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# The hidden financial costs of ERP software

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## Abstract

**Purpose** – The purpose of this paper is to detail how the adoption of enterprise resource planning (ERP) systems creates major distortions in the corporate decision-making process.

**Design/methodology/approach** – The approach is to focus on the distortion in the capital – budgeting process of corporations emanating from the rigidity of ERP software. The rigidity negatively influences decision-making because ERP software often dictates that the firm must change its core business procedures and processes to fit the software.

**Findings** – Lack of flexibility limits the introduction of new products, or targeting a new customer segment by increasing costs and imposing delays in implementation.

**Research limitations/implications** – Firms would benefit from performing detailed analysis of the impact of ERP systems on their ability to make operational decisions.

**Originality/value** – This paper focuses on the problem of decreased flexibility in making changes in the production and accounting components of the firm when purchasing and installing ERP systems that cannot accommodate minor or major changes in the corporation.

**Keywords** Manufacturing resource planning, Capital budgeting, Decision-making

**Paper type** Conceptual paper

## Introduction

Strategic restructuring, innovation implementation, and continuous improvement are strategies used by firms in their quest for greater efficiency and lower costs to increase firm value. Successful implementation of these strategies requires a firm to make marginal changes across a multitude of dimensions of the firm (see Kanter *et al.*, 1992; Nadler and Tushman, 1997; Tushman *et al.*, 1997; Tushman and Romanelli, 1985). Marginal changes in production, sales, human resources, or accounting can lower costs, increase efficiency, or increase sales. A crucial component in making these changes is flexibility. Decision makers with a larger opportunity set for making changes have a greater possibility of making modifications that enhance the value of the firm.

In this paper, we identify a serious threat that is affecting decision flexibility in firms and ultimately their ability to increase value. We argue that the adoption of enterprise resource planning (ERP) systems, as they have been configured, has created major distortions in the corporate decision-making process by raising the cost of making value-enhancing decisions and negatively influencing the overall capital-budgeting process[1]. This, in turn, has led to lower firm value. The increased cost of change due to ERP systems leads to rejection of many cost-saving or efficiency-enhancing projects that would otherwise be adopted. For example, when changes to software are required to accommodate a cost-savings change in an accounting procedure, the benefits in accounting are weighted against the present and future costs of changing the software. Additionally, other important and valuable changes in other parts of the firm are not undertaken because the cost of software changes becomes the paramount concern and driving force in decision-making.

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Over the past two decades, the exponential increase in computing power has provided multiple opportunities for firms to innovate and increase firm efficiency. Increased computing power also has increased firms' ability to act and react to market change and make internal changes that increased the value of the firm. Historically, such important innovations have increased firm productivity and decreased costs for long periods without significant tradeoffs. Over time, these cost-benefit tradeoffs (with positive financial outcomes) become marginal and economic benefits decrease while costs increase. Some of this narrowing of benefits relative to costs becomes readily apparent before major investments are made. However, some are discovered only after major investment and changes have been undertaken. Those investment decisions in which it is apparent early that costs outweigh benefits (negative net present value [NPV] projects) are not implemented. Those discovered long after a project is accepted impose long-term costs to the firm leading to a decline in firm value.

After a decade of utilizing computer software that expanded the integration of information across functional components of the firm, it has become problematic whether further integration will have diminishing marginal returns (Kerstetter, 2003). More important, the marginal costs from integrating information increase sharply while the complexity of the software system reduces the degrees of flexibility for the firm to change and innovate. The integration of information across functional components of the firm is appealing because it provides greater control and accountability. The initial productivity gains from integration of information were large; however, ERP software firms have since developed and sold software that have taken integration to a much higher level. ERP programs integrated the firm's data and systems into one package, and provided "best business practices" integration of information across manufacturing, financial, and human resources operations[2]. ERP systems have paid off for many firms, particularly firms whose existing structure was amenable to accommodating an ERP system (Johnston and Cotteleer, 2002).

Nevertheless, even when successful on implementation, ERP systems that integrate data across the major functions of a large organization are not benign: They can have a negative impact on the functional aspects of the firm. Integration of data across functional areas reduces the options available to decision makers to make changes within the functional area because information systems are rigid (Brown and Hagel, 2003). Decision makers cannot make changes that improve efficiency or reduce costs without altering the ERP software. Because integrated software systems are difficult and expensive to alter, the costs of innovation and change are higher.

The conflict between data integration and the ability to make changes occurs because ERP systems require a level of integration that conflicts with basic economic and management principles. Namely, ERP systems distort the authority relation that should exist between line and staff functions. That is, decision-making authority is superseded or even transferred from a line or core business function to an ancillary or auxiliary service. As such, the staff or auxiliary department becomes dictating, rather than facilitating or advisory. Information technology (IT) or management information system (MIS) departments are but one of many ancillary functions in a firm including human resources, planning, accounting, and legal departments. Although crucial to the success of the firm, these staff functions are only indirectly involved in the core business of producing and selling a product or service. As such, they should serve in an advisory or facilitating role in regard to the line function and should be only indirectly involved in decision-making related to the core business.

Conversely, the philosophy behind ERP systems is to bend the firm's core business procedures and process to fit ERP software (Turbit, 2003). As a result, ERP system requirements become lexicographically ordered to dominate all other firm activities. Firms, however, have multifactor production functions and cannot have a lexicographic ordering of priorities if they are to be successful. Integration of MIS functions cannot take precedent over all other activities; the MIS department cannot be the driving force behind all decision-making. Profit maximization suggests that inputs be utilized to the point at which marginal revenue product equals marginal cost. Although this is obvious when stated, the conditions under which ERP systems are sold, implemented, and serviced create an environment in which firms find their software system has become a major impediment when changes are considered in core functions[3].

In contrast, successful firms are not those in which most or all activities of the firm are dictated by the human resource department, planning department, accounting department, legal department or IT department. History has demonstrated that firms that have allowed staff or auxiliary functions to dictate consistently to line have suffered[4]. For instance, planning departments often accrue decision-making authority to the point of dominating the strategic future of the firm. One classic case is General Motors (GM) in the late 1970s when its complex planning process led to serious delays in new product development and higher unit costs than its competitors, putting the company at a disadvantage in the market. The planning process was so intrusive throughout the firm that to produce the Saturn, GM had to circumvent the planning department's authority and create a new stand-alone division (Miles and Snow, 1994). Another example is IBM after the six-year antitrust suit brought against the company by the Justice Department in the 1970s. Following from that, the legal department became such a driving force that no decisions – product development or otherwise – were made without the company attorney's approval (Carroll, 1993). IBM was brought to a virtual standstill, missing important innovations and product improvements.

To examine the hidden costs of ERP and the threat to decision flexibility, we present a brief review of ERP software systems, and we then provide details on how ERP systems impede change and innovation in a firm. We provide a summary of our argument in the conclusion.

## The history and impact of ERP systems

ERP software systems have mixed performance results. Early on, the failure rate (i.e. not fully implemented after 36 months) was estimated to be 70 per cent (Gillooly, 1998). Headline failures include Hershey Foods Corporation, Whirlpool, Gore-Tex (Calogero, 2000), and to a lesser extent Dow Chemical, Boeing, Dell Computer, Apple Computer, and Waste Management (Osterland, 2000). Nonetheless, corporations, government organizations, and universities have continued to implement ERP systems (Donovan, 2001), although there are notable exceptions, such as Wal-Mart and Microsoft, in which firms have utilized internally generated systems (Iansiti, 2003). Some firms also have added a second software package to maintain a legacy system using the data collected by their ERP system.

In addition to the lack of meeting deadlines for implementation, ERP systems often came in over cost and were accompanied by serious turmoil and disruption in the firm. The disappointing lack of performance and outright failures were routinely blamed on the host firm rather than attributed to software failure or limitations. Examples of host firm failures include a failure to train employees properly, a failure to maintain

accurate data records, and a reluctance to change the host firm's "bad business practices". In keeping with the concept of bending the firm's core business procedures and process to fit ERP software, bad business practices were defined as business practices that do not conform to the software rather than practices that are inefficient or ineffective (Southwell, 2003; Turbit, 2003). Occasionally, there is an admission that the firm was a mismatch with the software – a situation that indirectly implicates the software vendor as either uninformed about its own software or knowingly selling a product that would not meet expectations (Osterland, 2000). Seldom are the implementation failures attributed to the deficiencies of the software or the underlying strategy of bending the firm to fit the software.

*The illusion of cost reduction*

A selling point for ERP systems is that they would lower long-run costs. In the short run, costs were expected to be high due to implementation and training. The future cost savings were expected to result from less on-site software development, plus the efficiencies created in other areas such as production, sales, inventory, and accounting. ERP vendors suggested that the firm could reduce the amount and quality of in-house staff currently involved in development and maintenance of software. Vendors presented a plausible argument that development and maintenance of software was not the purchaser's core competency and it would be more efficient and effective to buy the expertise. Upper level management may have found this argument persuasive based on their past experiences. IT staffs often were considered expensive, technically focused, and less amenable to compromise than other staff. Moreover, they often brought truth in the form of bad news to management using terms and concepts that were only vaguely familiar to others.

Into this environment arrived a sales staff of a major software provider. They seldom brought bad news about what cannot be done; instead, they intimated that adopting their software would fix all of the MIS problems including many heretofore unknown to management. The sales pitch was presented by people selected for their communication skills who revealed, along with other pleasant news, that adoption of the software package would reduce the need for in-house IT personnel. The crest of the ERP adoption wave was also driven by the much over-hyped year 2000 fears, with the consequent apparent need to make a major investment under a hard deadline. Given this scenario, it is easy to see how attractive it was for firm executives to decide to purchase the ERP system, which promised to make them more efficient and reduce their dependence on in-house staff.

The issues presented supporting the purchase of ERP packages were persuasive, and future problems associated with making changes in processes over time were not made clear. Also unanticipated were implementation costs[5]. Because the ERP vendor would have incentives not to raise these issues, it would have had to come from inside the firm. As discussed later, the level at which decisions were made and the contentious relationship with IT staff reduced the possibility of these objections being heard or heeded.

*How software became a decision maker*

Major corporations did not consciously set out to elevate computer software to a position in which it would dominate decision-making across the firm. Firms discovered the extent to which software dictated decisions in an incremental fashion on a decision-by-decision basis. In retrospect, firm executives operated on insufficient information

and background knowledge at the time the implementation decision was made. At least three factors contributed to this lack of information and knowledge.

One factor was the speed with which the computer/software changes occurred. The rapid advancement in speed of machines and the complexity of software required decisions makers, whose expertise was in other areas, to make more and more decisions about acquiring and managing IT processes. The IT world changed much faster than the learning curve of most organizations.

A second factor was the composition of IT staff and their level of prominence in the decision-making process. By the very nature of the functions IT staff perform, IT employees differ in background and culture from the more traditional management groups in large firms. Thus, clashes occurred between the traditional corporate culture and the less conforming culture of narrowly focused IT technicians. Often, computer/software activities were outsourced to reduce the costs of what were perceived to be expensive employees and activities. As a result of outsourcing, the core group with computer and software expertise within the firm often were either gone or reduced in stature such that they were a small factor in the decision process (Outsourcing Not a Company Cure-All, 2003).

The third factor was the change in the relative percentage of the firm's one-time resources that were necessary to purchase an ERP system. Because ERP systems were comprehensive, a very large investment was made at time zero instead of being spread over time. The outlay was much more visible than smaller incremental costs previously made, and the larger investment cost led to the decision being made at a higher managerial level than before. In most cases, there was less expertise at the chief executive officer level. A situation developed in which the cost was high, expertise was limited, future costs were uncertain, and ERP sales personnel promised large savings. Corporate-level decision makers paid less attention to the contents of the software product and relied more on information provided by software vendors[6].

Because purchasing an MIS system is time-consuming and difficult, it is reasonable that CEOs (or managers) attempt to economize on the decision process. However, the decision could have future negative implications if the decision turns out badly. Both the risk of being wrong and the burden of evaluating reams of information make it attractive for decision makers to find short cuts in the process. One of those short cuts is to monitor the actions of other firms in the field and adopt or mimic their practices (DiMaggio and Powell, 1983; Schrage, 2002). Similar to a bandwagon effect, managers mimic practices that are implemented by a large number of firms in the field, thereby, taking for granted legitimacy or efficiency of the behavior without further evaluation (Haunschild and Miner, 1997). Moreover, managers imitate actions of larger or more nationally known firms in the field mistaking public visibility as legitimacy of the practice (Kostova and Roth, 2002). Specific to this paper, if a large successful company adopts a particular ERP software system, this legitimizes the practice and serves as a signal to decision makers in other firms, which in turn, mitigates their risk exposure. In the event of a bad outcome, management decisions are less likely to be criticized if other major firms in the field have also implemented the ERP system.

CEOs also face agency problems that may not be evident during the decision-making process. One agency problem is the result of a conflict between the goals of ERP users and the goals of ERP providers. The goal of ERP users is to continue using existing versions of software if they serve their purpose and have few "bugs". ERP users also wish to continue to use any modifications to the system that are of importance to the firm (i.e. the firm does not want to bear the cost of reinventing

modifications). Conversely, because ERP companies have specialized in developing proprietary software code, their revenue is enhanced by creating and selling new software in predetermined intervals of short duration. Revenues are further enhanced if older versions of the software can be made obsolete by no longer providing service or advice on old software.

A second agency problem occurred because software providers severed the connection between software development and sales from the service and training segment of the process. Sales were handled directly by the software provider, and installation, maintenance, and fix-ups (changes to the software) were handled by consultants who were independent operators recommended by the software provider. This separation of sales from installation and maintenance insulated the software provider from the client with deleterious results. First, information feedback from the client about problems with the software was not presented to the software developer or, at best, was filtered. Second, the separation created an incentive for the software developer that was not in the client's best interest. This incentive was to create new and different software (called upgrades) that generated sales with secondary regard to the needs and interest of the customer. Although the customer was free not to purchase an upgrade, software developers usually reduced support to older versions. Thus, the software firm benefited most from selling and altering the software often and from making it difficult for the customer to retain and maintain the existing software. Consultants benefited from the complexities of the software, modifying the software, and training employees. Large training costs, lost productivity from time away from job, and a decline in overall employee morale were not evident in the beginning.

The upshot was that software clients became entrapped due to the large initial outlays and the ballooning consulting costs. For most firms, implementation was longer than anticipated, and productivity declined during this phase. Because ERP software did not integrate easily with other software and was not accommodating to changes in data entry or retrieval, the firm became a captive of the software provider. ERP software systems went from being an anticipated cost-saving or revenue-enhancing undertaking to a NPV abandonment exercise to determine if the firm could escape.

## How ERP systems impede change and innovation

Sources of conflict between the goals and objectives of core business functions and ERP software occur when information is inputted into the IT system, when information is processed, and when information output is retrieved from the system. Most core functions provide information used elsewhere in the firm and utilize information inputted elsewhere in the firm. ERP software constrains each core function because the software prescribes precisely what data can be inputted and the format by which that data can be entered or retrieved. As noted earlier, deviation from the prescribed process may require costly programming that must be recreated when a new software version is developed. The constraint on entering and retrieving data forces the user to enter and process information in a "straight-jacketed" manner that is referred to as "best business practices". There is no accommodation for how the firm previously collected and inputted information, or how they may wish to do so in the future. Correspondingly, information output is likewise restricted.

An original selling point of ERP software packages was that they conformed to the "best practices" criteria, which would cut costs and increase efficiency. This premise was based on the notion that a standard exists that transcends across businesses and

firms without regard to how they are organized or what products or services they provide. If these specific practices are not currently in place in the firm, processes and employees have to go through major changes that are not limited to the usual IT functions. At a minimum, the firm would have to change how it collected, processed, reported, and structured information. These changes were undertaken without sufficient evaluation of the negative impact on many aspects of the firm. Some of these impacts surfaced quickly, particularly those that affected customers or suppliers. Other impacts, such as the toll on the human capital assets of the firm, were less obvious and appeared with a lag[7].

From a financial perspective, ERP software made less likely the innovations and changes that would increase efficiency and lower costs. Because innovation and lower costs routinely are the result of changes in processes (i.e. how the business is run), prospective changes seldom are localized. Thus, changes affected the rest of the firm via the ERP software. Changes in a functional area that required changes in data input or data output were not possible or were possible only after costly changes were made to the software program. Consequently, the ability to make those marginal changes throughout a firm became limited. Particularly limited were small changes that taken alone were not large enough to cover the costs of software change. However, the sum of many small improvements over a period would have a significant effect on the bottom line of the firm.

*How ERP software affected decision-making*

ERP software restricted how data were entered and outputted for each function in the firm, and once adopted, each core function of the firm had to conform its IT interaction to that of other core functions of the firm. Conforming may have brought more efficiency and lower costs, but it also meant that the firm could not make marginal adjustments to its processes that involved IT interaction without incurring additional costs. Also, core functions that interfaced with stakeholders outside of the firm became more difficult and costly than they had been previously. Brown and Hagel (2003) succinctly describe the dilemma facing firms with ERP systems.

> Introducing a new product or service, adding a new channel partner, or targeting a new customer segment – any of these can present unseen costs, complexities, and delays in a business that runs enterprise applications. The expense and difficulty can be so great that some companies abandon new business initiatives rather than attempt one more change to their enterprise applications. Far from promoting aggressive near-term business initiatives, enterprise architectures stand in their way.

Several examples of how the rigidity of ERP software can affect decision-making in various functions are presented in the following discussion. The examples are for expository purposes and do not cover the compete spectrum of functional areas affected. These examples demonstrate the conflict between making innovative changes and the inflexibility of ERP software in handling problems in areas of sales, finance and accounting, inventory, human resources, and production scheduling.

*Conflict with sales.* Consider that one or more customers have approached a major supplier about providing an interface so that customers can place their orders electronically and be billed in the same manner. Customers indicate that their order level would increase if they could use this method to purchase routine items, and research shows that this capability would attract additional customers. Customers vary in the types of software used and their level of sophistication, so the interface would need to be sufficiently general to accommodate several different customers. The

supplier firm finds that the ERP software has a rigid and complex interface for orders and billing that cannot accommodate this change without significant modification[8]. Consultants recommended by the ERP provider say they can develop some additional software that will accommodate this request, but the price tag for the software change exceeds the expected increase in profits from the increased sales. In addition, the consultants tell the firm that when the new upgrade comes out in 18 months they will have to repeat the process to make the additional software compatible with the new and improved ERP software. Given the cost, the NPV of the project often is negative and the project is rejected.

*Report generation problems.* An important component for strategic change in any organization is the need for information in the form of reports and statements that are produced routinely in an acceptable format. However, information often is needed and sought that is not part of the routine reporting mechanism of the ERP software – information that may well have been an integral part of the internally developed systems replaced by the ERP system. For instance, troubleshooting when unusual problems occur, special attention required for new products, formulating strategic change, and marketing research for future products all require information. This essential information previously was made available using the pre-ERP "home-grown" firm-specific software. If this information does not fall into the category of best business practices dictated by the ERP system, costly and temporary modifications would have to be made[9]. The requests for unique or unusual information cannot be accommodated without incurring significant additional costs.

*Issues with human resources.* Assume that a new union contract includes various wage payment options or deductions that are not standard in the ERP software. The ERP software will have to be adapted to accept these changes by consultants at substantial cost. Because the options are not standard, the consultants will be required to make adaptations each time the software is upgraded. The cost of the initial change and future changes should be considered as costs of the new agreement. However, it would be more likely that these costs were not even considered during negotiations.

*Accounting/finance conflict.* Customers are promised a $25 gift certificate to fill out a survey and 1,000 customers are surveyed. The sales group submits a list of customer names receiving the certificates to accounting as one transaction. The sales group assumes that the simplest way to handle the financial transaction is to batch process rather than submitting 1,000 individual transactions. However, the ERP software requires each certificate to be entered separately by customer name. The sales group will have to bear the cost of submitting 1,000 separate requests, and accounting will bear the cost of processing each of these requests.

*Inventory problems.* For many companies, inventory levels are kept to a minimum by forecasting anticipated inventory needs and maintaining only a small level of backup inventory, thereby, reducing the firm's capital investment in inventory. Imperative in keeping a low level of inventory are accurate records plus quick and accurate communication within the company and with suppliers. The problems encountered with rigid ERP software can make it more difficult to maintain low levels of inventory, particularly if it depends on communication among many departments and many outside suppliers.

In each of the preceding cases, the opportunity cost of utilizing an ERP application compared to an alternative application was evident after implementation rather than in the planning stages. This cost is ex post the ERP purchase decision and only shows up as each innovation is evaluated. Real implementation costs were greatly

underestimated because the lack of information led CEOs to ignore the opportunity costs of ERP systems, which, in turn, led to a reduction of future innovation and changes. It would be difficult to calculate the reduction in productivity and economic growth that have occurred over the aggregate of firms adopting ERP systems. However, the more important question for firms is how long do they want to continue with ERP systems and lose opportunities to innovate and change? Also, how will the firm modify their interaction with ERP systems so as to reduce the barrier to innovation?

As noted earlier, ERP systems violate the principle of separation of line and staff functions. In addition, ERP systems conflict with the principles of the theory of the firm. Coase's (1937) seminal article on the theory of the firm specifies that a firm is an organization that combines resources and activities to produce output at a cost lower than that provided by the market. Conversely, a firm will avoid producing within the firm those components that can be purchased at a price lower than the firm's internal cost. Such an arrangement is not a static condition; rather, firms change and evolve to take advantage of each situation that renders an internal cost lower than the corresponding market price. An example in which firms find it cheaper to purchase inputs instead of producing them internally would be automobile producers who purchase vehicle tires rather than producing their own. Another example is when large (over the road) truck manufacturers purchase truck engines from Cummins or Caterpillar rather than producing their own.

Many factors contribute to situations in which firms change processes because internal costs exceed market prices. One example is a change in technology that lowers costs internally and the firm reduces it dependence on buying an input in the market and produces it internally. The converse would be a situation in which increasing labor costs or lower priced inputs from foreign markets create an incentive for the firm to purchase the input. In other cases, inefficient management or bad decision-making could lead to inefficiencies or create barriers to change. ERP software implementation falls into the later category rather than the former. As note earlier, however, the "bad decision" became apparent only after the implementation of the software. The rigidity of the software impeded the ability of the firm to make many of the marginal changes that would allow it to continue to have internal costs that are lower than market prices. It should be noted that it is not that market prices decreased, but that internal costs increased.

## Conclusions

In this paper, we have argued that the adoption of ERP systems, as they have been configured, has created major distortions in the corporate decision-making process by raising the cost of making value-enhancing decisions and negatively influencing the overall capital-budgeting process. ERP systems have led to a rejection of many cost-saving or efficiency-enhancing projects that otherwise would have been adopted. Because ERP systems are structured such that the firm must bend its core business procedures and process to conform to the ERP software, ERP system requirements take precedent over all other firm activities. This dominance of software over the decision process leads to suboptimal strategic outcomes and is neither profit maximizing nor firm value enhancing.

ERP systems were expected to lower long-run costs, although in the short run, costs were expected to be high due to implementation and training. Many firms were successful in lowering costs and improving the bottom line because the software was

implemented efficiently and the system "fit" the firm. However, even these successful firms are not immune from the problems of inflexible and rigid software if the software does not fit the future firm. Innovation and lower costs routinely are the result of changes in processes (i.e. how the business is run), and these changes often affect other parts of the firm through the ERP software.

To accomplish the high level of integration of data across functions, ERP software dictates that the firm must change its core business procedures and processes to fit the software. Consequently, the ancillary IT function becomes dictating rather than facilitating. From a finance perspective, ERP software raises the cost of capital budgeting. Although many large projects have cash flows sufficiently large enough to have a positive NPV, many of the cost-savings and efficiency-enhancing activities in firms are from numerous small marginal changes in processes. Over time, the compounding of the absence of these marginal changes will leave the firm less competitive.

ERP systems have provided positive benefits despite their lack of flexibility. Thus, it is unlikely that ERP systems will be abandoned. The challenge will be to retain the benefits of ERP systems while providing flexibility to accommodate changes at low cost. To some degree, the sheer weight of increases in computing power lowers the cost of incremental changes. Lower computing costs together with the increased power and flexibility of the tools available to IT will make it possible in the future for firms to develop solutions that are not cost effective today. For instance developing a "practical" solution to the gift certificate example described previously may have required the services of multiple highly skilled engineers to deliver a solution that works on the current platform using the available tools. On faster systems a solution using less compute-efficient programming methods may be practical. New tools and platforms abstract and hide much of the complexity, thus enabling greater productivity and requiring less technical skill from IT staff. Lower computing costs mean that it is not as necessary to be concerned about computational efficiency but rather with increased IT productivity. This trend lowers the cost of incremental process improvement.

Another effect of the exponential decline in the price of processing speed and storage capacity is the rise of the data warehouse. The highly tuned databases that underlie ERP systems are designed to facilitate transactions, not reporting. Much of the data that flows through the system is aged out and discarded or is otherwise inaccessible because of the adverse impact that retrieving it can have on system operations. Consequently, much of the information the firm painstakingly enters into the system is not readily available for analysis. As costs have plummeted, it has become possible to build huge databases using the historical data from the ERP systems. The data warehouses are built to support business analytics, the detailed and highly segmented analysis of the firm's past performance. Yet these information stores also make it possible to perform troubleshooting, strategic change planning, and marketing research for future products-functions that ERP systems may not have performed as well as the systems they replaced.

One trend that is causing excitement in IT is systems architectures based on services – specifically, Web services based on open standards such as the HTTP protocol, XML, and SOAP. This architecture is more open and flexible than the current architecture that underlies the ERP systems. In today's environment, if a firm wants to make a connection between an external partner and its internal ERP system, the connection is a custom, one-of-a-kind connection. Each connection is specifically coded for its purpose. Any change to a system requires all of the different connections to be

reworked. Under the services architecture, connections are "published" as loosely coupled transactions with defined interfaces. The promise of this architecture is that as long as the user conforms to the published interface, changes to the underlying system can be made that are transparent to the consumer of the service. Upgrades can be made without reworking all of the connections. If ERP vendors migrate their products toward this architecture, the barrier to innovation is reduced.

The services architecture is not a panacea. The underlying protocols and standards leave much room for variation. Companies and vendors must agree on vocabularies, security, and authentication. Not all changes are transparent, but the underlying protocols and standards make it much easier to manage changes. There is also a question of whether ERP vendors will truly support the open standards. Still, this model shows significant promise for increasing flexibility and driving down the cost of change for the firm.

If technology can overcome some of the impediments inherent in ERP systems, the internal cost of change will decrease and there will be greater compatibility between the goals of the firm and their software systems. The higher capital budgeting costs imposed by the system will decline. However, technology will not correct the agency problems now inherent in ERP software systems (i.e. the incentive to create proprietary software that is upgraded, often creating planned obsolesce of previous versions). History shows that market forces work to reduce or eliminate sources of monopoly power. If so, then markets likely will reward ERP software firms that can incorporate the flexibility necessary to accommodate their clients' needs. Cost-reducing technology also may encourage firms to return to greater emphasis on in-house development of systems. Even if in-house systems are more expensive, they may have greater value to the firm if they facilitate the ability to change – the hallmark of successful firms.

**Notes**

1. The phrase capital budgeting as used in this paper covers any decision that affects potential cash flows, whether large or small.
2. Some of the major vendors of ERP software systems are J.D. Edwards, Oracle, PeopleSoft, SAP AG, and Baan. More recently, there has been mergers and consolidation of software firms resulting in fewer, but larger, providers.
3. "This inflexibility is endemic today. Big suites of enterprise-wide applications like those in ERP suites, designed to integrate disparate corporate information systems, dominate client-server architectures. Unfortunately, the one-time, "big-bang" and tightly defined way in which these applications have been implemented, as well as their massive bodies of difficult-to-modify code, mean the enterprise applications integrate business only by limiting the freedom of executives" (Brown and Hagel, 2003).
4. We recognize that ancillary functions by their nature often constrain core activities. Examples are GAP constraints imposed by the accounting function, lawful practices required by the legal department, or risk constraints imposed by the risk management function. However, the aforementioned ancillary functions are general in nature and advisory rather than controlling. In contrast, ERP systems are much more invasive into the processes of the firm. ERP systems touch almost all areas of the firm and most of the employees directly or indirectly. Indeed, ERP systems are designed to encompass the total firm.
5. "Costs associated with ERP implementation are extensive and often unanticipated. Most companies fail to identify the true cost of ownership because they do not include many of associated costs from hardware and software upgrades, inefficiencies moving to the new application, and other hidden costs" (Best Software Inc., 2003).

6. In contrast, Ross and Weill (2002, 2003) suggest that more IT decisions should be made by top management.
7. Although out of the scope of this paper, two examples of the impact of ERP systems on human capital are serious morale issues and the alibi syndrome in which employees can avoid legitimate changes (i.e. work) by claiming that the software will not allow it.
8. Electronic data interchange interfaces to ERP systems are notoriously complex, and interfaces usually were implemented only for the firm's largest customers because of the cost.
9. For an example in which historical records became an issue see "Briggs and Stratton: Harnessing the power of its ERP systems" (SAS Institute, Inc., 2002). After installing SAP in 1988, they lost a portion of their reporting layer that gave managers data in the specific form they needed to manage their areas. To continue utilizing these reports, they had to set up a second system using SAS that took the information from SAP and created a separate reporting system.

## References

Best Software Inc. (2003), "Industry trend: from tier one to mid-market solutions", available at: www.bestsoftware.com/vertical/manufacturing/industry_trend.cfm (accessed 21 January 2005).

Brown, J.S. and Hagel, J. III (2003), "Flexible IT, better strategy", *The McKinsey Quarterly*, Vol. 4, available at: www.mckinseyquarterly.com/article_abstract.aspx?ar=1346&L2=13&L3=13 (accessed 21 January 2005).

Calogero, B. (2000), "Who is to blame for ERP failures?", *Server World*, June, available at: www.serverworldmagazine.com/sunserver/2000/06/erp_fail.shtml (accessed 21 January 2005).

Carroll, P. (1993), *Big Blue: The Unmaking of IBM*, Crown Publishing, New York, NY.

Coase, R.H. (1937), "The nature of the firm", *Economica, New Series*, Vol. 4 No. 16, pp. 386-405.

DiMaggio, P.J. and Powell, W.W. (1983), "The iron cage revisited: institutional isomorphism and collective rationality in organizational fields", *American Sociology Review*, Vol. 48, pp. 147-60.

Donovan, R.M. (2001), "No magic cure will fix all ERP ills", *Advanced Manufacturing Magazine*, available at: www.advancedmanufacturing.com/January01/implementing.htm (accessed 21 January 2005).

Gillooly, C. (1998), "Enterprise management disillusionment", *Information Week*, 16 February, available at: www.informationweek.com/669/69iudis.htm (accessed 21 January 2005).

Haunschild, P.R. and Miner, A.S. (1997), "Modes of interorganizational imitation: the effect of outcome salience and uncertainty", *Administrative Science Quarterly*, Vol. 42, pp. 472-500.

Iansiti, M. (2003), "Integration: the right way, the wrong way", *CIO Magazine*, 15 March, available at: www.cio.com/archive/051503/integration.html (accessed 21 January 2005).

Johnston, S.J. and Cotteleer, M.J. (2002), "ERP: payoffs and pitfalls", *HBS Working Knowledge*, 14 October, available at: hbsworkingknowledge.hbs.edu/item.jhtml?id=3141&t=strategy (accessed 21 January 2005)

Kanter, R.M., Stein, B.A. and Jick, T.D. (1992), *The Challenge of Organizational Change*, The Free Press, New York, NY.

Kerstetter, J. (2003), "Commentary: business software needs a revolution", *Business Week Online*, 23 June, available at: www.businessweek.com/magazine/content/03_25/b3838630.htm (accessed 21 January 2005).

Kostova, T. and Roth, K. (2002), "Adoption of an organizational practice by subsidiaries of multinational corporations: institutional and relational effects", *Academy of Management Journal*, Vol. 45 No. 1, pp. 215-33.

Miles, R.E. and Snow, C.C. (1994), *Fit, Failure, and the Hall of Fame*, The Free Press, New York, NY.

Nadler, D.A. and Tushman, M.L. (1997), *Competing by Design: The Power of Organizational Architecture*, Oxford University Press, New York, NY.

Osterland, A. (2000), "Blaming ERP", *CFO Magazine*, 1 January, available at: www.cfo.com/article.cfm/2987370 (accessed 21 January 2005).

Outsourcing Not a Company Cure-All (2003), *Business Day*, 20 October, available at: www.bday.co.za/bday/content/direct/1,3523,1461499-6078-0,00.html (accessed 21 January 2005).

SAS Institute, Inc. (2002), "Briggs and stratton: harnessing the power of its ERP systems", available at: www.sas.com/offices/europe/austria/html/download/success/briggs_stratton.pdf (accessed 21 January 2005).

Schrage, M. (2002), "Mimetic management", *Technology Review*, Vol. 105 No. 5, p. 20.

Southwell, M. (2003), "Poor project planning leads to ERP failure", *Arabic Computer News*, July, available at: www.itp.net/features/details.php?id=930&tbl=itp_features (accessed 24 January 2005).

Turbit, N. (2003), "ERP implementation: the trials and tribulations", *World Trade*, Vol. 16 No. 7, p. 39.

Tushman, M.L., Newman, W.H. and Romanelli, E. (1997), "Convergence and upheaval: managing the unsteady pace of organizational evolution", in Tushman, M.L. and Anderson, P. (Eds), *Managing Strategic Innovation and Change*, Oxford University Press, New York, NY, pp. 583-94.

Tushman, M.L. and Romanelli, E. (1985), "Organizational evolution: a metamorphosis model of convergence and reorientation", in Staw, B.M. and Cummings, L.L. (Eds), *Research in Organizational Behavior*, JAI Press, Greenwich, CT, pp. 171-222.

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