**Chapter I**

# The Evolution of ERP Systems: A Historical Perspective

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ERP systems are now ubiquitous in large businesses and the current move by vendors is to repackage them for small to medium enterprises (SMEs). This migration has many consequences that have to be addressed through understanding the history and evolution of ERP systems and their current architectures. The advantages and disadvantages of the ERP systems will impact their penetration in this new market. The market position and general strategy of the major systems providers in preparation for this push are described. The chapter concludes that the growth and success of ERP adoption and development in the new millennium will depend on the legacy ERP system's capability of extending to Customer Relationship Management (CRM), Supply Chain Management (SCM) and other extended modules, and integration with the Internet-enabled applications.

## INTRODUCTION

The unprecedented growth of information and communication technologies (ICT) driven by microelectronics, computer hardware and software systems has influenced all facets of computing applications across organiza-

tions. Simultaneously the business environment is becoming increasingly complex with functional units requiring more and more inter-functional data flow for decision making, timely and efficient procurement of product parts, management of inventory, accounting, human resources and distribution of goods and services. In this context, management of organizations needs efficient information systems to improve competitiveness by cost reduction and better logistics. It is universally recognized by large and small-to-medium-size enterprises (SME) that the capability of providing the right information at the right time brings tremendous rewards to organizations in a global competitive world of complex business practices.

Starting in the late 1980s and the beginning of the 1990s new software systems known in the industry as enterprise resource planning (ERP) systems have surfaced in the market targeting mainly large complex business organizations. These complex, expensive, powerful, proprietary systems are off-the-shelf solutions requiring consultants to tailor and implement them based on the company's requirements. In many cases they force companies to reengineer their business processes to accommodate the logic of the software modules for streamlining data flow throughout the organization. These software solutions, unlike the old, traditional in-house-designed company-specific systems, are integrated multi-module commercial packages suitable for tailoring and adding "add-ons" as and when required.

The phenomenal growth of computing power and the Internet is bringing ever more challenges for the ERP vendors and the customers to redesign ERP products, breaking the barrier of proprietorship and customization, and embracing the collaborative business over the intranet, extranet and the Internet in a seamless manner. The vendors already promise many "add-on" modules, some of which are already in the market as a sign of acceptance of these challenges by the ERP vendors. It is a never-ending process of reengineering and development bringing new products and solutions to the ERP market. ERP vendors and customers have recognized the need for packages that follow open architecture, provide interchangeable modules and allow easy customization and user interfacing.

# ERP SYSTEMS DEFINED

Enterprise resource planning systems or enterprise systems are software systems for business management, encompassing modules supporting functional areas such as planning, manufacturing, sales, marketing, distribution, accounting, financial, human resource management, project management, inventory management, service and maintenance, transportation and e-busi-

ness. The architecture of the software facilitates transparent integration of modules, providing flow of information between all functions within the enterprise in a consistently visible manner. Corporate computing with ERPs allows companies to implement a single integrated system by replacing or re-engineering their mostly incompatible legacy information systems. American Production and Inventory Control Society (2001) has defined ERP systems as "a method for the effective planning and controlling of all the resources needed to take, make, ship and account for customer orders in a manufacturing, distribution or service company." We quote several definitions from the published literature to further explain the concept: "ERP (enterprise resource planning systems) comprises of a commercial software package that promises the seamless integration of all the information flowing through the company–financial, accounting, human resources, supply chain and customer information" (Davenport, 1998). "ERP systems are configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization" (Kumar & Van Hillsgersberg, 2000). "One database, one application and a unified interface across the entire enterprise" (Tadjer, 1998). "ERP systems are computer-based systems designed to process an organization's transactions and facilitate integrated and real-time planning, production, and customer response" (O'Leary, 2001). The concept of the ERP system can be illustrated, following Davenport (1998), with the diagram in Figure 1.

## EVOLUTION OF ERP SYSTEMS

The evolution of ERP systems closely followed the spectacular developments in the field of computer hardware and software systems. During the

*Figure 1: ERP systems concept*
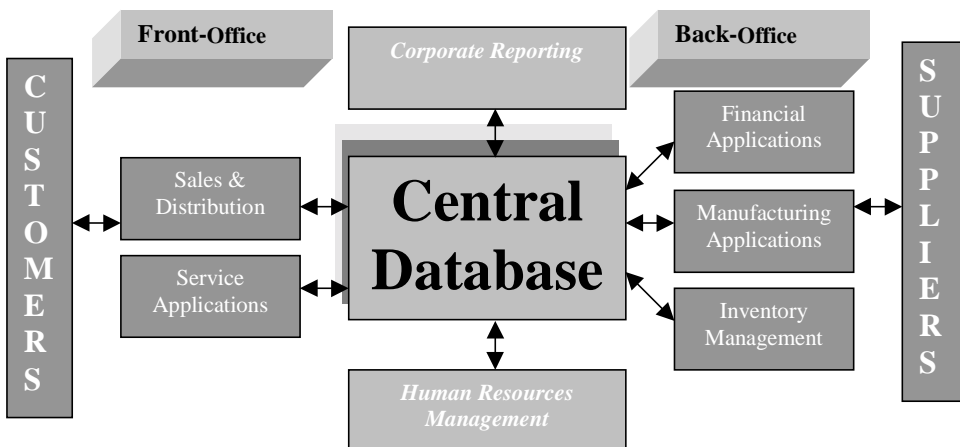
1960s most organizations designed, developed and implemented centralized computing systems, mostly automating their inventory control systems using inventory control packages (IC). These were legacy systems based on programming languages such as COBOL, ALGOL and FORTRAN. Material requirements planning (MRP) systems were developed in the 1970s which involved mainly planning the product or parts requirements according to the master production schedule. Following this route new software systems called manufacturing resources planning (MRP II) were introduced in the 1980s with an emphasis on optimizing manufacturing processes by synchronizing the materials with production requirements. MRP II included areas such as shop floor and distribution management, project management, finance, human resource and engineering. ERP systems first appeared in the late 1980s and the beginning of the 1990s with the power of enterprise-wide inter-functional coordination and integration. Based on the technological foundations of MRP and MRP II, ERP systems integrate business processes including manufacturing, distribution, accounting, financial, human resource management, project management, inventory management, service and maintenance, and transportation, providing accessibility, visibility and consistency across the enterprise.

During the 1990s ERP vendors added more modules and functions as "add-ons" to the core modules giving birth to the "extended ERPs." These ERP extensions include advanced planning and scheduling (APS), e-business solutions such as customer relationship management (CRM) and supply chain management (SCM). Figure 2 summarizes the historical events related with ERP.

*Figure 2: ERP evolution*

| | |
|---|---|
| **2000s** | **Extended ERP** |
| **1990s** | **Enterprise Resource Planning (ERP)** |
| **1980s** | **Manufacturing Resources Planning (MRP II)** |
| **1970s** | **Material Requirements Planning (MRP)** |
| **1960s** | **Inventory Control Packages** |

# ERP SYSTEMS AND ORGANIZATIONS

It is generally a misleading perception that implementing an ERP system will improve organizations' functionalities overnight. The high expectation of achieving all-round cost savings and service improvements is very much dependent on how good the chosen ERP system fits to the organizational functionalities and how well the tailoring and configuration process of the system matched with the business culture, strategy and structure of the organization. Overall an ERP system is expected to improve both backbone and front-end functions simultaneously. Organizations choose and deploy ERP systems for many tangible and intangible benefits and strategic reasons. In many cases the calculation of return on investment (ROI) is weighted against the many intangible and strategic benefits. The benefits that an industry standard ERP system may bring to organizations are shown in Table 1. To reap the benefits of ERP systems, however, organizations need to overcome certain problems and disadvantages, which are listed in Table 2.

It was estimated that the spending on ERP systems in 1998 was about US$17 billion following annual growth rates ranging from 30% to 50%. Companies also spend a multiple of licensing costs on services related to implementation and maintenance of the software. The worldwide license and maintenance revenue for ERP systems was US$21.5 billion in 2000, which represented a growth of 13.1% from the 1999 market value of $US19 billion (Broatch, 2001). The continued growth of the ERP systems market is

*Table 1: Advantages of ERP systems*

| What benefit | How |
|---|---|
| Reliable information access | Common DBMS, consistent and accurate data, improved reports. |
| Avoid data and operations redundancy | Modules access same data from the central database, avoids multiple data input and update operations. |
| Delivery and cycle time reduction | Minimizes retrieving and reporting delays. |
| Cost reduction | Time savings, improved control by enterprise-wide analysis of organizational decisions. |
| Easy adaptability | Changes in business processes easy to adapt and restructure. |
| Improved scalability | Structured and modular design with "add-ons." |
| Improved maintenance | Vendor-supported long-term contract as part of the system procurement. |
| Global outreach | Extended modules such as CRM and SCM. |
| E-Commerce, e-business | Internet commerce, collaborative culture. |

*Table 2: Disadvantages of ERP systems*

| Disadvantage | How to overcome |
|---|---|
| Time-consuming | Minimize sensitive issues, internal politics and raise general consensus. |
| Expensive | Cost may vary from thousands of dollars to millions. Business process reengineering cost may be extremely high. |
| Conformity of the modules | The architecture and components of the selected system should conform to the business processes, culture and strategic goals of the organization. |
| Vendor dependence | Single vendor vs. multi-vendor consideration, options for "best of breeds," long-term committed support. |
| Features and complexity | ERP system may have too many features and modules so the user needs to consider carefully and implement the needful only. |
| Scalability and global outreach | Look for vendor investment in R&D, long-term commitment to product and services, consider Internet-enabled systems. |
| Extended ERP capability | Consider middle-ware "add-on" facilities and extended modules such as CRM and SCM. |

attributed to the fact that the vendors are adding applications such as supply chain management, customer relationship management and the integration of Internet-enabled applications for e-business.

More than 60% of the Fortune 1000 companies have installed or are in the process of implementing packaged ERP systems to support their back-end business activities (Kraft, 2001). These packages implemented by the Fortune 1000 companies run well over the IT budgets for most SMEs. ERP vendors are targeting this untapped SME market with supposedly scaled-back systems suitable for smaller firms by offering simple, cheaper and pre-configured easy-to-install solutions within budget and time constraints. For some vendors this may lead to offering centrally managed Internet-enabled ERP-system-based services for SMEs to access and use anytime from anywhere.

# ERP SYSTEMS ARCHITECTURE

ERP vendors, mostly experienced from the MRP and financial software services fields, realized the limitations of the old legacy information systems

used in large enterprises of the 1970s and 1980s. Some of these old systems were developed in-house while others were developed by different vendors using several different database management systems, languages and packages, creating islands of noncompatible solutions unfit for seamless data flow between them. It was difficult to increase the capacity of such systems or the users were unable to upgrade them with the organization's business changes, strategic goals and new information technologies.

An ERP system is required to have the following characteristics:

- Modular design comprising many distinct business modules such as financial, manufacturing, accounting, distribution, etc.
- Use centralized common database management system (DBMS)
- The modules are integrated and provide seamless data flow among the modules, increasing operational transparency through standard interfaces
- They are generally complex systems involving high cost
- They are flexible and offer best business practices
- They require time-consuming tailoring and configuration setups for integrating with the company's business functions
- The modules work in real time with online and batch processing capabilities
- They are or soon they will be Internet-enabled

Different ERP vendors provide ERP systems with some degree of specialty but the core modules are almost the same for all of them. Some of the core ERP modules found in the successful ERP systems are the following:

- Accounting management
- Financial management
- Manufacturing management
- Production management
- Transportation management
- Sales & distribution management
- Human resources management
- Supply chain management
- Customer relationship management
- E-Business

The modules of an ERP system can either work as stand-alone units or several modules can be combined together to form an integrated system. The systems are usually designed to operate under several operating platforms such as UNIX, MS Windows NT, Windows 2000, IBM AIX, and HP-UX systems. SAP AG, the largest ERP vendor, provides a number of modules with its famous R/3 ERP system, which are shown in Table 3. New modules are introduced by SAP and other vendors in response to the market and technological demand such as the Internet technology.

*Table 3: Some of the modules of SAP's R/3*

| Financial Accounting | FI | Controlling | CO | Asset Management | AM |
|---|---|---|---|---|---|
| Project System | PS | Workflow | WF | Industry Solutions | IS |
| Human Resources | HR | Plant Maintenance | PM | Quality Management | QM |
| Production Planning | PP | Materials Management | MM | Sales & Distribution | SD |
| Investment Management | IM | Enterprise Controlling | EC | Treasury | TR |

| Modules of Internet version **mySAP.COM** | | |
|---|---|---|
| mySAP Workplace | mySAP E-Procurement | mySAP Human Resources |
| mySAP Supply Chain Mgmt. | mySAP Product Lifecycle Mgmt. | mySAP Marketplace by |
| mySAP Customer Relationship | mySAP Business Intelligence | SAPMarkets |
| Mgmt. | mySAP Mobile Business | mySAP Hosted Solutions |
| mySAP Financials | | mySAP Technology |

Enterprise systems employ thin client/server (C/S) technology or client/ fat server (C/FS) architecture, creating a decentralized computing environment. In a C/S system a number of client devices operated by end users such as desktop PCs request services from application servers, which in turn get the requested service-related information from the database servers. The requests may be simple data files, data values, communication services, transaction processing or master file updates. The general practice is to have three-tier architecture such as in Figure 3. In this three-tier system the user interface runs on the client. To run ERP systems relatively powerful PCs (clients) and powerful servers are required where most of the hundreds of thousands of operations are performed. The client/server system functions are performed following three layers of logic:

- **Presentation Layer:** Graphical user interface (GUI) or browser for data entry or accessing system functions
- **Application Layer:** Business rules, functions, logic, and programs acting on data received/transferred from/to the database servers
- **Database Layer:** Management of the organization's operational or transactional data including metadata; mostly employs industry standard RDBMS with structured query language (SQL) provisions

This logical arrangement helps the ERP user interface to run on the clients, the processing modules to run on the middle-tier application servers, and the database system to run on the database servers.

# COMMERCIAL ERP SYSTEMS

The five dominating ERP software suppliers are SAP, Oracle, PeopleSoft, Baan and J.D. Edwards. Together they control more than 60% of the multi-billion dollar global market.

*Figure 3: Three-tier ERP systems architecture*
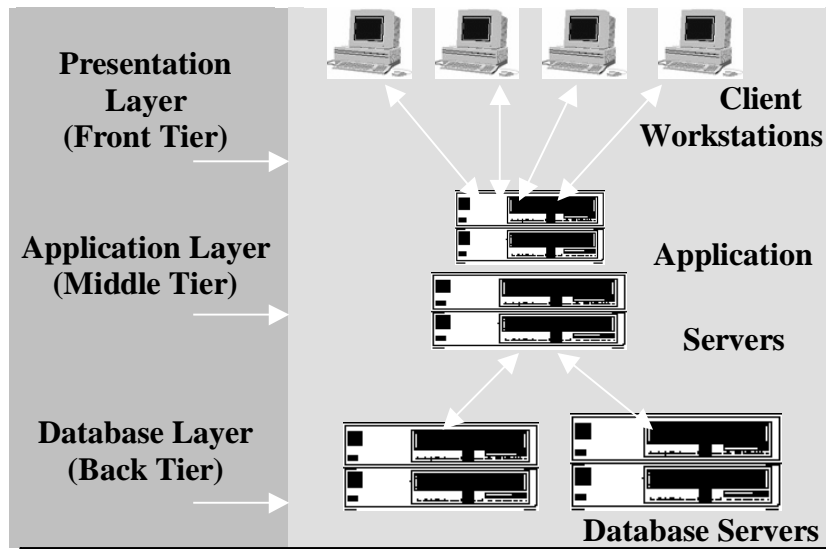


Each vendor, due to historic reasons, has a specialty in one particular module area such as Baan in manufacturing, PeopleSoft in human resources management, SAP in logistics and Oracle in financials. There are also about 50 established and a few more newly emerging smaller and midsize ERP vendors including third-party developers competing for the ERP market. The result is stiff competition and feature-overlapping products difficult to differentiate. Due to keen competition for control of the lucrative ERP market share, the vendors are continuously updating their products and adding new technology-based features. Long-term vision, commitment to service and support, module features, specialty, experience and financial strength for R&D are considered the major vendor qualities for product selection and turnkey implementation. In the following sections we provide brief profiles of these five ERP giants.

## SAP AG–Flagship Products *R/3, mySAP.COM*

SAP AG ("Systeme, Anwendungen, und Produkte in Datenverarbeitung"), or Systems, Applications and Products in Data Processing, was started by five former IBM engineers in Germany in 1972 for producing integrated business application software for the manufacturing enterprise (SAP, 2001). Its first ERP product, R/2, was launched in 1979 using a mainframe-based centralized database that was then redesigned as client/server software R/3 in 1992. System R/3 was a breakthrough and by 1999 SAP AG became the third largest software vendor in the world and the largest in the ERP sector with a market

share of about 36% serving over 17,000 customers in over 100 countries. In 1999 SAP AG extended the ERP functions by adding CRM, SCM, sales-force automation and data warehousing. SAP has also invested significantly in its R&D sector with the result of newer versions of R/3 3.1, 4.0, 4.6 including Internet functionalities and other enhancements. SAP's Internet-enabled ERP solutions are provided by the recently launched ERP product called mySAP.COM. SAP has the broadest ERP functionality, capacity to spend significantly on R&D, strong industry-focused solutions and long-term vision.

## Oracle Corporation–Flagship Product *Oracle Applications*

Oracle (Oracle, 2001), founded in 1977 in the USA, is best-known for its database software and related applications and is the second largest software company in the world after Microsoft. Oracle's enterprise software applications started to work with its database in 1987. It accounts for $2.5 billion out of the company's $9.3 billion in 1999, which places Oracle second to SAP in the enterprise systems category with over 5,000 customers in 140 countries. Oracles ERP system is known as Oracle Applications, having more than 50 different modules in six major categories: finance, accounts payable, human resources, manufacturing, supply chain, projects and front office. Oracle has other strong products in the software field including DBMS, data warehousing, work flow, systems administration, application development tools (APIs), and consulting services. A notable feature of Oracle is that it is both a competitor and a partner to some of the industry leaders in the ERP market such as SAP, Baan and PeopleSoft because of the use of Oracle's DBMS in their ERP systems.

Oracle has integrated its ERP solutions with the Internet and has introduced several applications in the electronic commerce and Internet-based commerce areas. Oracle's Internet infrastructure is created around two powerful products: Oracle9i Database and Oracle9i Application Server. Another significant feature of Oracle is its OSBS, or Oracle Small Business Suite which provides consistent financials, payroll, inventory control, order entry, purchase orders, and CRM functionality–all delivered as a Web service. Oracle also offers an easy-to-activate Web presence that helps companies to sell their goods via the Internet.

## PeopleSoft Inc.–Flagship Product *PeopleSoft8*

PeopleSoft is one of the newest ERP software firms started in 1987 in Pleasanton, California, with specialization in human resource management and financial services modules. PeopleSoft quickly managed to offer other corporate functions and attained a revenue of $32 million in 1992. Enterprise

solutions from PeopleSoft include modules for manufacturing, materials management, distribution, finance, human resources and supply chain planning. SAP AG and Oracle–with longer experience, stronger financial base and worldwide presence–are the main competitors to PeopleSoft. Many customers comment that PeopleSoft has a culture of collaboration with customers, which makes it more flexible than its competitors. One of the strengths of PeopleSoft is the recognition by its customers that it is flexible and collaborative. The flagship application PeopleSoft8 with scores of applications was developed by PeopleSoft with an expenditure of $500 million and 2,000 developers over 2 years as a pure Internet-based collaborative enterprise system. "Our revolutionary eBusiness platform is the first open XML platform to offer scalability and ease of use for all users. PeopleSoft 8 requires no client software other than a standard Web browser, giving you the ability to securely run your business anytime, anywhere" (PeopleSoft, 2001). "Our eBusiness applications and consulting services enable true global operations–managing multiple currencies, languages, and business processes for more than 4,400 organizations in 109 countries" (PeopleSoft, 2001). PeopleSoft with about 10% market share, is the third largest ERP vendor after SAP AG and Oracle.

## The Baan Company–Flagship Product *BaanERP*

Founded in 1978 in The Netherlands, Baan (Baan, 2001) started with expertise in software for the manufacturing industry and by 1997 claimed an ERP market share of roughly 5%. Bann's revenue in 1998 was roughly $750 million and while facing a slight slowdown in 1999 started growing again in 2001 with sales up 12% at £7,231 million and operating profit of £926 million. Baan has more than 15,000 customer sites all over the world and more than 3,000 employees. Baan believes that "the Internet is the ultimate enabler" and "Internet technologies help companies become order-driven and customer-focused by enabling collaboration across the 'value chain.' Suppliers, distributors, manufacturers and customers can work together to deliver the right product at the right price." ERP solution areas that Baan covers include finance, procurement, manufacturing, distribution, integration and implementation, planning, sales, service and maintenance, business portals, collaborative commerce and business intelligence. Bann's flagship product is BaanERP (formerly called Triton, then Baan IV), launched in 1998. One innovative product from Baan is the Orgware tool that can cut implementation cost significantly by automatically configuring the enterprise software. Baan's ERP software is best known in the aerospace, automotive, defence, and electronics industries.

## J.D. Edwards & Co.–Flagship Product *OneWorld*

J.D. Edwards was founded in 1977 in Denver (cofounded by **J**ack Thompson, **D**an Gregory and C. **Edward** McVaney) with long experience of supplying software for the AS/400 market. J.D. Edwards' flagship ERP product called OneWorld is "capable of running on multiple platforms and with multiple databases, ... [and] revolutionizes enterprise software by liberating users from inflexible, static technologies" (JD Edwards, 2001). The product includes modules for finance, manufacturing, distribution/logistics and human resources, quality management, maintenance management, data warehousing, customer support and after-sales service. J.D. Edwards' revenue jumped to $944 million in 1999 from $120 million in1992, having more than 5,000 customers in over 100 countries. The OneWorld system is considered to be more flexible than similar competing products and within the reach of smaller enterprises. J.D. Edwards' Internet-extended version of OneWorld was launched recently as OneWorld Xe ("Xe" stands for "extended enterprise").

# EXTENDED ERP

The proliferation of the Internet has shown tremendous impact on every aspect of the IT sector including ERP systems becoming more and more "Internet-enabled" (Lawton, 2000). This environment of accessing systems resources from anywhere anytime has helped ERP vendors extend their legacy ERP systems to integrate with newer external business modules such as supply chain management, customer relationship management, sales force automation (SFA), advanced planning and scheduling (APS), business intelligence (BI), and e-business capabilities. In fact ERP is becoming the e-business backbone for organizations doing online business transactions over the Internet. Internet-based solutions are destined to improve customer satisfaction, increase marketing and sales opportunities, expand distribution channels, and provide more cost-effective billing and payment methods. The extension to SCM and CRM enables effective tri-party business relationships between the organization, suppliers and the customers. A supply chain management has sub-modules for procurement of materials, transformation of the materials into products and distribution of products to customers. "Successful supply chain management allows an enterprise to anticipate demand and deliver the right product to the right place at the right time at the lowest possible cost to satisfy its customers. Dramatic savings can be achieved in inventory reduction, transportation costs and reduced spoilage by

matching supply with actual demand" (IBM, 2001). With the deployment of a CRM, organizations are able to gather knowledge about their customers, opening opportunities to assess customer needs, values and costs throughout the business life cycle for better understanding and investment decisions.  The sub-modules found in typical CRM packages are marketing, sales, customer service and support systems using Internet and other access facilities with the intention of increasing customer loyalty through improved customer satisfaction.

E-commerce is the conduct of business transactions among organizations with the support of networked information and communication technologies, especially utilizing Internet applications such as the Web and e-mail, effectively reaching global customers. Adoption of e-commerce and e-business solutions, especially business-to-business (B2B) solutions, are seen by many as the wave of current and future extensions of traditional ERP systems of most small, medium and large vendors. The front-end Web-based Internet-business applications are integrated with the back-office ERP-based applications, enabling business transactions such as order placement, purchasing, inventory updates, employee benefits, etc. to take place between the customers, suppliers and the enterprise based on reliable, relevant data and applications instantly in a border-less domain.

The legacy ERP systems designed to integrate enterprise functions within the four walls of the enterprise have introduced software solutions with a Web-interface essentially extending to Internet-enabled CRM, SCM and other Internet-business models. Examples of such extended ERPs are available from most of the ERP vendors.  Thus SAP's Internet-enabled integrated ERP system called mySAP.COM  (SAP, 2001) is a suite of ERP, CRM and other products that can be linked together using Internet portals. The concept of the Internet-enabled extended ERP system is shown in Figure 4.

An example of an extended ERP system may be Oracle's e-business suite of ERP systems that connects to CRM and SCM. Oracle's FastForward Web Store (Oracle, 2001) provides applications for establishing online stores for handling transactions and services with the possibility of linking into Oracle's ERP applications. ERP and e-commerce applications of an enterprise can share a common database with the deployment of Oracle Applications 11i (Oracle, 2001) integrating Web sites with ERP back-office applications. Baan has integrated its ERP, CRM and SCM with manufacturing management software. J.D. Edwards' Oneworld ERP package is reengineered to OneWorld Xe ("Xe" stands for "extended enterprise"), which enables the organization to extend the enterprise beyond physical walls to collaborate with customers, partners, and suppliers with additional tools for business-to-business (B2B)

*Figure 4: Web-enabled extended ERP system*
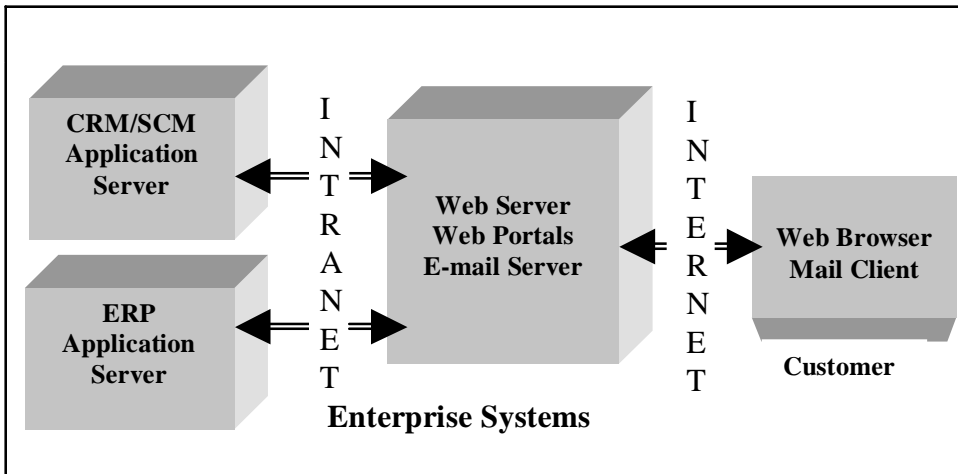


success. The Swedish ERP vendor Intentia International AB (Intentia, 2001) has a product suite called Movex that integrates ERP, CRM and other management software.


# SUMMARY AND THE FUTURE

The major industrial information systems manufacturers that emerged from the 1980s and early 1990s defined the history of the development of ERP systems. Hence the major providers are representatives of certain industries as much as competitors in a common marketplace. To this extent there are still opportunities for new ERP vendors to emerge from industries that so far have not contributed to the ERP phenomenon. Some obvious examples are the aerospace industry, the finance industry and the logistics industry. Analysis of the market penetration of ERP systems shows clearly that the current players have to downsize their products and offerings to be attractive to SMEs. There appears to be no public discussion as to how this will be achieved and whether it requires a significant change in software architecture. This situation again is an opportunity for smaller players to seize the day and offer smaller systems running on smaller hardware platforms more effi-ciently. These innovators will ultimately take the lead in the ERP software market as large systems will not produce the continual income stream that small, robust, easy-to-use systems can achieve. Importantly these attributes contribute to a system becoming ubiquitous in the same way that Microsoft has achieved ubiquity for its operating system. Future successful vendors will

capture large markets of smaller businesses, who will provide a more consistent and enduring income stream.

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