being able to afford to properly maintain and enhance the SIS, or c) falling victim to high exit barriers. These risks are highlighted in the first column of Table 3 by denoting them as "High". Pitfalls where the risk is high but not quite as high are marked as "Medium". For example, the risk of not having a market is relatively higher for fund-poor organizations since they may not have the resources required for advertising, promotion, and other market building activities. They may also not have the resources required to weather a long profitless startup phase.

These firms are also at risk in ventures involving telecommunications, since the cost of qualified specialists is currently so high. Vendor problems are similarly likely, in that the fund-poor firm may not be able to afford the top quality vendor or vendors who are capable of developing the system. Leading edge technology is a greater risk since the firm may not be able to pay for the in-house expertise necessary to locate and utilize the leading edge. Finally, oversubscription is a greater challenge since it is less likely that necessary resources will be readily available.

In summary, there is, of course, some sense that any organization would prefer to have more money, and most would be able to put it to good use. However, the particular pitfalls highlighted above are those to which monetary resource-poor organizations are most vulnerable.

### **C. Technological Sophistication**

Technological sophistication, like money, is clearly a resource of which most organizations could use more. However, certain of the pitfalls are more likely to trap firms that are relatively

unsophisticated adopters of technology. There are a number of possible clues as to where a firm may rate on a relative technological sophistication scale. Does the firm have a history of being an “early adopter” of technology? Has the firm had any previous successes it can point to where technology has been used, even internally, to solve a business problem? If the answer to those questions is no, this may indicate that the technology aspects of SISs will pose relatively greater risks than they would to other firms. If formal mechanisms, such as an “advanced technology group” within information systems, or a CIO position are not present, these too may be warning signs that the firm rates relatively low on the technological sophistication scale. Finally, is there a steady source of new ideas in the form of new hires either from firms that are recognized as technological leaders or even recent graduates from the nation’s leading technology intensive programs? These new staff members can be an important source of information about the latest technology alternatives. In addition, it is likely to be worthwhile to attempt to occasionally broaden the scope of hiring to include other organizations that are not necessarily from the firm’s own industry, as it has been traditionally defined. These new hires may bring in not only needed specific technical knowledge, but also may act as catalysts for thinking about the firm’s products and services in new ways.

For example, in the case of MasterNet, the Los Angeles Times asserts that B of A, once a technology leader in the 1950s, had, by the 1970s, not kept up the required technological advances, and had “fallen far behind in the computer race” [Fran88]. Therefore, they may have made an overly ambitious choice in trying to correct this deficiency via the reputedly 3.5 million lines of codes MasterNet project. Another example to watch will be UPS’s attempts to match Federal Express in the overnight delivery market. As noted by Wiseman, Federal’s success has relied heavily on sophisticated computer and telecommunications systems [Wise85, p. 114]. The telecommunications systems include links to customer support centers, the central computer, and the courier vans. The computer systems include systems that perform routing by taking into account weather and traffic, and high speed package scanning and conveyor belts. It is easy to imagine UPS having difficulty in matching Federal’s capabilities.

Firms that rate poorly on this resource dimension would have three relatively high risk areas: a) technological feasibility of an SIS idea, b) telecommunications intensive SISs, and c) leading edge technology applications. Other areas of lesser but still considerable risk are somewhat less obvious. Technology unsophisticates may have greater difficulties in conceiving SIS ideas, since many SIS ideas are driven by new advances in technology. The necessarily greater reliance on outside vendors will be compounded by the lack of in-house expertise with which to monitor them. In addition, a lack of thorough understanding of the interfaces among multiple technologies



will make it relatively more difficult to sort out inevitable multi-contractor disputes. For example, the failure of an interface between a telecommunications vendor and a hardware vendor may be blamed by each on the other, and the client firm will be required to sort out these conflicting claims. Finally, the technologically unsophisticated firm is more likely to develop an SIS whose technological approach is more easily copied.

#### **D. Organizational Adaptability**

One notion that seems to appear in many of the SIS case studies is that systems rarely develop exactly as planned. Changing requirements, technologies and markets all conspire to upset carefully laid out developments. Therefore, organizational adaptability or flexibility is likely to be a valuable resource.

One example of how organizational adaptability allowed a firm to achieve success was Merrill Lynch's CMA [Wise85, p. 111]. CMA originally floundered, with sales moving very slowly. Merrill found that brokers were not sufficiently promoting the accounts. Then, Merrill began offering free trips to brokers as rewards for attracting the most CMA customers. This organizational move allowed them to increase the number of CMA customers from 180,000 to over 1,000,000 in 1983. Additionally, Merrill's ability to successfully manage an inter-organizational relationship with BancOne, the processor of CMA's checking and debit cards, has also allowed them to be successful.

The lack of organizational flexibility greatly raises the risk of key line and staff members not getting together to conceive SIS ideas. Problems between B of A's San Francisco computer systems staff and its Los Angeles based securities clearing staff have been cited as contributing to the MasterNet failure [Fran88, Ande88a]. Inability to work well with outside organizations make IOS-type SISs relatively more risky, and the slowness at adapting to unanticipated over-subscription is also a relatively greater risk.

Gauging where a firm ranks on a scale of organizational flexibility may be the most difficult of the three scale judgements to make. Positive signs of organizational flexibility would be indicators of a fairly heterogeneous culture, whereby staff members with a mix of backgrounds often work together. This may be accomplished through hiring staff from a wide variety of educational and experience backgrounds, or through rotation of current staff through a variety of assignments. Matrix organizations and so called "Theory Y" organizations would also be positive indicators. A final clue may be provided by how well the organization has handled any period of rapid growth or

change in its history. That experience may be a precursor to the impact of an SIS on parts of the organization.

Lesser, but still significant risks for organizations with limited flexibility include the difficulties in creating customer demand in areas that have not traditionally been the firm's markets. These new markets may require tactics and practices that the firm will have to quickly learn, and rigid organizations may not be able to react in time. Finally, as has been pointed out, eventually many firms will have to exit SIS ventures. Inflexible players in those markets will find this task relatively more difficult, and therefore are more likely to fall victim to high exit costs.

## **E. Conclusion**

Clearly, information technology can be successfully used to support the execution of a firm's strategy, and the current business literature is replete with descriptions of these systems. The goal of this paper has not been to argue against those successes, but to temper the current enthusiasm with an acknowledgement that significant systems development challenges exist with these types of systems. While all information systems may face challenges, this paper has argued that the nature of SISs, as promoted by the successful case studies, make them especially difficult to define, develop, and maintain. This thesis has been supported by numerous industry examples that graphically illustrate that SISs are often difficult and complex. Management must be aware of the pitfalls that can prevent a system from achieving success, and must work toward avoiding as many as possible. While avoiding all risk is unlikely to be an optimal plan, it is important for managers to be aware of as many potential risk factors as possible so as to make informed decisions. By reviewing the unpleasant experiences of other organizations presented in this paper managers should now be prepared to perform an "audit" on their own SIS plans. Managers need to secure the financial, technical and organizational resources that will be required for SIS success prior to embarking on an SIS project. This list of pitfalls and the accompanying risk failure matrix should serve as guides to reduce the likelihood of an SIS failure.

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