ERP as a Strategic Management Tool: Six Evolutionary Stages

Over the past 50 years computers have evolved from vacuum tubes to integrated circuits to PCs. As hardware changed so did managerial computing, from MIS to ERP. Outsourcers developed niche markets and the promise of seamless processing for strategic decision-making seemed possible. Here the history, progress to date, and unmet challenges are explored.

Developments in information technology (IT) in the last decade have made it possible for companies to implement ERP systems that not only improve basic transaction processing and streamline business processes, but also provide a wealth of new information for management decision-making. Here we review these developments in the context of the 50-year history of “managerial computing.” We propose a six-stage framework to classify how the implementation of ERP systems will affect “strategic management.” This stages hypothesis provides managers with criteria to assess the level of development of ERP in their firm and to assess the benefits achieved in terms of creating sustainable competitive advantage and enhancing shareholder value. We argue that only in stage six is ERP really a comprehensive management tool.

IT and Management Decision: 1950 to 2000

In each decade since computers replaced bookkeeping machines in the 1950s, the technology supporting business data processing has made tremendous progress. Since 1960, computers have evolved from vacuum tubes, to transistors, to integrated circuits, to “minis,” to PCs, and to client/server networks. The beat goes on today with Web-enhanced intranets and extranets. In each decade the claim has been made that, finally, business computing has evolved from just faster and more accurate record keeping into a senior management tool.

In each decade, however, that claim was largely hollow. Consider, in hindsight, the lack of substantial strategic management use in each decade: management information systems (MIS) in the 1950s; decision support systems (DSS) in the 1960s; computer-based information systems (CBIS) in the 1970s; and executive information systems (EIS) in the 1980s. The net result has almost always been lots more money spent on IT and much more powerful transaction processing capability, but not much “executive management” use of all the accumulated “information.”

In the 1990s, much was written arguing that, finally, things were different. The creation of comprehensive, new computing architecture that would simultaneously solve Y2K, legacy systems, and European Monetary Union problems, while creating real strategic management support certainly seemed plausible for the 1990s. Enhancing the credibility of the promise was the emergence of the “supersoftware” firms that offered products not just for individual applications, but also for firm-wide information systems.

Software companies, such as Baan, JD Edwards, Oracle, PeopleSoft, and SAP, became well known for their integrated, enterprise-wide software systems. Further enabling this new wave promise for business computing was the growing prominence in ERP implementation support of many world-class consulting firms, such as Accenture (formerly known as Andersen Consulting), Deloitte and Touche, Electronic Data Systems, Ernst & Young, KPMG, and PricewaterhouseCoopers – the so-called “systems integrators.” IBM and Hewlett-Packard also offered consulting services in this arena.

New hardware, new software, new operating systems, and new consulting support were all focused in the 1990s on the challenge of computer-enabled strategic management support.

From Data Processing to Value Creating Activities

Continuing challenges from Internet-based business processes, increasing global economic integration, increasing demand for supply chain integration, and reconfiguration still confront managers today. In response, IT has advanced dramatically so that managers now have innovative customer support systems (CRM), vendor support systems, and online
analytic processing systems (OLAP) to produce business decisions that create enhanced value for customers, suppliers, and shareholders.

Value creation can be viewed narrowly as improvements in major internal processes or functions of the enterprise, such as research, production, procurement, finance, sales, or human resource management. Value creation can also be viewed broadly as improvements in the entire chain of value creating activities of which the enterprise is one part. The former is often referred to as the internal value chain. The latter view is much broader because it goes beyond internal value creating activities to also link the single enterprise with its suppliers, business partners, and customers. That is, it encompasses enterprises and individuals outside the traditional boundaries of the enterprise. Thus, the fundamental business functions of sales, production, procurement, accounting, and human resource management must be integrated with external data (customers, suppliers, markets) so that managers have accurate, timely information for operational and strategic decision-making.

Since the slackening of the ERP wave around 1999, major software vendors have started to concentrate either on such topics as supply-chain management (Ariba and CommerceOne), customer relationship management (Broadvision, Saratoga Systems, and Siebel Systems), or expense management systems (Concur and Captura). These applications were missing from major ERP vendor packages in the 1990s. In response, the ERP software vendors are now working to integrate comparable new applications into their ERP packages.

**Six Stages in the Evolution of ERP**

Based on a review of the published literature, discussions with software vendors and systems integration consultants, and interviews with business executives regarding their ERP experiences, we identified six relatively distinct stages in the development of ERP systems in American companies. These stages are certainly not discrete or independent and are not necessarily sequential. But, they can be used to assess the progression of an enterprise as it moves from gaining the basic benefits of 1990s computing technology to the realization of strategic benefits. Is the ERP helping to achieve competitive advantage in what is rapidly becoming the cyber-marketplace? The concept of a stages hypothesis for understanding data processing evolution was first introduced by Cyrus Gibson and Richard Nolan 30 years ago. This text here is a summary of the six stages, each framed to reflect “yes” answers to a generally progressive series of questions:

- **Stage 1:** Has each of your basic transaction processing systems been comprehensively updated to eliminate legacy problems and to achieve transnational capability, in the context of a defined information architecture?
- **Stage 2:** Have you linked your transactions processing systems (interconnectivity), both within each basic process category (vendor processes, customer processes, employee processes, and accounting processes) and across the four categories?
- **Stage 3:** Have you achieved linked transaction processing functionality along the supply chain of firms of which you are a part?
- **Stage 4:** Have you created a comprehensive data warehouse (DW) to hold all the data from Stages 2 and 3 above?
- **Stage 5:** Does your DW also include critical business information beyond transaction data and is it equipped with user-friendly, drill-down, and synthesis capabilities?
- **Stage 6:** Is your DW being used to facilitate strategic management?

**Stage 1: Applying New ERP Technology Basic Transaction Processing Systems**

Every company's business day is filled with events that produce business transactions that can be categorized as involving customers, vendors, and/or employees. In addition, there are accounting processes that collect, summarize, and report business transactions.

Customer processes include billing systems, accounts receivable systems, and cash application systems. Vendor processes include procurement systems, accounts payable systems, and cash disbursements. Employee processes include payroll systems, travel and entertainment reimbursement systems, benefits administration systems, and other human resource management systems. Accounting processes include the monthly closing and the generation of all financial and managerial accounting reports.

**First Stage Examples**

One of the primary purposes of ERP systems is to facilitate gathering, storing, and retrieving information from basic transactions in each of these four categories. At a minimum, all ERP implementations should achieve this level of results. It is not difficult to find many examples of firms that have gone at least this far.

Owens-Corning Fiberglass (OCF) was one of the earliest companies to recognize the need in the 1990s for new IT and reengineering of basic business processes. In the first phase starting in 1993, it simplified and centralized its transaction processing for payables, travel and entertainment, payroll, and financial accounting. This resulted in a reduction of $165 million in working capital, a reduction in the monthly closing cycle from 18 to four days, and a reduction of the annual budget process from four to two months. The second phase of implementing new technology involved using SAP's ERP software to replace more than 200 legacy systems. At the time, OCF projected completion in early 1997 with annual savings of $43 million. The SAP system that cost $75 million was finally successfully implemented in 1999.

Added capabilities include a new global procurement process, finished goods tracking through warehouses and distribution channels, and a reduction of spare parts inventory.

Gillette linked five business units that had operated as a cluster of independent companies with different fiscal year ends. Previously, razor blades and toothbrushes were delivered to the same customer in different trucks using different invoices. Using SAP software, Gillette standardized much of its business transaction processing and consolidated its products into two divisions—one for batteries, shampoos, and razors; the other for toothbrushes, coffee makers, and stationery. The ERP implementation also resulted in a restructuring of operations in which Gillette cut back 11 percent of its 43,000 employees and closed 14 factories, 12 warehouses, and 30 offices, for a total annual savings of $200 million.

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Stage 2: Have You Linked All Your Transaction Processing Systems (Interconnectivity)?

Communication Between and Among Business Processes
In the second stage of ERP implementation, the various transaction processing systems are linked together so that interconnectivity among the systems is possible. Interconnectivity means that the data from one system is accurately communicated to another. Thus, for example, the customer order provides input to the procurement process; the payroll system generates data for the general ledger; the billing process is connected to the accounts receivable process; the accounts payable process is linked to the procurement process; and the travel and entertainment (T&E) process is linked to payroll disbursements.

Second Stage Examples
Elf Atochem, NA viewed ERP in strategic and organizational terms and stressed the “enterprise.” It focused on the four key transaction processes that it felt had greatest impact for its customer – materials management, production planning, order management, and financial reporting. A 60-member ERP team representing all business functions selected SAP modules that integrated transactions across its four key areas and across its 12 business units. The ERP system made it possible to consolidate all customer orders into one invoice. Customer-service units were combined into a single unit with one point of contact. At ERP completion, only one competitor had such extensive customer service capability, which gave Elf Atochem a significant competitive edge.

Bay Networks (acquired by Nortel Networks) went through a nine-month implementation of SAP’s general ledger, distribution, and manufacturing modules. The firm resisted customization of software or including optional features, arguing that the objective should always be to aim high enough to make a difference, but not so high that the target will be missed. The firm focused on three principles: scope management, speed, and constant care. “Power users” were identified for ongoing training and information system liaison. The company reported that it realized a $20 million return on investment from the ERP improvements, including better inventory turns and on-time delivery.

Not all ERP implementations are smooth. Westinghouse Electric began using SAP’s ERP general ledger and purchasing segments for six business units in 1994. Numerous problems were experienced due to loss of division autonomy and confusion from attempts at standard reporting structures and common processes. One lesson here is not to ignore corporate culture and change management principles in an ERP project.

Stage 3: Have You Linked Functionality Among Firms Along Your Supply Chain?
Extending ERP Along the Value Chain
The third stage of ERP implementation extends the reach of the software systems beyond the borders of the company to include other firms in the value chain, including customers, business partners, and suppliers. In the first two stages, the ERP system focuses primarily on internal transaction processes. While customers and suppliers generate input data for the company’s various transaction processes, such as orders or payments or invoices, there is no explicit attempt to link the company’s transaction processes with those external to the firm.

Indeed, the original ERP vendors did not initially envision the need to be linked with customer or supplier processes. They designed their initial software around internal transaction processing. This focus on internal integration of back-office processes has proved to be a serious limitation for companies that seek to link with other participants in their value chain. Having invested millions of dollars in otherwise successful ERP projects, companies can wind up unable to communicate and exchange data with customers and suppliers in the new B2B or B2C age.

EDI systems provide a partial solution to this problem, but the value added networks (VANs) through which EDI operates are so costly to create and maintain that they normally are extended only to very large customers and suppliers.

Third Stage Examples
Even with the shortcoming in the original ERP packages, there is evidence that some companies have extended their ERP systems to link with other firms in their value chain.

AlliedSignal’s Turbocharging Systems Division installed ERP software from SAP in 18 different sites across 11 countries with nine languages to improve productivity in logistics and supply chain management. The company took a “Big Bang” approach over a seven-month period to complete the implementation. This involved setting uniform data standards and systems for each country. A 15-member global team eased the implementation by screening customization requests and resolving coordination conflicts. A central database managing customers and suppliers, raised on-time deliveries from 65 percent to 92 percent.

Domino’s Pizza started evaluating ERP systems in 1997. The company wanted an integrated transaction processing system for its 250 products across 24 North American distribution centers comprising 4,500 company-owned and franchised stores. The new system had to be compatible with Domino’s Informix database and use the existing servers at the 24 distribution centers. Management decided on a single vendor approach, selecting PeopleSoft and using its packages for general ledger, financial reporting, order management, inventory and asset management, manufacturing, and production and planning. The company integrated the PeopleSoft software with legacy Manugistics systems for transportation management and legacy Prescient systems for sales forecasting. Cambridge Technology Partners assisted with training, prototyping, and implementation. For a competitive edge, Domino’s management decided to customize the ERP software, rather than modify the company’s business processes to match the software. The ERP system was installed on the corporate headquarters mainframe computer rather than on the distribution center servers. However, desktop computers and the servers were linked to the mainframe. Domino’s approach was to get basic transaction processing functioning first and then undertake business process change.

Stage 4: Have You Put All Transactions Data Into a Data Warehouse?
The premise for Stage 4 is that successfully implemented transaction processing systems alone cannot satisfy all management reporting, decision-making, and analysis requirements. While the transaction processing systems provide a consistent source of accurate, well-defined, and basic data, additional technology is necessary to efficiently store and retrieve the data to meet managers needs. It is not enough to compile only part of the transaction information.
Early Databases - DSS and EIS

In the 1970s and early 1980s, information systems were already attempting to assist managers in making choices for improving operations, planning, and measuring performance. For example, budgeting processes were facilitated using spreadsheet programs, such as Visicalc or Excel. Optimal manufacturing site selection was modeled with mathematical programming. But, such decision support systems (DSS) proved to be difficult for managers to routinely operate unless they were extensively trained. The supporting databases also had to be created as overlays onto basic accounting information.

Later in the 1980s, DSS were followed by executive information systems (EIS), which attempted to standardize the internal information that managers require for decision-making and to supplement it with external data on competition and markets. The objective of these decision-support databases was to make it easier for managers to use the information system. The primary difference between DSS and EIS was that DSS generally focused on specific analytical decisions whereas EIS took a broader view of the domain of management decision needs.

But, EIS databases still were separate overlays to the basic transactions systems that were loaded into PCs. Even with an EIS the analytical capabilities were limited by the structure of the databases. The emergence of relational databases and OLAP tools in the late 1980s, and the development of new software for storing and retrieving data by multiple users, led to the creation of the first real DWS around 1990.

Data Warehouse

The DW became the contemplated centerpiece of information systems architecture. The purpose of the DW is to integrate all of the enterprise’s online transaction data with external data collected from other business systems to provide multiple users with readily available information for inquiries, analysis, and decision-support.

Although ERP software sits atop a relational database system (often Oracle’s), the ERP programs typically did not permit extensive user-friendly applications. Some form of facilitating software was needed.

To prevent user demands from degrading operational computing efficiency, a DW is typically separate from the company’s online transaction processing systems and is designed specifically to support business decisions. Usually placed on a separate server, the DW is read-only. Technical personnel periodically update the content with the designated current transaction data and designated nontransaction information.

Fourth Stage

Because of the significant value gained from combining ERP transaction systems with a DW, planning and design of the DW should take place at the same time as the design of the new transactions systems. There is no necessary reason why the DW could not be created before all internal transaction systems are linked. Connecting the DW to transactions all along the supply chain as well as not a fixed requirement. But, we believe that these developments should precede the DW if it is to be maximally useful.

Stage 4 is best seen as an extension of ERP development beyond Stage 3. There is evidence to suggest that some companies, but not many, have achieved this level of development.

Stage 5: Extending Data Warehouses to Include Nontransaction Information

Placing transaction data in a DW may serve such single objectives as using production data to help manufacturing managers achieve cycle time reductions or more efficient product routings. Of course, the DW may also include nonfinancial data. For example, a retail bank’s DW may include social security numbers, addresses, and phone numbers for all past and present customers. A broader warehouse would also include data on noncustomers, such as contacts or visits, lost customers, lost orders, and share of the market by customer segment or region.

The DW may include information on competitors and suppliers as well as customers. Sources of this external data could include A.C. Nielsen or Dun & Bradstreet databases and any of the numerous sources of benchmark data for business processes.

Opening the Data Warehouse

No matter how rich the contents of the DW, it is only useful if it is widely accessible with user-friendly, drill-down, and analysis capabilities. Sensitive data, such as payroll records, may be password restricted to certain employees. Other areas may be “open access” to all employees through desktop computers or Web browsers. If persons external to the firm, such as suppliers, business partners, or customers, are given access it may be limited to procurement, production, or shipment files using security codes. External access is especially important for building strong supply chain relationships.

Today, DWs can be available worldwide using Internet capabilities. PC-based tools, ranging from relatively simple query software to very powerful multidimensional analysis tools with graphic presentations, access almost all DWs. Online analytical processing (OLAP) is the quick access of shared multidimensional information for performing analyses. Software vendors, such as Hyperion and Cognos and SAS Institute, provide both general purpose and customized OLAP applications for producing whatever specialized reports a particular application may require.

Fifth Stage Examples

Successful examples at this stage include JP Morgan Chase’s warehouse, which was created in 1998 to support a $10 billion credit card portfolio with 22 million records on 15 million accounts. Bethlehem Steel integrated operational data on steel production in a DW that helped identify quality consistency patterns for production of higher quality steel.

KeyCor’s DW, established in 1995, held data on 3.3 million households and 7 million customers by 1999. The company uses IBM’s software for relationship marketing and general ledger. Other software is used to select current and past customers for direct mail marketing. Analytical tools such as Hyperion’s Essbase are used for analysis and reporting. Using the DW capabilities, direct mail response rates increased from an average of one to two percent to a range of five to 10 percent. Also, nine of the bank’s offerings were found to be unprofitable and were removed.

Charles Schwab implemented FinanceNOW, a three-tier client-server system based on an Oracle database using a Microsoft SQL Server to enable all managers to access the DW using Web browsers. First Union used a single large DW to integrate corporate data with acquired companies’ legacy systems and customer databases. Lesco wanted to gain knowledge about market conditions and customers’ wants and needs. Using a minicomputer to host its DW, two Cognos products were selected: Impromptu...
define the strategic importance of the DW

At Stage 6, there are three key questions that define the strategic importance of the DW technology. The first question is who actually is using the DW? Line managers at every level and all staff analysts are potential users. The second question is how do they use the DW? Possible uses would include data mining based on OLAP with algorithms such as multivariate statistical models, neural networks, and decision trees to uncover customer buying patterns or relationships. Some innovative uses of data mining taken from Hyperion’s solutions packages include:

• Using buying patterns to segment customers’ groups.
• Profiling customers for individual relationship management.
• Increasing response rates from individual marketing campaigns.
• Understanding why customers leave for competitors.
• Uncovering factors affecting purchasing patterns.
• Predicting whether a credit card transaction will be fraudulent.
• Anticipating a customer’s future action based on identified characteristics.

The third question concerning the strategic use of the DW technology is what actual decisions have been made differently, and hopefully better, using the DW? These three questions define the extension from tactical to strategic use of the DW.

Sixth Stage Examples
Quantum, a disk drive company, used Oracle’s ERP system to link order management and financial systems for nine global business units. The company outsources all manufacturing but maintains full control over the customer delivery interface. Hewlett-Packard provided the server hardware and ERP systems integration services. Business intelligence software modules were provided by Brio Technologies and Aris Software. In an extremely competitive industry with very thin operating margins, the company’s DW helps managers monitor quality control and on-time deliveries for the company and its suppliers. A “just-in-time” system is used to monitor each supplier’s stage of production and closely match it to incoming customer orders. Also, the DW is used to evaluate the performance of suppliers. Quantum reduced purchase costs by combining orders across the entire company and tracking vendors based on company-wide performance statistics, achieving higher quality and service from all suppliers. ERP transaction data is transferred daily to the DW. Quantum reported more than 600 users in all nine divisions accessing the DW in 1999. Each is trained to design his or her reports.

Farmers Insurance used IBM’s data mining software to examine warehouse data pertaining to sports car owners. The company discovered that a large group of sport car owners are 30 to 50 years old, married, and own two cars. Farmers’ data mining showed that this group does not fit the profile of a high-risk driver. The company adjusted its insurance premium rates to attract these customers. Farmers gained a competitive edge because its competitors had not identified this pattern in their data.

SAS Institute and Hyperion both offer software for acquisitions, mergers, and organizational realignments that is used to visualize a business by different perspectives, such as customer, product line, market sector, geography, or currency.

Forrester Research believes that stage six is conceptually impossible in ERP. Its analysts believe that no matter how successful ERP is in automating the business, it will never be able to optimize it. In their view, ERP-automated business processes are conceptually unable to adapt themselves once they are up and running. Obviously, firms such as Quantum and Farmers Insurance noted above do not accept this limitation.

Conclusion
There is no question that the decade of the 1990s presented major opportunities for companies to create comprehensive, fully interconnected transactions processing systems. These ERP systems permit managers to finally have timely, accurate information for operational and strategic decision-making. The benefits can be profiled as accumulating in six linked stages as illustrated by the real company experiences cited here. Even Stage 1 represents major improvements in business transaction processes over prior information systems. But, we believe the potential benefits from moving on toward Stage 6 are too great not to at least migrate toward them.

Once companies embark on the ERP journey, there is no end destination. It is dangerous to be satisfied at even the sixth stage. The path is constantly changing due to advances in technology, global competitive forces, and new business models that are yet to be defined. The ideas presented here are intended to provide one general management framework for assessing both progress to date and unmet challenges.