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ERP as a Strategic Management Tool: Six Evolutionary Stages

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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 itpossible for companies to implement ERP systems that not only improve basictransaction processing and streamline business processes, but also provide awealth of new information for management decision-making. Here we review thesedevelopments in the context of the 50-year history of managerial computing. We propose a six-stage framework to classify how the implementation of ERP systemswill affect strategic management. This stages hypothesis provides managerswith criteria to assess the level of development of ERP in their firm and toassess the benefits achieved in terms of creating sustainable competitive advantageand enhancing shareholder value. We argue that only in stage six is ERP reallya 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 integratedcircuits, to minis, to PCs, and to client/server networks. The beat goes ontoday with Web-enhanced intranets and extranets. In each decade the claim hasbeen made that, finally, business computing has evolved from just faster andmore 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: managementinformation systems (MIS) in the 1950s; decision

support systems (DSS) in the1960s; computer-based information systems (CBIS) in the 1970s; and executiveinformation systems (EIS) in the 1980s. The net result has almost always beenlots 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 simultaneouslysolve Y2K, legacy systems, and European Monetary Union problems, while creatingreal 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 alsofor 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. Furtherenabling this new wave promise for business computing was the growing prominencein ERP implementation support of many world-class consulting firms, such asAccenture (formerly known as Andersen Consulting), Deloitte and Touche, ElectronicData Systems, Ernst & Young, KPMG, and PricewaterhouseCoopers – the so-called systems integrators. IBM and Hewlett-Packard also offered consulting servicesin this arena.New hardware, new software, new operating systems, and new consulting supportwere all focused in the 1990s on the challenge of computer-enabled strategicmanagement support.

From Data Processing to Value Creating Activities

Continuing challenges from Internet-based business processes, increasing globaleconomic integration, increasing demand for supply chain integration, and reconfigurationstill confront managers today. In response, IT has advanced dramatically sothat managers now have innovative customer support systems (CRM), vendor supportsystems, and online analytic processing systems (OLAP) to produce business decisionsthat create enhanced value for customers, suppliers, and shareholders.Value creation can be viewed narrowly as improvements in major internal processesor functions of the enterprise, such as research, production, procurement, finance,sales, or human resource management. Value creation can also be viewed broadlyas improvements in the entire chain of value creating activities of which theenterprise is one part. The former is often referred to as the internal valuechain. The latter view is much broader because it goes beyond internal valuecreating activities to also link the single enterprise with its suppliers, businesspartners, and customers. That is, it encompasses enterprises and individualsoutside the traditional boundaries of the enterprise. Thus, the fundamentalbusiness functions of sales, production, procurement, accounting, and humanresource management must be integrated with external data (customers, suppliers,markets) so that managers have accurate, timely information for operationaland strategic decision-making.Since the slackening of the ERP wave around 1999, major software vendors havestarted to concentrate either on such topics as supply-chain management (Aribaand CommerceOne), customer relationship management (Broadvision, Saratoga Systems,and Siebel Systems), or expense management systems (Concur and Captura). Theseapplications were missing from major ERP vendor packages in the 1990s. In response,the ERP software vendors are now working to integrate comparable new applicationsinto their ERP packages.

Six Stages in the Evolution of ERP

Based on a review of the published literature, discussions with software vendorsand systems integration consultants, and interviews with business executivesregarding their ERP experiences, we identified six relatively distinct stagesin the development of ERP systems in American companies. These stages are certainlynot discrete or independent and are not necessarily sequential. But, they canbe used to assess the progression of an enterprise as it moves from gainingthe basic benefits of 1990s computing technology to the realization of strategicbenefits. Is the ERP helping to achieve competitive advantage in what is rapidlybecoming the cyber-marketplace? The concept of a stages hypothesis for understandingdata processing evolution was first introduced by Cyrus Gibson and Richard Nolan30 years ago. This text here is a summary of the six stages, each framed toreflect 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 transactionsthat can be categorized as involving customers, vendors, and/or employees. Inaddition, there are accounting processes that collect, summarize, and reportbusiness transactions.Customer processes include billing systems, accounts receivable systems, andcash application systems. Vendor processes include procurement systems, accountspayable systems, and cash disbursements. Employee processes include payrollsystems, travel and entertainment reimbursement systems, benefits administrationsystems, and other human resource management systems. Accounting processes includethe monthly closing and the generation of all financial and managerial accountingreports.

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 thisfar.Owens-Corning Fiberglass (OCF) was one of the earliest companies to recognizethe 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 transactionprocessing for payables, travel and entertainment, payroll, and financial accounting.This resulted in a reduction of $165 million in working capital, a reductionin the monthly closing cycle from 18 to four days, and a reduction of the annualbudget process from four to two months. The second phase of implementing newtechnology involved using SAP s ERP software to replace more than 200 legacysystems. At the time, OCF projected completion in early 1997 with annual savingsof $43 million. The SAP system that cost $75 million was finally successfullyimplemented in 1999. Added capabilities include a new global procurement process,finished goods tracking through warehouses and distribution channels, and areduction of spare parts inventory.Gillette linked five business units that had operated as a cluster of independentcompanies with different fiscal year ends. Previously, razor blades and toothbrusheswere delivered to the same customer in different trucks using different invoices.Using SAP software, Gillette standardized much of its business transaction processingand consolidated its products into two divisions – one for batteries, shampoos,and razors; the other for toothbrushes, coffeemakers, and stationery. The ERPimplementation also resulted in a restructuring of operations in which Gillettecut 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.

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 processingsystems are linked together so that interconnectivity among the systems is possible.Interconnectivity means that the data from one system is accurately communicatedto another. Thus, for example, the customer order provides input to the procurementprocess; the payroll system generates data for the general ledger; the billingprocess is connected to the accounts receivable process; the accounts payableprocess 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 stressedthe enterprise. It focused on the four key transaction processes that it felthad greatest impact for its customer – materials management, production planning,order management, and financial reporting. A 60-member ERP team representingall business functions selected SAP modules that integrated transactions acrossits four key areas and across its 12 business units. The ERP system made itpossible to consolidate all customer orders into one invoice. Customer-serviceunits were combined into a single unit with one point of contact. At ERP completion,only one competitor had such extensive customer service capability, which gaveElf Atochem a significant competitive edge.Bay Networks (acquired by Nortel Networks) went through a nine-month implementationof SAP s general ledger, distribution, and manufacturing modules. The firm resistedcustomization of software or including optional features, arguing that the objectiveshould always be to aim high enough to make a difference, but not so high thatthe target will be missed. The firm focused on three principles: scope management,speed, and constant care. Power users were identified for ongoing trainingand information system liaison. The company reported that it realized a $20million return on investment from the ERP improvements, including better inventoryturns 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. Numerousproblems were experienced due to loss of division autonomy and confusion fromattempts at standard reporting structures and common processes. One lesson hereis not to ignore corporate culture and change management principles in an ERPproject.

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 systemsbeyond 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 customersand suppliers generate input data for the company s various transaction processes,such as orders or payments or invoices, there is no explicit attempt to linkthe company s transaction processes with those external to the firm.Indeed, the original ERP vendors did not initially envision the need to belinked with customer or supplier processes. They designed their initial softwarearound internal transaction processing. This focus on internal integration ofback-office processes has proved to be a serious limitation for companies thatseek to link with other participants in their value chain. Having invested millionsof dollars in otherwise successful ERP projects, companies can wind up unableto communicate and exchange data with customers and suppliers in the new B2Bor B2C age.EDI systems provide a partial solution to this problem, but the value addednetworks (VANs) through which EDI operates are so costly to create and maintainthat 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 thatsome companies have extended their ERP systems to link with other firms in theirvalue chain.AlliedSignal s Turbocharging

Systems Division installed ERP software from SAPin 18 different sites across 11 countries with nine languages to improve productivityin logistics and supply chain management. The company took a Big Bang approachover a seven-month period to complete the implementation. This involved settinguniform data standards and systems for each country. A 15-member global teameased the implementation by screening customization requests and resolving coordinationconflicts.A central database managing customers and suppliers, raised on-time deliveriesfrom 65 percent to 92 percent.Domino s Pizza started evaluating ERP systems in 1997. The company wanted anintegrated transaction processing system for its 250 products across 24 NorthAmerican distribution centers comprising 4,500 company-owned and franchisedstores.The new system had to be compatible with Domino s Informix database and usethe existing servers at the 24 distribution centers. Management decided on asingle vendor approach, selecting PeopleSoft and using its packages for generalledger, financial reporting, order management, inventory and asset management,manufacturing, and production and planning. The company integrated the PeopleSoftsoftware with legacy Manugistics systems for transportation management and legacyPrescient systems for sales forecasting. Cambridge Technology Partners assistedwith training, prototyping, and implementation. For a competitive edge, Domino smanagement decided to customize the ERP software, rather than modify the company sbusiness processes to match the software. The ERP system was installed on thecorporate headquarters mainframe computer rather than on the distribution centerservers. However, desktop computers and the servers were linked to the mainframe.Domino s approach was to get basic transaction processing functioning firstand 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 processingsystems alone cannot satisfy all management reporting, decision-making, andanalysis requirements. While the transaction processing systems provide a consistentsource of accurate, well-defined, and basic data, additional technology is necessaryto efficiently store and retrieve the data to meet managers needs. It is notenough to compile only part of the transaction information.

Early Databases – DSS and EIS

In the1970s and early1980s, information systems were already attempting toassist managers in making choices for improving operations, planning, and measuringperformance. For example, budgeting processes were facilitated using spreadsheetprograms, such as Visicalc or Excel. Optimal manufacturing site selection wasmodeled with mathematical programming. But, such decision support systems (DSS)proved to be difficult for managers to routinely operate unless they were extensivelytrained. The supporting databases also had to be created as overlays onto basicaccounting information.Later in the 1980s, DSS were followed by executive information systems (EIS),which attempted to standardize the internal information that managers requirefor decision-making and to supplement it with external data on competition andmarkets. The objective of these decision-support databases was to make it easierfor managers to use the information system. The primary difference between DSSand EIS was that DSS generally focused on specific analytical decisions whereasEIS took a broader view of the domain of management decision needs.But, EIS databases still were separate overlays to the basic transactions systemsthat were loaded into PCs. Even with an EIS the analytical capabilities werelimited by the structure of the databases. The emergence of relational databasesand OLAP tools in the late 1980s, and the development of new software for storingand retrieving data by multiple users, led to the creation of the first realDWs 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 transactiondata with external data collected from other business systems to provide multipleusers 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, aDW is typically separate from the company s online transaction processing systemsand is designed specifically to support business decisions. Usually placed ona separate server, the DW is read-only. Technical personnel periodically updatethe content with the designated current transaction data and designated nontransactioninformation.

Fourth Stage

Because of the significant value gained from combining ERP transaction systemswith a DW, planning and design of the DW should take place at the same timeas the design of the new transactions systems. There is no necessary reasonwhy the DW could not be created before all internal transaction systems arelinked. Connecting the DW to transactions all along the supply chain as wellis not a fixed requirement. But, we believe that these developments should precedethe DW if it is to be maximally useful.Stage 4 is best seen as an extension of ERP development beyond Stage 3. Thereis evidence to suggest that some companies, but not many, have achieved thislevel of development.

Stage 5: Extending Data Warehouses to Include Nontransaction Information

Placing transaction data in a DW may serve such single objectives as usingproduction data to help manufacturing managers achieve cycle time reductionsor more efficient product routings. Of course, the DW may also include nonfinancialdata. 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 wouldalso 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 & Bradstreetdatabases 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 widelyaccessible with user-friendly, drill-down, and analysis capabilities. Sensitivedata, such as payroll records, may be password restricted to certain employees.Other areas may be open access to all employees through desktop computersor Web browsers. If persons external to the firm, such as suppliers, businesspartners, or customers, are given access it may be limited to procurement, production,or shipment files using security codes. External access is especially importantfor building strong supply chain relationships.Today, DWs can be available worldwide using Internet capabilities. PC-basedtools, ranging from relatively simple query software to very powerful multidimensionalanalysis tools with graphic presentations, access almost all DWs. Online analyticalprocessing (OLAP) is the quick access of shared multidimensional informationfor performing analyses. Software vendors, such as Hyperion and Cognos and SASInstitute, provide both general purpose and customized OLAP applications forproducing whatever specialized reports a particular application may require.

Fifth Stage Examples

Successful examples at this stage include JP Morgan Chase s warehouse, whichwas created in 1998 to support a $10 billion credit card portfolio with 22 millionrecords on 15 million accounts. Bethlehem Steel integrated operational dataon steel production in a DW that helped identify quality consistency patternsfor production of higher quality steel.KeyCor s DW, established in 1995, held data on 3.3 million households and 7million customers by 1999. The company uses IBM s software for relationshipmarketing and general ledger. Other software is used to select current and pastcustomers for direct mail marketing. Analytical tools such as Hyperion s Essbaseare used for analysis and reporting. Using the DW capabilities, direct mailresponse rates increased from an average of one to two percent to a range offive to 10 percent. Also, nine of the bank s offerings were found to be unprofitableand were removed.Charles Schwab implemented FinanceNOW, a three-tier client-server system basedon an Oracle database using a Microsoft SQL Server to enable all managers toaccess the DW using Web browsers. First Union used a single large DW to integratecorporate data with acquired companies legacy systems and customer databases.Lesco wanted to gain knowledge about market conditions and customers wantsand needs. Using a minicomputer to host its DW, two Cognos products were selected:Impromptu (a query tool) and PowerPlay (an OLAP tool with a multidimensionalcube format that lets users drill down several levels of detail). The companyreported that sales and pricing strategies improved dramatically because ofDW access by 230 stores, 68 stores on wheels, and 50 direct sales representativesto analyze customer buying habits and prepare sales reports comparing budgetversus actual for customer groups.Novartis Pharmaceuticals selected SAS Institute s technology for data acquisition,clean-up, and front-end viewing. The DW contains laboratory information relatedto analysis of manufactured products at various stages of production leadingup to and including finished goods. This is a scientific DW to which Novartisadds information from a variety of quality control activities including customer feedback.

Stage 6: Using Data Warehouses for Strategic Management

Faced with global competition and rapid advances in IT, all senior-level managersseek continually to reduce the time it takes to get a product to market, toshorten order-delivery cycle times, to speed up innovation, and to improve customerrelationships. Stage 6 of ERP implementation addresses the use of an ERP-enabledDW for business issues at this strategic decision-making level.Business intelligence (BI) is the new term used to describe reporting and analyticalsoftware systems that link ERP systems and DWs to desktop computers for strategicanalysis throughout the value chain (e.g., Hyperion, Brio Technologies, Cognos,IBM, SAS Institute). This goes beyond OLAP applications to also include balancedscorecard, business driver analysis, and business modeling. For example, HCIA,a provider of healthcare data and analysis services, makes its Cognos toolsavailable to customers to perform their own business analyses of the HCA relationshipon the Internet. SAS Institute markets its Web-based Intelligent WarehousingSolution software for ERP packages.

Three Questions on Strategic Use of the Data Warehouse

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

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 whatactual decisions have been made differently, and hopefully better, using theDW? These three questions define the extension from tactical to strategic useof the DW.

Sixth Stage Examples

Quantum, a disk drive company, used Oracle s ERP system to link order managementand financial systems for nine global business units. The company outsourcesall 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 andAris Software. In an extremely competitive industry with very thin operatingmargins, the company s DW helps managers monitor quality control and on-timedeliveries for the company and its suppliers. A just-in-time system is usedto monitor each supplier s stage of production and closely match it to incomingcustomer orders. Also, the DW is used to evaluate the performance of suppliers.Quantum reduced purchase costs by combining orders across the entire companyand tracking vendors based on company-wide performance statistics, achievinghigher quality and service from all suppliers. ERP transaction data is transferreddaily to the DW. Quantum reported more than 600 users in all nine divisionsaccessing the DW in 1999. Each is trained to design his or her reports.Farmers Insurance used IBM s data mining software to examine warehouse datapertaining to sports car owners. The company discovered that a large group ofsport 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 identifiedthis pattern in their data.SAS Institute and Hyperion both offer software for acquisitions, mergers, andorganizational realignments that is used to visualize a business by differentperspectives, 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 thebusiness, it will never be able to optimize it. In their view, ERP-automatedbusiness processes are conceptually unable to adapt themselves once they areup and running. Obviously, firms such as Quantum and Farmers Insurance notedabove do not accept this limitation.

Conclusion

There is no question that the decade of the 1990s presented major opportunitiesfor companies to create comprehensive, fully interconnected transactions processingsystems. These ERP systems permit managers to finally have timely, accurateinformation for operational and strategic decision-making. The benefits canbe profiled as accumulating in six linked stages as illustrated by the realcompany experiences cited here.Even Stage 1 represents major improvements in business transaction processesover prior information systems. But, we believe the potential benefits frommoving 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 isdangerous to be satisfied at even the sixth stage. The path is constantly changingdue to advances in technology, global competitive forces, and new business models that are yet to be defined. The ideas presented here are intended to provideone general management framework for assessing both progress to date and unmetchallenges.