Evaluation of STRATEGIC

INVESTMENTS in Information Technology

Developing a strategic application—intended to make a company more flexible, more responsive to customer needs, or more able to adapt to rapidly changing conditions in the competitive environment—is fundamentally different from investments undertaken to automate the back office to reduce expenses or increase capacity. Alternative techniques for evaluating the business case for strategic systems have been developed and have worked well in practice. Several cases are presented here.

Eric K. Clemons

For investment decisions, evidence has shown that businesses have difficulty in evaluating when to use information technology. This problem really is fundamental to the continuing application of information technology in business and government. We have made far more progress in determining how a system should be built; software professionals have readily adopted progress in algorithm and data structure design, significantly improving application performance. We have made far more progress in determining how to make systems reliable; again, the data-processing community has adopted (sometimes slowly) progress in available tools and languages, and in management of software development, statistical quality control, and testing, to produce systems of greater quality. We have made even more progress in the soft areas such as interface design. Of course, the most important question is determining what to build. In this area there has been very little formal progress, and even less has been published by the research community.

The increasing competitive impact that information systems are having, make information technology a new concern of senior management. Strategic application of information technology, for order entry, for travel agent reservation systems, for securities trader support, or just for organizational infrastructure are by now part of the executive's folklore. Calls go out from the executive suite for information systems that will deliver sustainable competitive advantage. How can opportunities for these systems be evaluated? How should a senior executive make the decision to invest in a strategic program based on information technology?

Many decisions that clearly appear to have been correct from today's perspective, were neither easy nor obvious at the time that they were reached. American Airlines's travel agent reservation system, Sabre, is today one of the most widely cited examples of a competitive use of information technology. In September 1988, when American's parent, AMR, announced that it would consider bids for Sabre, Wall Street placed a value of $1.5 billion on Sabre—at a time when the market capitalization of AMR itself was only $2.9 billion. In a dozen years, the reservation system had come to account for over half of AMR's operating income, and its market value had become greater than that of the airline's core business.[1] And yet when American was first considering the development of Sabre, the decision was neither easy nor obvious. American's major competitor, United Airlines, had developed its own system, Apollo, first, but stopped selling it to agencies after a small initial rollout; American responded vigorously, and United's market share has lagged behind American's ever since. Perhaps more striking is the number of carriers that chose not to participate with American when initially offered the opportunity.

Clearly, if given another chance, these carriers would not be willing to allow control of reservation systems to remain in the hands of a competitor. This is reflected by the structure chosen for travel agent reservation systems in the rest of the world. Perhaps because of the experience in the United States, airlines in Europe and the Far East, have formed consortia—Galileo, Amadeus, Abacus—to own and operate these systems.

These decisions are not getting any safer or easier: In the United States, Chemical Bank's aggressive launch of *Pronto*, its electronic home-banking offering, ultimately resulted in almost no return to show for its multi-million dollar investment.[2] And investments directed toward strategic positioning can now involve astronomical sums. National Westminster Bank, a major United Kingdom clearing bank, is replacing its entire information technology infrastructure at an estimated cost of several hundred million dollars [3]! Work has already begun on rewriting hundreds of the bank's 12,500 computer programs.

These decisions are difficult because available techniques have not kept pace with the needs of current practice. Evaluation of a system's development based on potential competitive impact is fundamentally different from evaluation based on cost. This is far more complex than selecting hardware based on throughput and the cost of MIPS, or than justifying a purchase because the curve for transaction processing requirements is approaching current capacity. It is also more complex than trading off the cost of the system against the reduction in operating cost attributable to automation. This problem with system evaluation is just one specific example of a more pervasive problem noted by Robert Kaplan [13,18,19]: Discounted cash flow, and other analytic techniques taught to generations of M.B.A. students, are consistently misused when applied to strategic investment decisions. Much of Kaplan's criticism is directed toward the desire for precision, at the expense of accuracy; when decision makers cannot precisely estimate benefits accurately—all too common when evaluating the competitive impact of innovative applications—hard-headed financial analysts

[1]Sabre and Apollo have become essential to all airlines. Since these reservation systems are used by virtually all major travel agencies, and since these agencies account for about 80 per cent of the airlines' traffic, it is essential for all carriers to be listed in all major systems. As this became appreciated by American and Apollo, they were able to charge very considerable fees for the services they provide to other carriers. This is described in some detail in [10].

[2]In fact, ultimately the bank was forced to take a write-down of tens of millions of dollars on its home-banking service. According to Industry estimates Chemical spent $20 million developing *Pronto*, and Chemical and AT&T subsequently spent another $50 million developing Covidea, a videotex service [17].

often force the use of zero as the value of these benefits. These same analysts frequently use unjustifiably high estimates for the cost of capital as a surrogate for dealing with uncertainty in a meaningful way.

There are other, more fundamental difficulties with strategic innovations, not tied to problems with accounting. Often the strategic programs being undertaken have extremely long lead times. In particular, during the time between making the investment decision and the strategic program coming on-line, the environment itself may have changed, confounding analysis and adding considerable uncertainty. This problem is particularly acute in rapidly changing, newly deregulated industries. And often the technologies involved are so new that not even the experts are certain about what their implications will be. The affected managers are often without the experience, information, or methodology needed to evaluate their programs.

The problems of evaluating investments in factory automation are illustrative. This should not be viewed as new technology for making *today's* automobiles, but rather as new technology for making *tomorrow's* automobiles. This requires assumptions about how manufacturing engineering will advance to exploit new manufacturing technology, and how marketing will be able to exploit the ability to make more limited runs—perhaps production runs of size one—to fill specific demands from individual customers. What are the cost implications of these improved manufacturing engineering methods? Will the marketplace reward greater flexibility with increased margins or market share? How can these effects be predicted with any accuracy, or even measured after implementation?

Most importantly, the programs themselves, if successful, may so dramatically alter the business environment that their very success engenders much uncertainty. Current financial projections are consequently nearly meaningless. The Chicago Mercantile Exchange has recently announced GLOBEX, an electronic, screen-based system for after-hours trading. How will GLOBEX affect the profitability of floor traders on the Merc? Big Bang, the deregulation of the London Stock Exchange, replaced a comfortable, club-like trading floor with an efficient electronic market, allowing London to capture market share from Continental exchanges, and even to recapture some trading volume lost to American markets [10]. Unfortunately, in this efficient market it has been extremely difficult—some would say impossible—for the Exchange's member firms to deal profitably, and the annual running rate of their losses is estimated to exceed £1 billion. Should it have been possible to estimate in advance the effects of this efficiency on its members' profitability?

When the costs and the risks are high enough, it is tempting for managers to delay action until the last estimate is quantified and the last analysis is complete. Unfortunately, in many cases this is impossible. The numbers will never be known with sufficient precision or certainty, and the calculations will not be sufficiently unambiguous to enable the executive to decide to take action without risk to the firm or to his or her career. As David Freedman notes in a recent article, "assigning a hard value to a strategic information system is a slippery task that is unlikely to lead to more effective decision making." In fact, he goes on to add, "insisting on a dollars-and-cents analysis of every project can seriously damage an organization's competitiveness." [16]. In the same article, Don Lucas, vice president of information systems of Otis Elevator, adds, "We've learned that it is very difficult to quantify the value of some strategic systems."

Of course, these investment decisions do get made. Fortunately, there are some guidelines and principles that executives can use to structure their analysis of strategic information systems investments. Based on our own study of a range of such analyses with major corporations in the United States and abroad, including some in which we directly participated, we offer the following suggestions:

LESSON ONE

Rank Alternatives

Even when it is not possible to compute explicit, precise values associated with embarking on strategic programs, it may be possible to estimate, with enough accuracy, to rank alternatives. Just as importantly, it may be possible to structure the analysis carefully so that the preferred alternative becomes clear, even without numerical estimates.

Bloomberg Financial[3]

The problem: *Merrill Lynch owns a minority share in Bloomberg Financial Markets, probably the premier analytics package available to the Street for support of fixed-income investments (bonds). Bloomberg gets real-time price feeds for corporate bond offerings through Merrill Lynch and for government bonds through primary dealers; additional feeds from derivatives markets provide prices for bond futures and for interest rate futures.*[4] *Analytic packages then allow a trader to perform a wide variety of functions:*

- *Finding the most attractively priced instruments*
- *Finding the most appropriate instruments to cover a short position*[5]
- *Designing a hedge, through short sales, bond futures, or interest rate futures contracts, and displaying the results of the hedge graphically, both for individual investments and an entire portfolio.*

[3]Material for this section comes from *The Wall Street Journal* [24,25] and private conversations with Merrill Lynch and Bloomberg Financial Markets personnel (New York, September and October, 1980).

Merrill's bond traders and salesmen use the system, and Merrill's most senior executives were deciding whether or not to allow Bloomberg to sell to their largest competitors. Should Bloomberg be unchained and allowed to sell?

An argument can be made both for and against selling the system to competitors.

Con: Merrill may make more money selling bonds or trading for its own account using the system when competitors do not have it.

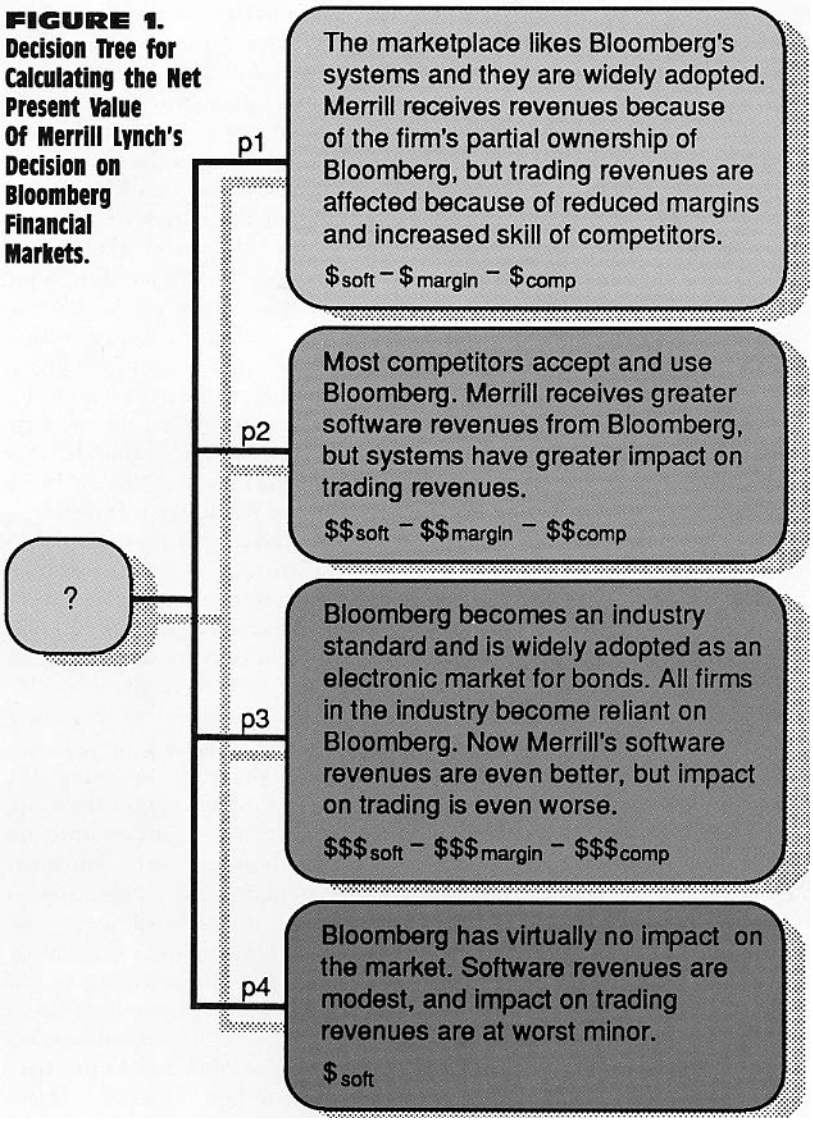
Additionally, the fixed-income market for corporate debt, unlike the market for corporate equities, lacks a central marketplace such as the New York Stock Exchange. As additional firms begin to feed their prices to Bloomberg, using Bloomberg as an electronic marketplace, and as pricing information thereby improves, the market will become more efficient. Spreads will narrow, and margins for bond traders will deteriorate.[6]

Pro: If we do not do it, someone else will. The effect on the market will be the same, but we will forgo our chance to make a significant profit on our investment in Bloomberg. And it is difficult to demonstrate that our traders or salesmen are doing any better than competitors because of the system.

Con: It is always difficult to demonstrate soft benefits from a support system.

And it really does not matter how profitable the business potentially can be! Merrill is a securities house, not a software house. One of Merrill's country heads said to me, in essence, "If the time ever comes when we have to replace our trading income with software revenues, I for one say 'It's time to fold this old trading house and die!'"

FIGURE 1. Decision Tree for Calculating the Net Present Value Of Merrill Lynch's Decision on Bloomberg Financial Markets.



Analysis: *The analysis needed to compute the net present value [NPV] of the decision to allow Bloomberg to market more aggressively can be structured as shown in the decision tree in Figure 1. Only those outcomes related to the decision to market are shown in the tree. If the systems are offered, and the marketplace likes them, Merrill Lynch will make money on its investment in Bloomberg. If the marketplace response is very strong, Merrill stands to make a great deal of money letting Bloomberg sell. And if the marketplace moves toward use of Bloomberg as a standard electronic market for corporate debt, resulting in nearly universal adoption, Merrill may find that its investment in Bloomberg Financial Markets was very*

[4]Futures contracts represent an obligation between two parties to trade a commodity, security, or other item at a later time (the expiration date) and at a prearranged price. Futures contracts originally evolved as a means of managing risk for producers and consumers of commodities. Farmers could lock in an assured price for their harvest by selling futures, and bakers could protect themselves against unanticipated price changes by buying these futures contracts. Of course, speculators also find commodities futures attractive. Financial futures have similar uses: A manufacturer that knows of a future need for foreign currency to pay suppliers can hedge with a currency future. And a bank with bonds or fixed interest rate loans may protect itself against interest rate changes with futures contracts.

[5]A short position results when an investor sells securities he or she does not yet own. It ultimately will be necessary for the investor to cover this position by buying back these securities at a later time. Investors will normally sell a security short in anticipation of a drop in its price.

[6]Spreads represent the difference between the price at which dealers are willing to buy and sell securities; they provide much of the profits earned by bond dealers. And there is a large body of evidence that indicates that as markets become more transparent and prices become more widely known to traders, spreads are reduced.

profitable indeed! Of course, in this final scenario, as the market becomes more transparent and more efficient, Merrill's bond-trading operations may earn less, but even this is uncertain; Wall Street's experience with deregulation of commissions on the New York Stock Exchange in 1975 indicates that reduction in trading costs can increase trading volumes to such an extent that profits are actually increased.

It would appear that this is an extremely difficult financial analysis. It is necessary to determine probabilities of each of four outcomes: ranging from extremely limited marketplace response to widespread adoption as an industry standard for an electronic market for corporate bonds. It is then necessary to estimate the associated beneficial and negative impacts for each outcome on revenue. One positive component, $\$_{soft}$, represents the contribution from Merrill's partial ownership of Bloomberg. A second component, $\$_{margin}$, represents the change in trading profits associated with more efficient and more competitive markets; this is expected to be negative, but if trading volumes are increased substantially this may actually be positive. A third component, $\$_{comp}$, represents the loss in trading income due to the increase in competitors' skills and the loss of Merrill's traders' advantage when Bloomberg is more widely available.

Thus, determining the NPV requires at least fourteen estimates: four probabilities, four estimates of $\$_{soft}$, and three estimates of $\$_{margin}$ and $\$_{comp}$. It is virtually impossible to get an accurate prediction for any *of these numbers. Moreover, the final overall value computed for the decision may be strongly affected by a small change in probabilities. It is not surprising, therefore, that the most senior management at Merrill Lynch was unable to agree, for over a year, on a course of action.*

Alternative Analysis: *Paradoxically, the analysis can be substantially simplified by increasing the complexity of the tree. This is illustrated in a variant of the decision tree shown in Figure 2.*

Note that with the tree structured as in Figure 2, Merrill's preferred course of action is now clear. If the systems will have only limited impact on the market, they should be sold and Merrill should accept its share of the limited additional profit that Bloomberg earns. Even if the systems have significant market impact, however potentially damaging they are to Merrill's trading profits, the firm should still allow Bloomberg to sell them. Compare the top three branches in Figure 2 with the following four. We can safely assume that p0 equals zero.[7] *Now it becomes clear that the two top subtrees, in which Merrill Lynch allows Bloomberg to sell more widely and in which Merrill Lynch does not, respectively, have identical structures. The probabilities associated with different marketplace responses are the same. The potential for negative impacts on Merrill's trading operations, $\$_{margin}$ and $\$_{comp}$, are also the same. The only difference is the firm's potential to earn significant profits from its investment in Bloomberg if Bloomberg is allowed to sell more aggressively. If Bloomberg sells to Merrill's competitors, Merrill receives its share of these profits. If it does not, then a competitor will eventually earn comparable profits instead. This is a very major difference indeed! Clearly, even in the case where Bloomberg has the potential to affect the market, Merrill prefers to receive some offsetting profits from its investment, and should allow Bloomberg to sell.*

Thus, by careful restructuring, we have transformed the problem from an intractable one, requiring a considerable amount of data that would be difficult or impossible to obtain, to an equivalent problem that can be solved by inspection with the information already at hand.

Key lessons: *Sometimes the decision can be made rationally and analytically, even when it cannot be made numerically. If the problem can be structured so that the ranking of various courses of action is insensitive to a wide range of assumptions, it may not be necessary to compute the expected return of each action.*

Two key lessons emerge from this analysis, which are general and readily applied to strategic systems investments. Merrill Lynch was able to avoid the following two traps, frequently encountered when considering strategic systems [11]:

1. *The trap of the negative* net present value
2. *The trap of the vanishing* status quo

Usually, strategic systems projects involve a substantial additional investment, unlike the one considered here; it is then increasingly difficult to justify an investment that appears to have a negative net present value. As we have seen, it does not matter whether or not the decision's value is positive in absolute terms; it matters only that the value is superior to (less negative than) the alternatives. As in many strategic investments, the alternative to taking action may not be the continuation of the status quo. *Frequently a competitor will choose to exploit an opportunity even if the firm does not; in this case, the alternative the firm then faces is likely to entail reduced margins, loss of market share, and a generally deteriorating competitive position. Barwise et al., describe these problems as "misstating the base case"; they argue that executives spend too little time considering the alternative to undertaking a strategic venture [1]. The principal contribution of restructuring the problem, as in Figure 2, was to structure the investment decision in the appropriate context, and thus to make the alternatives clear.*

Note that this analysis was not easy. The absence of numerical estimates does not imply that no data were used; rather, given that quantitative analysis was not possible, alternatives had to be developed that exploited all available information.[8] *Merrill Lynch's board agonized over this decision for more than a year, before the problem was structured in a*

[7] Bloomberg's systems are extremely well done, but virtually all of the technology and all of the mathematical analyses are standard. There is no barrier that would permanently deter a competitor from developing equivalent systems. And if these systems are seen to yield significant trading advantage to Merrill Lynch we can certainly expect them to become generally available as other large houses develop comparable offerings.

[8] We challenge the idea that strategic systems need to be undertaken based on an act of faith [22] if sufficiently precise numerical estimates are not available for discounted cash-flow computations.

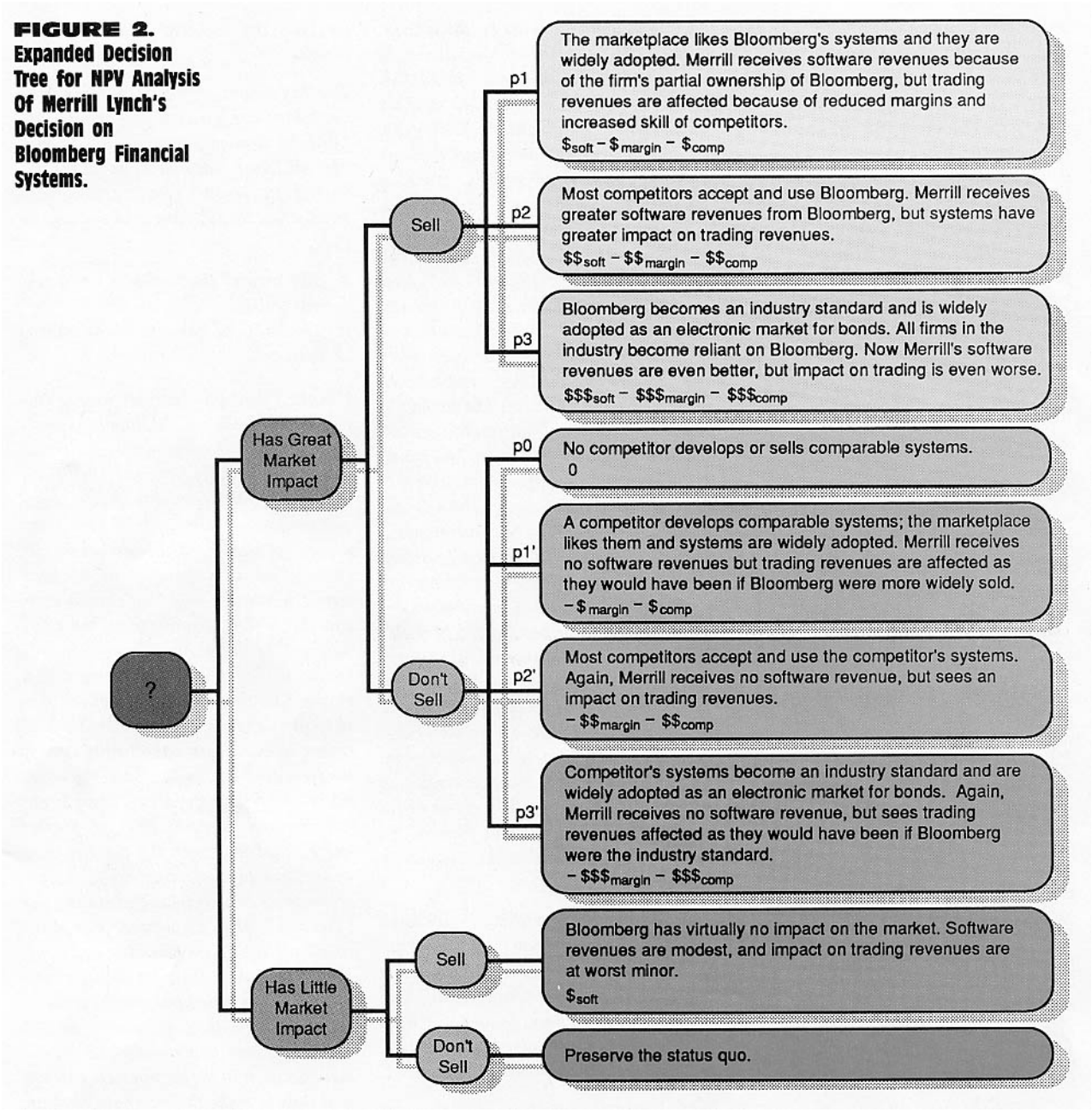


FIGURE 2.
Expanded Decision Tree for NPV Analysis Of Merrill Lynch's Decision on Bloomberg Financial Systems.

way that made a decision possible without precise estimates of individual competitive impacts. It is difficult to accept a recommendation that is not supported by detailed quantitative analysis. It is, however, in precisely this situation—with a great deal at risk, and no routine way of reaching an uncontested decision by traditional analyses—that senior executives act as decision makers and prove their value to the firm.

LESSON TWO

Work with the Numbers

Sensitivity analysis is a widely used technique for dealing with uncertainty in decision problems. If it is not known precisely what value a parameter will assume, then the analysis is repeated with alternative values. The analyst may vary probabilities in a decision tree, or costs may be varied in a linear programming formulation, to determine how far parameters can be varied without altering the decision maker's selection of a preferred alternative.

It may be possible to compute

values for costs and benefits. Despite the uncertainty inherent in all estimates, sensitivity analysis may allow us to develop a fair degree of comfort in the conclusions.

McKesson Drug[9]

The problem: *McKesson Drug Company's Economost electronic order entry system is one of the best-known strategic information systems. It links McKesson to its customers: pharmacies and drugstores. In its most complete form Economost is both simple and powerful. It permits a drugstore employee to order by walking through the store with a bar-code reader and recorder, and waving a wand at any item that appears to be in short supply. Goods arrive the next day, in the store's order quantity, laid out in accordance with the store's floor plan and complete with the store's prices. Numerous management reports are available, some without additional charge. The information captured through Economost has been used to implement enormous efficiency improvements within McKesson, and a large portion of the benefits derived from these improvements have been passed along to McKesson's customers. The system is so attractive that over 99 percent of McKesson's order flow arrives electronically.*

Economost clearly has been strategic. In the first decade following its introduction, the number of drug wholesalers in the United States was reduced by 50 percent—from 180 to 90. Companies unwilling or unable to offer electronic order entry systems to their customers figured prominently among the early casualties. The benefits of systems like Economost are now so obvious that we take the basic system for granted, assuming that the decision to invest in Economost was easy, almost preordained.[10]

Actually, the decision was not *easy. A small prototype electronic order entry system was attempted in 1973 in three sites, and response to it was mixed. McKesson's salespeople thought it was competing with them, and they hated it. Senior management realized that they were giving users of the system major price concessions, and were convinced it was a bad idea. Dave Malmberg, now the senior strategic planning officer for McKesson Corporation, was told "We know its a terrible idea. Build a model to prove it!"*

A model was built and run under a wide range of assumptions, but the system still looked surprisingly attractive. Development of Economost was therefore begun.

Analysis: *Malmberg had to model the way the system would reduce McKesson's own costs, allowing them to reduce the prices they charged. He had to model the way reduced prices, and increased convenience, would increase customer order flow by getting customers to increase the share of their stock ordered from McKesson. He had to make assumptions about customers' willingness to cut their order frequency from once or twice a day to once or twice a week. There were no accurate estimates available for any of these. This seems to be an obvious opportunity for sensitivity analysis, which was of course performed. The target measure was return on investment [ROI], and the critical variables changed in the sensitivity analysis were pricing levels and sales effort.*

It was possible, however, for McKesson to arrange its investment in stages. Initially, a quick-and-dirty implementation was slapped together and installed in a few sites, at very limited cost. As the response to the system was received, the model was recalibrated, fit to the data, and rerun. Thus it was possible to reduce risk early, before significant software investment was made.

Key lessons: *Where there is uncertainty, but the possibility of quantifying some of the critical variables exists, financial analysis can be quite valuable. The sensitivity analysis that McKesson performed was essential in allowing them to reach their decision.*

The timing both of the investment, and the reduction of uncertainty, can be critical. Here, McKesson was able to obtain information, refine its model, and rework the numbers before incurring full development costs. And had the initial response been very different from the predictions, the firm would have been able to stop the project with very little lost investment.

Post script: *Economost was clearly a very good thing for McKesson, and failure to implement it would have been extremely dangerous. Still, it is interesting that a system that we now believe was a strategic necessity—instrumental in saving the drug wholesale business from pressures created by chain stores—was justified on such prosaic grounds. Impact on the industry was never considered. Competitor response also was not considered.*

LESSON THREE

It Is Necessary to Balance Many Forms of Risk

There are many forms of risk, requiring many different approaches to risk management.

First Boston[11]

The problem: *When Gene Bedell, vice president, Information Services, came to First Boston after about a dozen years away from the securities industry, he was astounded. The environment in securities trading had changed much more rapidly than the installed systems architecture. Most transactions had required accounting in only a single currency; now transactions could require as many as four currencies. Derivative products for hedging and new trading strategies*

[9]Material for this section comes from "McKesson Drug Company: A Case Study of Economost, A Strategic Use of Information Systems," [6] and from phone conversations with Dave Malmberg of McKesson Corp.

[10]McKesson's Economost has become almost an icon in the literature of strategic information systems. It has frequently and incorrectly been described as an example of competitive advantage, but the decision process leading to its adoption is seldom described in published work. In consequence, this has led to the mistaken idea that the decision was somehow easy, requiring little formal analysis.

[11]Material for this section comes from public sources [12,21,23] and from phone conversations and brief discussions with Gene Bedell in New York.

were increasingly important. The firm now traded entirely new financial instruments. Markets were global to an unprecedented degree. Regulatory climates were changing in the United States and abroad. Systems were increasingly important: in supporting complex trading strategies in real-time, in helping management assess and control trading risks, in selling effectively to increasingly sophisticated institutional investors, and in settling the large volume of trade. Yet the existing systems were surprisingly familiar, which of course meant they were surprisingly outdated. Like most major Wall Street houses in the 1980s, First Boston was forced to contemplate replacing all of its systems.

Any new architecture would have to support the following:

- *Responsiveness to change: Rapid support for new products, and for regulatory changes, would have to be provided.*
- *Ability to exploit new technologies, so competitors who started later would not end up with a competitive advantage: As Bedell noted, "we could not risk being locked into any one technology in an era of rapidly changing technologies."*
- *Increased data-processing productivity and quality.*
- *Flexible, fast, easy-to-use workstations for everyone who used computers, with full graphics capability.*
- *A fail-safe architecture was required, with the possibility of taking the central system down without an impact on traders. This is difficult in a global, 24-hour environment, where New York's midnight is the middle of Tokyo's trading day!*

From the start, the resulting architecture was based upon two guiding principles:

1) *Seamless cooperative processing: Jobs could be initiated on a workstation, with its attractive interface and low cost. As these jobs had increasingly complex requirements, they could continue to run on any machine, including remote mainframes for database processing, without a request from the user, and even without the user's knowledge.*
2) *Advanced programming tools: Computer-Aided Software Engineering (CASE) and Object-Oriented Programming Systems (OOPS) could dramatically increase programmer productivity. Unfortunately, when the project was started, these tools were in early, conceptual stages of development. No tools existed to support cooperative processing across equipment from different vendors.*

Bedell explains:

> *Even before we had any clue on how to implement, we knew that these would be characteristics of the architecture. We started with the business needs and came up with the solution that would best meet those needs. Unfortunately, there was no way to implement this solution with the tools available at the time!*

The initial architecture employed the following technology:

- *Trader workstations were built on powerful personal computers.*
- *These were driven by fail-safe mini computers called Stratuses, located on each site; in addition to supporting the workstations, the Stratuses recorded all local transactions when links to mainframe database machines were unavailable.*
- *The Stratuses linked to central IBM 3090 mainframes for database processing, and for archiving and maintenance of historical data.*

Discussion: *The real decision was between conventional technology and implementation using new technology—CASE, OOPS, and cooperative processing. Bedell notes a major complication for the firm's analysis:*

> *The new technology was emerging as concepts, but there were no products available for building the systems needed for day-to-day operation of a business.*

The project would require a five-year development effort. Bedell describes his two alternatives as follows:

1) *We knew that if we used conventional technology, even if we were successful, we would finish with a brand-new obsolete system.*
2) *Instead, we could attempt to develop the tools we needed. We would run a very high risk of failure in developing the tools, but the possibility would exist for considerable competitive benefit to the firm.*

Clearly, even if both development efforts had the same expected cost, they had very different cost distributions and very different risk profiles. With conventional architecture and conventional development methodologies, a statement of requirements would be developed and a system would be built to meet this fixed, unchanging specification. Unfortunately, the actual needs would certainly have changed during development, resulting in a system that was already drastically in need of overhaul immediately after completion. The CASE development effort could be divided into a fixed sunk cost, an investment made to gain a development capability, and a variable cost, the investment needed to develop applications of benefit to the firm. Since programmers could be far more productive with CASE tools available, it would be possible to modify or augment the statement of requirements, and to develop additional systems capability rapidly as changing requirements dictated. Given the anticipated improvements in productivity, and the need to respond rapidly to changing requirements in the industry, if it could be safely completed, the second alternative would be much more attractive.

The development of CASE tools could have been justified solely on the basis of cost savings resulting from increased productivity of systems personnel. This justification was rejected by the firm's most senior executives, who chose instead to emphasize the flexible response to changing needs that such productivity tools can provide.

How can such a decision be made?

Analysis: *There are many components of risk. While there are considerable associated risks involved in letting a securities firm develop CASE tools beyond those that had been attempted by any commercial software vendor, there are also risks in developing inflexible systems in a rapidly changing industry.*

We identify the following components of

risk, all of which must be managed and traded off against each other:

- Financial risk—*The firm cannot afford it. The financial exposure is unacceptable, or costs are not in line with projected benefits.*
- Technical risk—*It cannot be done. The necessary supporting technology is not available.*
- Project risk—*The firm cannot do it. The scale of the undertaking, or its technical complexity, or its fit with the skills and expertise of the development group, preclude successful completion of the project.*
- Functionality risk—*When the project is completed, it is unsuccessful: it is not what the user wants, or the environment has changed so dramatically during the time of development that the system is no longer functionally appropriate.*
- Systemic risk—*You just cannot win! The system is so successful, and it so dramatically alters the environment, that all assumptions about costs and benefits are rendered obsolete. This can be due to response from competitors threatened or harmed by the innovation, from customers or users within the organization, or in extreme cases, unfavorable regulatory changes made in response to the project's success.*

While Bedell believed that the project risk *obviously was considerable for First Boston's development of distributed multivendor CASE tools, he believed that this component of risk was also quite high for any massive conversion effort. The critical factor was* functionality risk: *in a rapidly changing global industry the programmer productivity and the resulting flexibility of the implemented systems, made possible by the CASE development environment, were the compelling reasons to choose the more technically advanced alternative.*

Key lesson: *Again, the decision appears to have been made rationally but not numerically. Payback period, return on investment, detailed sensitivity analyses were not factors. Real, carefully considered issues of risk management drove the decision. In particular, First Boston chose to accept considerably greater technical and project risk, in order to reduce functionality risk. That is, they accepted the possibility that they could not develop the tools they were attempting to create, knowing that if they were successful these tools would enable them to create and modify systems to meet uncertain and evolving needs. The alternative would have been the possibility of using traditional tools to develop less flexible systems that met only needs known at the time the project was begun, resulting in the possibility of a successfully completed project that would be certain to be inadequate to meet future needs.*

Post script: *The CASE development efforts were successful. First Boston estimates that they have received 100-fold (that is, close to 10,000 percent) increases in application programmer productivity! And they are now selling their CASE tools.*

LESSON FOUR

Actively Manage The Risk

Even when managers are confident that they have made the correct decision to proceed with a project, it is still necessary to manage risk. Identification of the various components of risk is the essential first step toward actively structuring and managing the risk of any large project.

Bell Canada[12]

The problem: *Bell Canada's current information systems evolved without a coherent plan or integrating architecture. Many of the programs are a dozen years old or more, and the overall system is inadequate to meet the challenges brought about by the changing marketplace, technological evolution, and changes in the Canadian telecommunications industry. Changes to billing can only be made slowly, and revenue and cost accounting can barely be done at all. Many programs are incompatible, requiring the rekeying of data to integrate them. The company has the technical capability to develop future telecommunications products, but it may not be possible to market them intelligently or bill for them efficiently. Examples include 800-service billing, and billing for virtually all ISDN*[13] *product offerings.*

Bell Canada will need to compete. It will need to increase its market. It will need to market effectively. As Robin Hamilton Harding, vice president and comptroller, noted:

> *How can you cut a dollar of expenses if you don't know whether it generates one dollar of revenue or two?*

How can you sell? How can you manage without knowing what is being sold? Marketers need to know what their deals mean.

Moreover, the structure of Canadian markets will change over the rest of this century. As Uwe Natho, assistant vice-president, noted:

> *Currently 25 percent of our revenue comes from deregulated lines of business. It will reach 75 percent.*

Therefore, under the comptroller's leadership, Bell Canada initiated the Corporate Revenue Information Systems Project (CRISP), the first and most crucial phase in developing a new information systems architecture. CRISP would involve a phased conversion of all of the programs and files associated with billing information, in excess of 5,000 program modules, 2.7 million lines of code, and 270 files; these would be replaced with approximately 25 program modules, and a shared relational database. Although the cost of the project would be considerable, Bell expected commensurate benefits to do the following:

- *greatly increase information available to marketing, including analyses by customer account and product line,*

[12]Material for this section comes from "The Bell Canada CRISP Project: A Case Study of Migration of Information Systems Infrastructure for Strategic Positioning" [8].

[13]Integrated Services Digital Networks (ISDN), is a family of standards that make possible a wide variety of new and sophisticated business telecommunications services.

When the environmental changes are rapid enough to be considered discontinuities, rapid and flexible organizational response becomes essential.

- *greatly increase flexibility in the reports, currently known and still unanticipated, that could be developed from the relational data,*
- *bring new applications on-line rapidly and cost effectively to support marketing needs,*
- *be more responsive to the needs of customers, especially commercial accounts,*
- *market information service products.*

Analysis: *Although the project was studied extensively, no formal financial analysis was used to justify proceeding. The system was described as a strategic necessity, and presented without detailed financial analysis, decision trees, payback period, or sensitivity analysis. Robin Hamilton Harding, the lead program officer and a senior officer with considerable credibility within Bell Canada, argued convincingly that the system's conversion would be essential for Bell to remain competitive.*

He thinks there are several reasons for the executive officers' approval in the absence of demonstrated hard economic benefits. Chief among these is the general support built into the organization prior to submitting specific project proposals. All affected business units were intimately involved with the development of the plan. Moreover, he consciously sought support for the project prior to embarking on the approval process. His staff had already developed considerable support among operational personnel in affected functional areas like marketing. This was intended to reduce the project's political risk.

In addition, although Bell believed that it was essential to proceed with the project, management took prudent steps to identify and manage various components of risk. They divided the large $30-to-$40 million project into several modules, none of which cost over $2 million, thereby reducing the exposure, the level of complexity, and magnitude of organizational change that must be managed at any one time. This greatly reduced the financial risk of the undertaking. The ordering of modules has been arranged by economic, organizational, and practical considerations. The most visible tasks, those that produce tangible outputs of immediate value, are to be completed first. Success on these tasks will establish an experience base and a visible track record that should facilitate the approval and implementation of other tasks; this also will reduce the project's political risk.

It was marketing personnel who were intended to be the major users of the new information, and thus would need to be instrumental in defining and improving the statement of system requirements. Therefore, the comptroller's staff cooperated closely with the marketing department. This was intended to reduce the risk of the system failing to meet the future needs of its users; that is, these actions were taken to reduce functionality risk.

Although it is expected that the new system infrastructure will considerably reduce the cost of developing new software, this was not used as a justification for the project. Since the flexibility in obtaining marketing information and the timeliness in supporting the marketing of new products in a changing environment was seen as crucial to the future success of the company, no attempt was made to quantify the benefits of this flexibility.

Key lesson: *Strategic necessity is a compelling argument. When the environmental changes are rapid enough to be considered discontinuities, rapid and flexible organizational response becomes essential. Even when the value of an architectural investment to obtain this flexibility is difficult to express quantitatively, it can be explained as buying an option that may be necessary to ensure the firm's survival. The credibility of the person raising the argument is critical. The need for such a champion is especially important for large projects, in which a feeling of ownership within the user organization will be crucial. And, even for strategic necessities, risks must be managed.*

LESSON FIVE

The Role of Critical Resources

A firm is unlikely to retain a long-term advantage, without some fundamental defense other than its technology. Our own experience, based on studies of numerous companies and industries, is that technology is readily acquired, systems are readily copied, and competitive advantage from systems is likely to be sustained only if it leverages key nontechnological assets not readily available to competitors [7].

BZW TRADE[14]

The problem: *Barclays de Zoete Wedd (BZW) is the largest market maker in the United Kingdom, making market in over 1800 equities.*[15] *Additionally, its market makers have one of the largest*

[14]Material for this section comes from our own study [9] as well as public sources [2,14,15,26,27,28], and extensive discussions with Nic Stuchfield, Peter Holloway, and Ian Macdonald of BZW's equities market making operations (London, August, 1989 and March, 1990).

shares of retail orders. Retail business traditionally has not been very important in London. While it is widely regarded as unprofitable, there are opportunities to improve the competitive situation with automation. In particular, BZW was evaluating customer-order entry systems, which could greatly reduce execution costs for both BZW and its customers, and increase the firm's market share as well. If a system to automate broker order entry should actually provide benefit, it would be necessary to defend against competitors' responses.

London's International Stock Exchange now has no trading floor. Market makers use the Stock Exchange Automatic Quotation (SEAQ) system to post their bids and offers, and the size at which they are prepared to deal. These prices are widely disseminated in real-time, to other market makers, to agency brokers, and to major institutional investors, in London, throughout the United Kingdom and abroad. All trades that do not exceed the posted size must be executed within the touch, *the best bid and offer. Firms have an incentive to post the best price—to be on the touch—to attract order flow; however, customers or their brokers are free to call around, and any market maker is permitted to deal if it is willing to match or beat the current best SEAQ price.*

BZW launched TRADE, an automatic order-entry system for retail brokerage, in the summer of 1988, seizing an opportunity created by repeated delays in the Stock Exchange's own automatic order-entry system, SAEF. TRADE uses the best prices prevailing on the London Stock Exchange, and automatically routes orders to BZW's market makers at these prices, even if the prices that BZW was offering on the Exchange at the time were inferior. Brokers are assured execution at the best available price, and automation reduces their back office expenses; the combination was expected to increase BZW's market share. And this same automation was expected to reduce BZW's own costs sufficiently to make retail brokerage orders attractive to the firm.

Discussion: *Many within the firm felt that retail orders were inherently unprofitable, and that nothing should be invested to increase retail business. Senior equities personnel at the time, Nic Stuchfield, director of United Kingdom Equities, Peter Holloway, managing director of Equity Trading, and Ian Macdonald, head trader U.K. Equities, however, felt that if costs were reduced sufficiently the business could be profitable.*

Moreover, Nic and Peter believed that any advantage gained through a system like TRADE could be defended: BZW makes market in the largest number of securities in Britain. A competitor launching an equivalent system could not offer customers the same range of coverage, and hence the same convenience; equities for which the competitor did not make market could not be ordered through their system. BZW's market makers enjoy one of the largest shares of retail orders, so most competitors could not capture the same scale economies available to BZW. BZW has long-established relationships with most of the brokers with whom they work. Thus, a competitor would have to counter both these working relationships and the advantages offered by TRADE.

Analysis: *Making the investment decision to proceed with the development and installation of TRADE involved the following:*

- *Estimating development costs—this seems right on target and was relatively easy.*
- *Estimating reduction in their own trading costs—They believe that their original estimates, that execution costs to BZW could be reduced from £7 to £2, were correct. It was, however, very difficult to make this argument convincing.*
- *Estimating increase in market share—this was very difficult. They had experience with their Retail Order Room, a manual version of TRADE, as an initial estimate. And they ran sensitivity analyses, varying estimates across a spectrum.*

Given the uncertainty in their estimates, it was necessary to perform sensitivity analysis. Analyses were done varying reductions in their own trading costs and increases in market share. Under a wide range of assumptions, TRADE appeared justified, and the decision was made to proceed.

BZW attempted to consider the response from competitors. BZW accurately foresaw the difficulty of other market makers attempting to launch competitive systems. Kleinwort Benson's BEST was launched before TRADE. Although competitors' systems are no doubt being developed, to date no other market maker has launched a competing system in response to TRADE.

Key lessons: *Sometimes we* can *do an NPV analysis, or a payback period analysis, even for strategic investments, and capture uncertainty through sensitivity analysis.*

If a venture is attractive to the firm, it may well be attractive to competitors. Thus advantage, if it is to be sustained, must be based on exploiting certain key assets—in this case, scale of retail operations and scope of market-making capability—not readily available to these competitors.

Post script: *Early evidence indicates that TRADE has been successful. Some brokers have doubled the share of the orders they bring to BZW from 20 percent to 40 percent, and have placed an artificial cap of 50 percent to avoid excessive dependence on any single firm.*

Moreover, no competitor has gone through with plans to launch a system to compete with TRADE. Despite the fact that the technology could readily be duplicated, the fundamental advantages enjoyed by BZW appear to represent a significant barrier to competitors.

[15] A *market maker* in London trades for the firm's own account, buying from or selling to brokers who have customer orders. While the broker earns money on commissions, generally a percentage of the value of the trade, the market maker earns much of his profit from the *spread*, the difference between the *bid*, or buying price, and the *ask*, or selling price, of the security.

While BZW makes market in over United Kingdom 1800 securities, and Warburg Securities does so in almost 1800, no other firm comes close in the United Kingdom market. Smith New Court is next with about 800, and international giants like Merrill Lynch, with under 120, and Nomura, with about 20, are inconsequential in United Kingdom equities.

LESSON SIX

Sustainable Cooperative Advantage?

We have found, in studies of numerous industries in the United States and abroad, that sustainable competitive advantage is quite rare and quite difficult to achieve. The sort of unambiguous resource advantage enjoyed by BZW occurs only rarely, thus, strategic ventures for competitive advantage may not always produce the desired results, even if systems development efforts are executed perfectly. And, given the high cost of developing software ventures and the ease of ratcheting up the volumes that they can process, cooperative ventures should be seriously considered. When competitive advantage appears unlikely, or when a major competitor's size places a firm at a competitive disadvantage, cooperation may offer significantly reduced costs.

Philadelphia National Bank MAC[16]

The problem: *When Girard Bank launched George, its proprietary ATM network for Girard's retail banking customers, it was clear that all other retail banks and savings and loans in Philadelphia would need to respond. Girard was a major Philadelphia bank and had the largest share of retail banking. Banks that could not, for whatever reason, match Girard's George faced the prospect of inevitable, serious decline in their share of Philadelphia area retail banking.*

Unfortunately for PNB, ATM networks exhibit significant economies of scale. The cost of central-site hardware and software to drive the network is largely independent of transaction volumes and the number of installed ATMs; a small bank, with very few ATMs, will thus have much higher average costs than a larger bank. Additionally, the value to customers increases rapidly with the number of ATMs installed. Customers expect ATMs convenient to where they bank, where they work, where they live, and where they shop. A large bank, with a large number of retail customers, can afford to put in enough ATMs; a small bank, with fewer customers, will once again be at a significant disadvantage.

Philadelphia National Bank found itself in an untenable position. It believed it was necessary *to respond to George. And, given the scale of its retail banking operations and the anticipated impact on its bottom line, it was unacceptable to bank management to pursue a meaningful proprietary response on its own.*

Officers at PNB realized that they could not be alone: they could not be the only retail bank in Philadelphia that was not the largest.

Consequently they launched MAC, a shared ATM network available to any and all banks.

MAC could have been launched as a joint venture, owned and operated by many participants. Instead, MAC was wholely owned by PNB, with other banks paying fees for transactions that MAC processed.

Analysis: *Participation of additional banks offered PNB an opportunity to achieve necessary scale. Each bank that joined MAC would increase the number of machines available to the cardholders of all participating banks and improve the regional coverage of machines; this would make the network coverage meaningful to the banks' customers. As the number of banks increased, and transaction volumes rose, MAC's average costs would decrease to the point that MAC would become profitable for PNB. MAC would also reduce operating costs for member banks.*

PNB chose to launch MAC as a single-owner shared ATM network, for two reasons. The first was ease of coordination and maintenance of bottom-line financial discipline. The second reason was the perceived up-side; their potential for future profits from MAC appeared greater with PNB as the owner. PNB launched MAC as a fully generic product, not branded or tied to PNB in any way. Moreover, it was clear to member banks that PNB did not receive preferential treatment nor enjoy any proprietary advantage from its operation of MAC. PNB's strategy for MAC required participation from other Philadelphia-area banks to achieve scale of operations and widespread deployment of ATMs. Only with PNB's foregoing competitive advantage in retail banking through its MAC connection would it receive the trust and cooperation from other banks needed to launch MAC and make it successful.

MAC can clearly be viewed as successful. After a recent sequence of acquisitions, including CashStream, the successor to Girard's George, MAC is now the only surviving ATM network in Pennsylvania. PNB is earning profits on MAC, member banks do not feel these profits are excessive, and at present the arrangement appears stable.

Key Lessons: *Through cooperation with competing banks, PNB not only countered a common threat from Girard, they ultimately owned the ATM network business in the state of Pennsylvania. Cooperation—working with or selling to competitors—can be an effective way to develop required scale or acquire other necessary resources. Cooperative arrangements are becoming increasingly frequent and increasingly important. Paradoxically, sometimes the best way to assure competitive success is to launch a cooperative venture.*[17]

LESSON SEVEN

Do Not Forget the Down-Side

When considering a strategic investment in information technology, the uncertainty associated with success may delay the undertaking. Alternatively, the attractive profit stream associated with current op-

[16]Material for this section is drawn from "Philadelphia National Bank's Strategic Venture in Shared ATM Networks" [14].

[17]This is explored in more depth in an earlier article [5].

erations may appear to offer a compelling reason to forgo strategic change. As noted in the discussion of Merrill Lynch's decision concerning Bloomberg, however, some investments should be made to limit the possibility of future losses, rather than to obtain long-term additional value.

The trap of the *vanishing status quo* is especially dangerous when used to justify avoiding investments needed to deal with radical environmental shifts. Most United States airlines, profitable under the regulatory regime of the mid 1970s, chose neither to develop computerized travel agent reservation systems nor to share the investment with a major player already developing such a system. These reservation systems did not appear to be necessary. Within a decade—which should be within the foreseeable future for executives—these systems became crucial. Some carriers are now paying hundreds of millions of dollars to acquire partial ownership. Others are paying hundreds of millions of dollars in booking fees to their competitors!

Sometimes an investment, not essential at present, should be undertaken to preserve the future courses of action open to the firm. Ned Bowman and Bill Hamilton refer to such opportunities as *strategic options* [20]. Once the investment has been made, it may permit the exploitation of opportunities that arise at a later time. Sometimes investing in a strategic system can be viewed as buying an option on the future survival of the firm. For example, some financial services companies enjoy limited competition in their markets, due to continuing regulation. These firms can expect their protected niche to be eroded in the future; at some later time, they will find themselves competing against CitiBank. Thus, while their information systems infrastructure may be adequate for their current competition, it is almost certainly inadequate for future needs. Infrastructure investments may be impossible to justify in terms of delivering current application needs; these same investments may be viewed as essential if they are seen as positioning the firm for the future, allowing it to respond rapidly to emerging competitive threats. Similarly, as noted above, Bell Canada's decision to embark on CRISP can be viewed as buying an option on the future of the company.

Finding and evaluating strategic opportunities to use information technology, and then justifying the decision to make the necessary investment all require a set of skills different from those historically required of IS executives.

Conclusions

We believe that information technology can be strategic to many firms. In fact, information technology is now likely to be essential to the delivery of any new strategic effort—in manufacturing, distribution, sales, or service.

The strategic impact of information systems poses a new problem for MIS management. Finding and evaluating strategic opportunities to use information technology, and then justifying the decision to make the necessary investment all require a set of skills different from those historically required of IS executives. *A priori,* the decision—to proceed with or to cancel a strategic program—is often difficult; only after the fact may the results appear obvious.

Part of the problem comes from viewing even strategic opportunities to invest in technology as projects, to be judged on their expected value, and included or excluded from the company's portfolio on capital budgeting criteria. Sometimes these opportunities may be too critical to be treated in this way: the future benefits are too wide-ranging to be estimated with any accuracy; or the implications of failure to invest in the technology may involve permanent loss of competitive strength within the industry. While these problems are not unique to information technology investments, they are being faced by IS executives for the first time. Additionally, some information systems ventures can, if successful, so radically alter the operating environment of the firm that precise predictions for quantitative analysis are impossible to obtain, making these programs especially difficult to evaluate.

Strategic systems can have enormous impact on a firm and its entire industry, and can involve commensurate risk. Therefore, when beginning a strategic program, it is essential to ask the following questions:

- What are the benefits, both tangible and intangible, of the proposed strategic program? How might changes in the firm's future operating environment, either externally imposed or actually caused by the strategic program, alter estimates of these benefits?
- What are the costs of undertaking the program, and what are the costs of potentially being frozen out of future opportunities by failing to undertake the program?
- What are the risks of proceeding with the program, and how can they be managed?
- What is the expected competitive impact? What proprietary resource advantage does it exploit, allowing advantage to be sustained and protected?
- If there is no resource advantage or barrier to competitors' duplication, would it make more sense

to develop cooperatively? Conversely, if there are resources that the firm lacks, might it make sense to develop with strategic partners, to counter these resource problems?

Evaluation of strategic investments in information technology, like all strategic decisions made by senior managers, will never be routine procedures. With the application of the guidelines presented above, however, these crucial decisions can be improved.

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