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USING ERP SYSTEMS IN EDUCATION

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TUTORIAL

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ABSTRACT

Enterprise Resource Planning systems are the new solution to business systems. These systems provide comprehensive business functionality in an integrated fashion using a state-of-the-art IT architecture. This trend towards enterprise systems in large and mid-sized organizations has a significant impact on IS careers paths. Enterprise systems essentially change fundamental business work processes thus implying that the system that supports these processes, and the design and development of these systems, also changed. Yet, most IS curricula do not provide significant coverage of ERP concepts, nor do they graduate students who are knowledgeable about these systems and the impact that these systems have on industry.

This paper identifies opportunities for incorporating the ERP body of knowledge into an IS program. The general spirit of the paper is that of experiential learning. That is, this paper focuses on curriculum that is enriched through the hands-on experience gained by students working on a real ERP system. The paper also discusses related topics such as costs and critical success factors.

Keywords: IS Curricula, ERP Systems, Experiential Learning, SAP

I. INTRODUCTION

An Enterprise Resource Planning (ERP) system is a generic term for an integrated enterprise computing system. It is a customized packaged software-based system that handles the majority of an enterprise's information systems requirements. It is a software architecture that facilitates the flow of information among all functions within an enterprise. It sits on a common database and is supported by a single development environment. ERP systems are customized to support an organization's business processes.

For many reasons, the commercial market for ERP systems grew rapidly in the 1990s.

- The client/server environment became a popular enterprise computing platform for many organizations and ERP systems are designed to take advantage of this platform.
- ERP systems implementations have been the catalyst and enabler for many corporate reengineering activities. They provide an opportunity for large corporations to shed aging legacy systems, old work processes and counter-productive company cultures, and to radically redefine how the business is run.
- ERP systems are year 2000 compliant.
- ERP systems are sold to CEO's and CFO's as strategic solutions and not as computer software.
- ERP systems are, arguably, a common sense approach to business computing: customized software with standard interfaces based on a common database. As such, an ERP system implementation essentially implies that a large part of the IS function (i.e., standard business application development and source code maintenance) in an organization is outsourced. Management consulting firms grew practices around this outsourcing opportunity, and generated many new career opportunities.

Of course, other factors contributed to the success of ERP systems in the 1990's but the point to be made is that these systems are being deployed successfully in many industries and by many large and small companies.

The market for people who can work with these systems, implement these systems, and understand how these systems transform organizations is strong, and growing. Many consulting firms recruit from graduate and undergraduate programs at Universities around the world to fill sizable gaps in their ERP consulting staff. In the recent past, many IS programs experienced a significant shift in the type of careers available to students. Even though a significant and growing proportion of IS graduates will be integrally involved with the design, development, implementation, operation, support and management of standard enterprise software systems, ERP systems remain largely absent from IS programs. This paper argues that there are significant opportunities for using an ERP-based curriculum to enhance or redefine an IS program.

It is important to note that ERP systems can provide curriculum improvement opportunities for business, engineering, and computer science schools. At LSU, faculty from Information Systems, Operations Management, Accounting, Human Resources, and Marketing are involved in the Alliance. Although the majority of students in these courses are business students, engineering and computer science students are also attracted to these courses. This paper focuses on the experience at Louisiana State University (LSU) using an ERP system in the IS curriculum.

Clearly, ERP concepts can be taught in a University environment without having access to a real system. The authors' experience indicates that hands-on exposure for students strengthens the student's learning experience (it is, after all, experiential learning); that is, their ability to understand business and business computing concepts and principles. Students are able to develop ERP skills that are highly valued by recruiters.

The students at LSU that attend these courses are, in general, not seasoned professionals. The undergraduate IS student will generally have

significant IS coop experience and may even be working full-time in an IS field. The graduate business student generally has a year or two of full-time experience or may have only coop experience similar to the undergraduate student. Of course, the program is sprinkled with returning adults from technical and non-technical backgrounds and careers that are looking for career enhancing opportunities. A significant fraction of the value added for a system such as the SAP R/3 System, in a program such as ours, is to educate students on business applications and functions.

This paper provides a broad view of ERP-enriched curriculum opportunities. It is divided into 4 main sections. After this introduction we provide background information on ERP systems and discuss why they should be used by IS programs. The main part of the paper is Section 3 where we discuss specific knowledge modules developed to enhance existing curriculum. Section 4 briefly presents a baseline for resource considerations. Finally, we end with some concluding remarks.

II. ERP OVERVIEW

ERP EVOLUTION

The basic concept of an enterprise resource planning system evolved over the past 30 years. The American Production and Inventory Control Society [APICS, 1998b] has been a strong advocate for ERP systems. APICS defines ERP [APICS, 1998b] as "an accounting-oriented information system for identifying and planning the enterprise-wide resources needed to take, make, ship, and account for customer orders. An ERP system differs from the MRPII system in technical requirements such as graphical user interface, relational database, use of fourth generation language, and computer-aided software engineering tools in development, client/server architecture, and open-systems portability."

ERP is also defined [Russell & Taylor, 1998] as an updated Manufacturing Resource Planning System (MRPII) with relational database management, graphical user interface, and client/server architecture. They define MRPII as an extension of Materials Requirements Planning (MRP) that plans all the resources necessary for manufacturing; including financial and marketing analysis, feedback loops, and an overall business plan. MRP is a computerized inventory control and production planning system for generating purchase orders and work orders of materials, components, and subassemblies. This brief evolutionary definition of ERP is depicted in Figure 1. ERP is further defined [CMU, 1998] as a strategic business solution that integrates all the business functions, including manufacturing, financial, and distribution

Clearly, an ERP system as defined above, and one that is properly implemented, can achieve unprecedented benefits for business computing. But consider also that ERP systems are a catalyst for radical business change that results in significant performance improvement (i.e., business process reengineering). With this in mind it is clear that ERP systems should have a significant impact on industry. Davenport [1998] suggests that "While the rise of the Internet has received most of the media attention in recent years, the business world's embrace of enterprise systems may in fact be the most important development in the corporate use of information technology in the 1990s".

ERP systems are also being referred to as Enterprise Systems [Davenport, 1998] and Enterprise Information Systems. ERP systems are traditionally thought of as transaction processing systems which is, indeed, what they are. But they are continually redefined based on the growing needs of an organization. For example, ERP system developers provide non-transaction based systems as an integral component of ERP systems. Electronic commerce, data warehouse, supply chain optimization, and advanced planning and

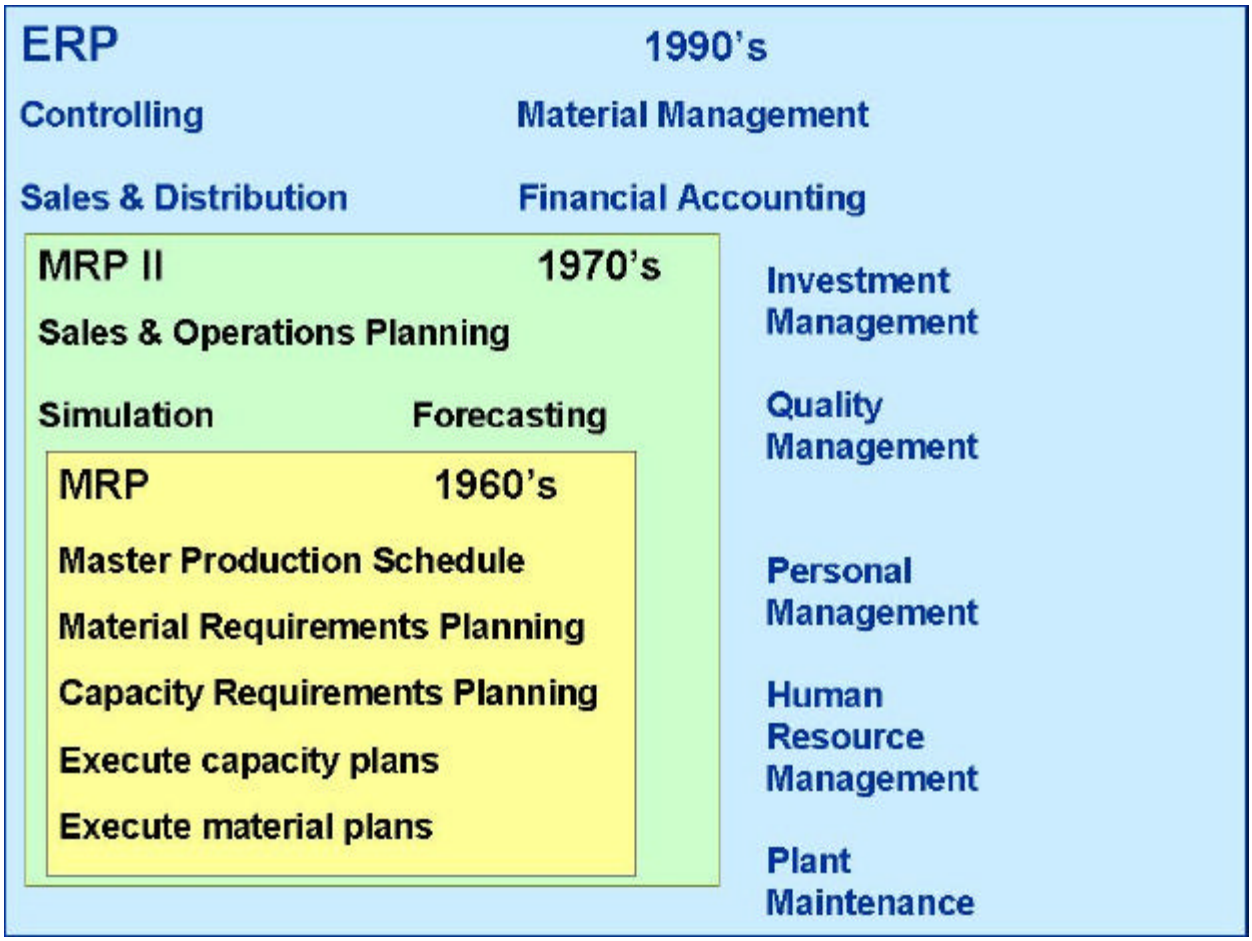

Figure 1: Evolution of ERP Systems

scheduling enterprise solutions are now available from ERP vendors. The growing interest in ERP solutions results in an industry with aggressive, powerful ERP providers that have research and development organizations loaded with PhDs that push the enterprise systems frontier faster than the academic world can keep up with it. Of course there is a need for technology oriented programs (at least) to stay abreast of developments and how they affect an industry. One such way for accomplishing this is through an ERP University Alliance program. The next section describes generically how an ERP University Alliance program

operates. Details about the SAP University Alliance of which LSU is a member are provided in the Appendix.

ERP UNIVERSITY ALLIANCE

An ERP University Alliance program provides an academic entity (e.g., a University, College, School, or Department) with a completely functional ERP system for research and teaching at reasonable or no cost. Without such an alliance it is doubtful that an academic unit could provide their students with access to such a system. Such a program provides significant learning opportunities for both faculty and students. What such an alliance offers is hands-on exposure to a real ERP system and a repository of related resources. For academic entities interested in providing an experiential-learning based hands-on approach to ERP systems education, there are a number of issues to consider. For example, what is the objective of an ERP initiative, how is an ERP system utilized by students, how does this enrich the curriculum, what are the benefits, and what are the costs. Section IV addresses these issues.

ERP HANDS-ON MODES OF OPERATION

This section identifies, at a fundamental level, various hands-on scenarios the authors have experimented with in classes. Table 1 summarizes this information.

OBJECTIVES OF AN ERP INITIATIVE

To use an ERP system successfully, one must develop and implement a sound plan. Doing so will require a significant amount of time, energy, and resources. It is important to determine, and agree upon, the objectives of the ERP initiative. Objectives that may be associated with an ERP system initiative include:

1. Develop a computer-based business simulator
2. Expose students to the real-world from the classroom

Table 1: Examples of ERP Hands-on Activities

Hands-on Scenarios	Description
Internet Surfing	By establishing a relationship with an ERP vendor, an academic entity has access to a repository of on-line (Internet) business and technical information. Also there are many public Internet resources available.
Intranet Surfing	The on-line help system available with ERP systems is essentially a business encyclopedia that serves as a valuable resource for study activities from finding out how to process a transaction to understanding business rules, principals, definitions and processes. This resource is integrated into the ERP system such that an inquiry directed from any location in the system will bring the user to location-specific documentation.
Role Playing	Role players use a business script. A business script defines a sequence of tasks used to simulate a business process (e.g. order management) or a business activity (e.g., business reporting and analysis). Processing a script is an (experiential learning) activity intended to illustrate a business concept or to conduct a business activity. This activity is *instructional* in nature.
Goal Seeking	Business scripts are not required to conduct business activity. The idea here is to provide students with an goal or objective (e.g., create a report to identify a relevant issue for a company, division, and/or distribution channel) and have the student figure out the best way to do it. These activities may develop various skills: *exploratory* (searching for the correct answer), *investigative* (building a case based on events that have occurred), and *diagnostic* (identifying patterns and causality, and determining the root of the problem).
Developing	Work in an integrated development environment to define needs and develop solutions using an array of development tools.
System Administration	Play the role of a system administrator and conduct typical administration, monitoring, and reporting activity for a client.
Simulating Implementation Consultant Activity	Use existing business models (i.e., blueprints) to benchmark best practices and to develop as-is and to-be scenarios for a specific process in an organization. Perform gap analysis. Use the ERP implementation tools to conduct an actual systems implementation of standard software (customized around a process or an organization). Available tools guide users from the beginning implementation phase to the final stages of implementation.

3. Develop cross-functional curriculum based on a state-of-the-art enterprise system
4. Enrich specific curriculum
5. Explore new research opportunities

6. Create a competitive advantage

1. Develop a computer-based simulator: Business schools are known for their business simulators that create pseudo corporate environments and challenge the decision-making skills of the students that play them. ERP systems provide such an environment in which to work. Compared to traditional simulators, ERP systems would be simulated at the transaction level. Unfortunately, such capabilities do not necessarily exist in commercial systems. If this is an objective, further research into the capabilities of specific ERP systems would be appropriate.

2. Expose students to the real world from the classroom: What an ERP system does provide is 'real-world exposure'. Student can take a look inside and see how it is built. Also, students can take it for a test run. After a few years of a traditional stove-pipe business education, students still have trouble understanding how all the components of an integrated system fit together. The ERP system provides this perspective. Students also have access to the "best practices" business models available in ERP systems.

3. Develop a cross-functional curriculum: Cross-functional business programs have recently regained popularity. ERP systems can be customized to fit the (cross-functional) business processes defined by an organization. As such, cross-functional case studies can be developed for an ERP system where students are required to solve a business problem using the ERP system. Any ERP-based exercise is a cross-functional exercise, but in-depth ERP-based case studies (that rival popular cross-functional Harvard Business School cases) are only beginning to develop.

4. Enrich specific curricula: Specific curricula, at the local level, can easily be enriched using an ERP system, as this paper illustrates. Traditional ERP educational material, generally geared toward an end-user audience, must be reworked in order to consider it University level educational material.

5. Explore new research opportunities: ERP systems should create research opportunities, and they do. From how these systems are developed, to

how these systems are implemented, to how these systems are used, to how these systems will grow, there are many opportunities for research.

6. Create a competitive advantage: As indicated earlier in this paper, an industry has been created based on ERP systems success. They spawned a new job market that has consulting firms and corporate leaders rethinking recruiting strategy. They provide an opportunity for academic units to develop a competitive advantage over rival schools.

Engaging in an ERP initiative can be justified simply by the need to know. Universities are criticized for their ignorance of and isolation from industry. Students and faculty knowledgeable about ERP systems help enhance the credibility of Business Schools in the eyes of industry.

We suggest that all of the above objectives are reasonable. Some are more difficult to achieve than others. The original intention when we began our ERP initiative was to give students real-world experience. This objective is being met. The second objective was to develop a cross-functional curriculum based on an ERP system. While trying to determine how to do it from a technical perspective, it became apparent that this objective would not soon be possible due to the complexity of reengineering an academic entity and the associated mental models. The third objective of enriching a specific curriculum became increasingly important as faculty realized how little they actually knew about ERP systems and how they work. A grass-roots approach to curriculum integration was initiated. The other objectives are, of course, active objectives that are continually pursued.

III. ENTERPRISE SYSTEMS KNOWDULES

The approach to curriculum development discussed here is referred to as the 'KnowDule' (know-jewel) approach. A KnowDule is short for a ‘knowledge module’ and is, ideally, designed to be an on-line learning module (presentation

material, presentation notes, references and links, and ERP hands-on exercises). Realistically, the particular KnowDules discussed here are used in a classroom/lab environment where team learning is encouraged.

The KnowDule approach for ERP education supported at LSU is as follows. An LSU College of Business Adminisration instructor involved in the ERP Alliance identifies a body of knowledge that may be uniquely supported by an ERP system, and develops a KnowDule that may be anywhere from 2 classes to 10 (or more) classes in duration. These KnowDules are then incorporated into specific courses, where appropriate. The courses are available to students at both the undergraduate and graduate level. Hence, a Systems Administration KnowDule may be used by 2 different instructors, each using it differently, and presenting it to different audiences (undergraduate IS students or MBA students who minor in IS, for example). This approach is illustrated in Figure 2. The KnowDules (right side) are developed for a general audience and utilized in specific courses (center) that are offered in a specific program (left side). The KnowDules are categorized based on if they are rather general, very specific to the process-orientation, considered advanced ERP functionality, or functionally oriented in a traditional sense. This structure gives each instructor flexibility in deciding how much time and effort to spend on a particular KnowDule.

This section presents ten KnowDules developed and used by the authors. The Knowdules described are illustrated on the right side of Figure 2 and are identified with a double asterisk. In the description of these KnowDules below, we indicate the number of 80 minutes sessions that we have used as lecture time to present and discuss this material. There is quite a bit of flexibility in how these KnowDules could be used.

SYSTEMS THINKING PERSPECTIVE

To begin the enterprise systems course, students are helped to appreciate the systems thinking perspective. ERP Systems provide a wholistic view of the business enterprise and epitomize the spirit of systems thinking [Forrester,1958]

as described by Senge [1990]. These concepts are introduced early in the program by way of the MIT Beer Game [1998; Forrester, 1961; Ackere, et al. 1993], a manually simulated team game. Players in the Beer Game form supply chain teams consisting of a factory, a distributor, a wholesaler, and a retailer.

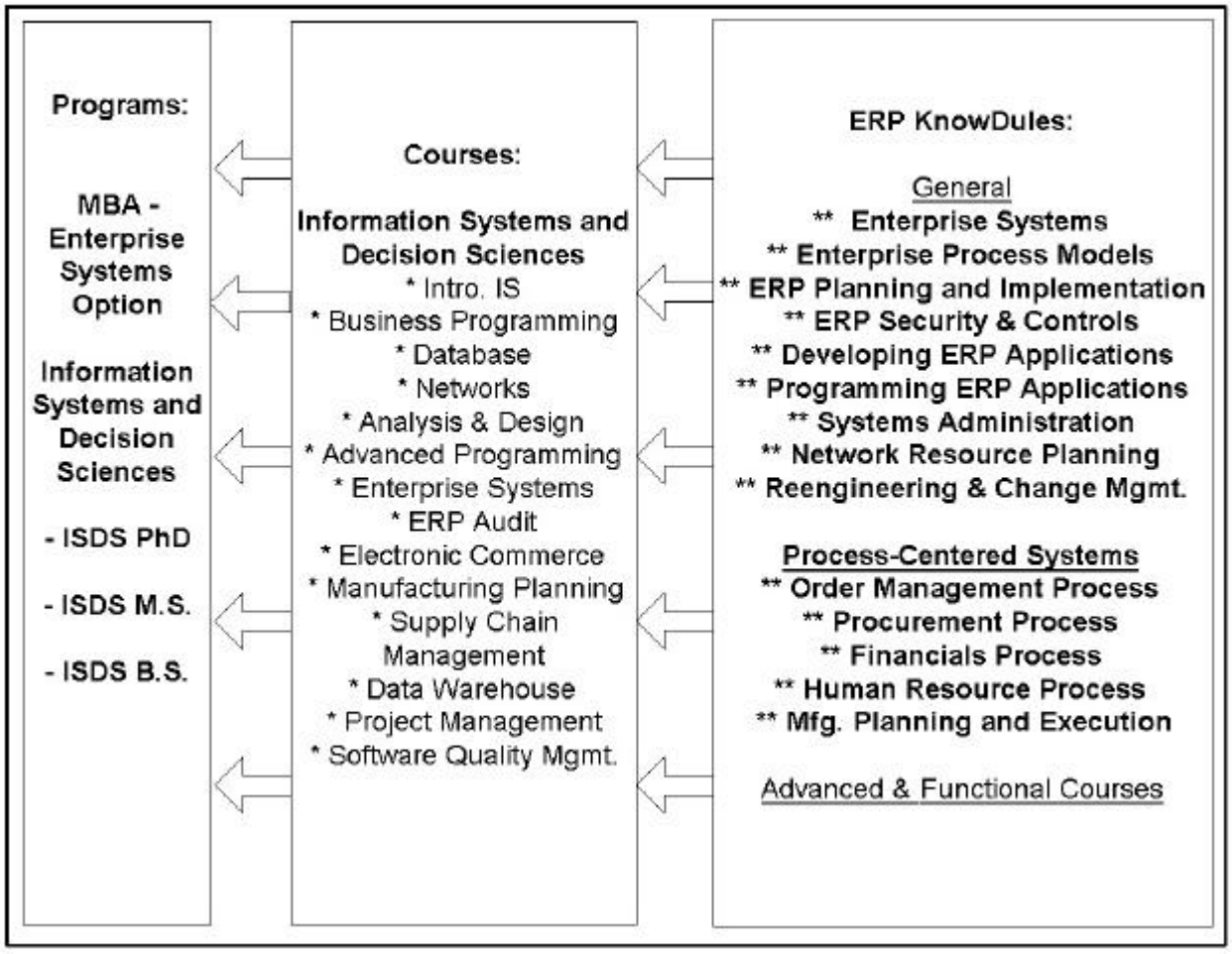

Figure 2: ERP KnowDules Incorporated into Specific Courses

Each team must assume a set of constraints and must simulate 50 periods of activity. At the end of the game, students are humbled by their poor performance, but dumbfounded when they learn that the performance of their team was due to their structure (e.g. constraints) and not due to the customer's demand uncertainty. This game forces students to appreciate the value of communication and team play in a complex organization. Later in the semester this game may be used to illustrate the dangers of local optimization by drawing

the analogy between the lack of communication between echelons in the beer distribution system, and the different (incompatible) information systems supported in a traditional legacy system.

KNOWDULE 1 (3 SESSIONS): ENTERPRISE SYSTEMS

At this level, enterprise (information) systems are introduced as the circulatory system of an enterprise. The objective in this KnowDule is to expose students to key elements of the ERP system:

1. comprehensive functionality,
2. concept of a business process,
3. implications of an integrated system,
4. common development environment, and
5. technical architecture (client/server)

Table 2 shows an outline of this KnowDule. In Part I, a case study involving Figure 3 is used to highlight many of the problems associated with legacy systems.

Table 2: Outline of Enterprise Systems KnowDule

Part	Title	Topics
I	Enterprise Systems Overview	• Historical perspective, legacy systems • Technical Architecture - the Client/Server model • Business Process Overview & Integration • Basic System • Planning and Implementation • The ERP Market & the Internet
II	Basic Business Process Overview	• Order Management and the Order -to-Cash Cycle • Integration points • Business blueprint • Audit procedures and reporting
III	Planning and Implementation Overview	• Strategies, Methodologies, Techniques, and R/3 tools • Configuration, Customization, and Modifications • Implementation Case Study
IV	SAP Basis Module Overview	• System Administration • Database Administration • Development Workbench • Business Engineering Workbench

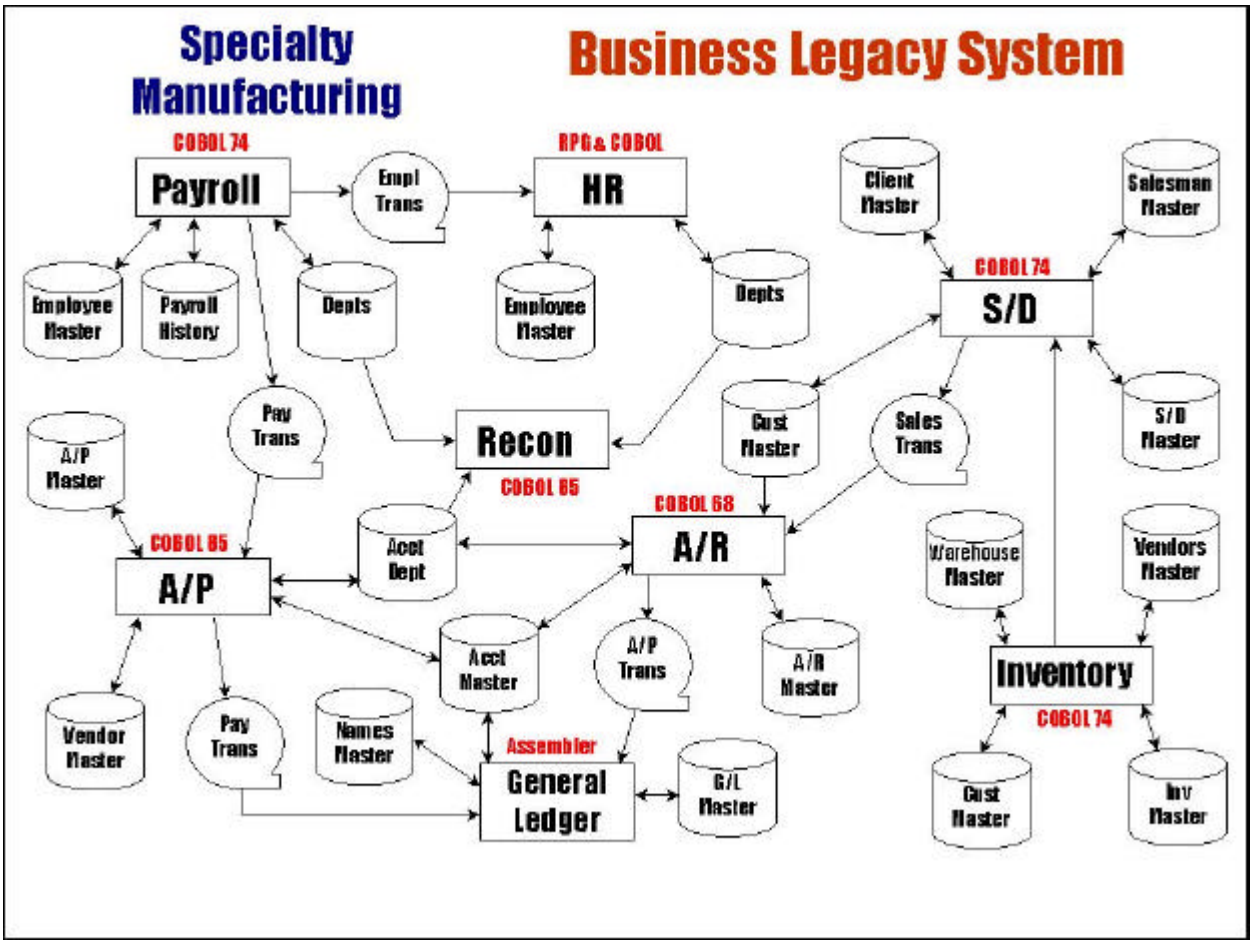

Figure 3: Business Legacy System Case Study

This KnowDule essentially provides a 50,000-foot altitude view of an ERP system. All topics, with the exception of Basic Business Process, require the instructor to demonstrate the appropriate system component(s) during the lecture. In the Basic Business Process topic, students are required to do a hands-on transaction processing exercise involving the order-to-cash cycle. A simple order management hands-on exercise is used to illustrate these points (Figure 4) and to introduce the concept of a process-centered organization and workflow. In order management, students are exposed to many aspects of the firm from sales and distribution, to production and accounting. The concept of an

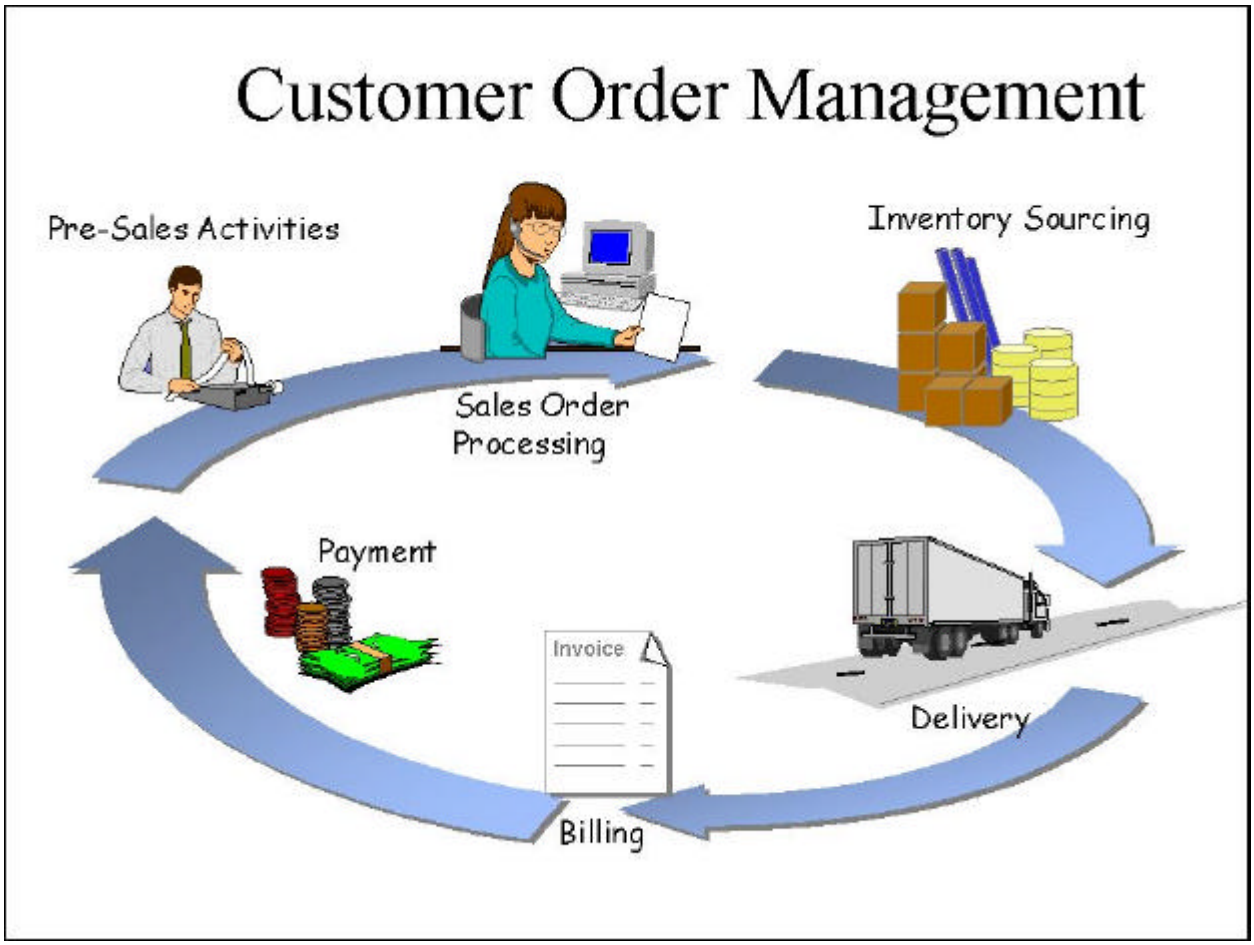

Figure 4: Hypothetical Order Management Business Process [SAP America, 1998]

integrated system is defined and illustrated by having students identify the activities performed by order managers that might typically be performed by accounting clerks (performing credit checks and creating billing document), inventory managers (determine inventory source and availability), and warehouse managers (creating delivery documents). Also, the students can see first hand what the implications of a common database are (e.g., how the vendor master record created by the order manager is the same one accessed by the accounting clerk for billing).

This KnowDule should illustrate to the students the importance of integrated systems in an enterprise. IS students can appreciate the role they play as change agents knowledgeable about both business and technology and the integration of business and technology. As communicated by a Partner at Deloitte Consulting [Gerth, 1998] "It is clear in our business that the most successful consultants/clients are those who do not try to separate the business process and the supporting technology."

KNOWDULE 2 (10 SESSIONS): PROCESS-CENTERED SYSTEMS

ERP systems provide the process-centered modeling perspective [Hammer, 1996; Hammer & Champy, 1993] so that organizations can design their work processes to support their core business processes (where a 'process' is simply defined as a set of tasks that add value to the customer). No longer do systems analysts design systems for functionally structured organizations. Instead, a process demands a system that integrates information and decisions from various parts of the organization, as illustrated in Figure 5.

In this KnowDule, the student studies five basic business processes (i.e., order management, procurement, financials, manufacturing, and human resources) each as part of an integrated system. Various concepts are emphasized and are supported by hands-on exercises:

1. Students study the *comprehensive functionality and integrated nature* of enterprise systems in very detailed exercises that require students to process transactions and determine the consequences of their actions [KLA & Hiquet, 1998]. Since much of the nuts-and-bolts of the system is hidden from the user, the student is forced to dig deep to determine what is going on behind the scenes. This process is challenging for the student.
2. To complete the exercises described in 1 above, students are required to reacquaint themselves to long-forgotten *business concepts* (e.g.,

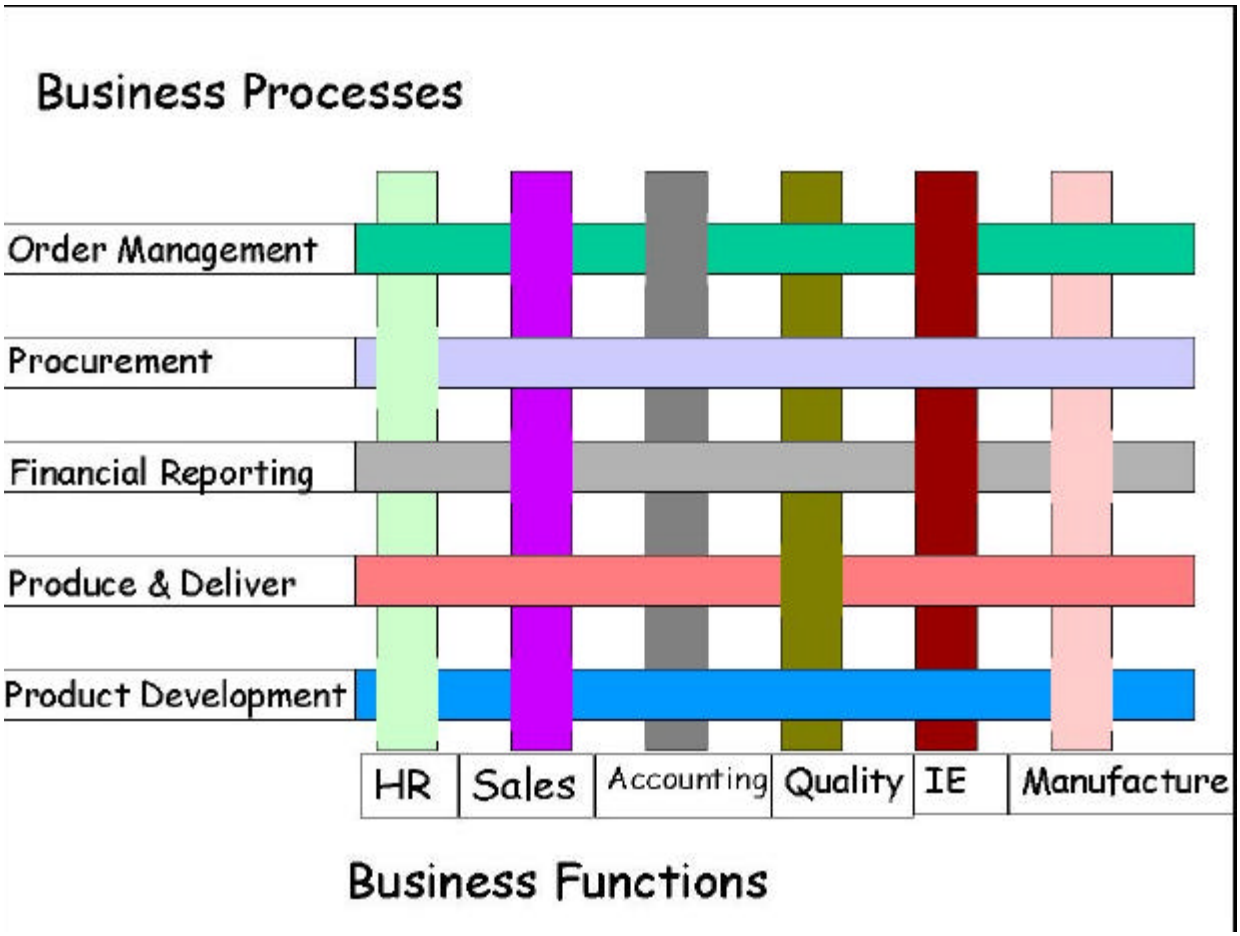

Figure 5: Process-Centered Integrated Systems

ABC analysis, MRP) and familiarize themselves with popular business terminology and definitions (e.g., dunning, post goods issue, delivery).

3. To complete the exercises described in 1 above, students are required to reacquaint themselves to long-forgotten *business concepts* (e.g., ABC analysis, MRP) and familiarize themselves with popular business terminology and definitions (e.g., dunning, post goods issue, delivery).
4. Students often are not very knowledgeable about the *data requirements* of an organization. The Enterprise System has an underlying database consisting of different types of data: master data,

transaction data, configuration data, and control data. Hands-on exercises provide students an opportunity to display existing data or create new data. Students tend to gain a decent understanding of the extensive data requirements in an organization, and of the different data types supported by an enterprise system.

5. Students use the *reporting and analysis functionality* in the system. They also can create their own reports and perform their own analysis.
6. Standard *business models* (i.e., best practices) are available in enterprise systems for viewing and manipulating. These models are another tool the students use to further study business processes.

KNOWDULE 3 (1-3 SESSIONS PER PROCESS): ENTERPRISE PROCESS MODELS

IS students are typically exposed to entity-relationships models, data flow diagrams, and (more recently) object-oriented models. But of all the popular modeling techniques that exist, none are very well suited to convey the integration of enterprise systems [Hay, 1995]. Other methods for describing business organizations and processes are quite complex and lack the ability to model parallel processes, or to provide important perspectives such as organizational or information-flow views [Curran & Keller, 1998]. The business models that underlie an enterprise system are complete and extensive and provide another dimension to the teaching of business models and business modeling. These models are referred to as *business blueprints* and *best practices*. The enterprise models used in this KnowDule are based on the concept of the event-driven process chain (EPC) method. "The EPC method portrays business information systems for the benefit of users, management, and consultants, while at the same time incorporating other important features such as organizational structures, functions, and data and information flow" [Curran & Keller, 1998].

In the SAP R/3 business blueprint, four basic integrated views of the enterprise are available:

1. process view: describes a business process as an integrated network of event driven process chains,
2. information view: concentrates on the essential information flow between event driven process chains,
3. function view: indicates the functionality available in any particular implementation, and
4. organization view: illustrates the semantic relationships between the various organizational units in the enterprise.

In this KnowDule, the ERP business models are used extensively to simulate process reengineering activity for industry projects. An existing process is selected, an as-is process blueprint is constructed (from the already existing business models) and a to-be process blueprint is proposed. The emphasis is on playing the role of a consultant to comprehend a real-world business process, conduct requirements analysis, identify and correct process inefficiencies, and develop a to-be process blueprint. It is also important to emphasize to students that the "software view" may not capture a complete picture of the "business view." Many consulting firms have business models that will complement the ERP system models. It is perhaps fair to say that SAP's business models account for up to 90% of business activity. Hence, business activity that is not captured by the ERP system and that is necessary to support will lead to system modifications or extensions. In this KnowDule, the students are confronted with the issues of where to draw the line between supporting functionality and paying for it.

KNOWDULE 4 (4 SESSIONS): ERP PLANNING AND IMPLEMENTATION

The over-all theme of this Knowdule is planning and implementing ERP systems. This KnowDule covers implementation planning strategies, methodologies, and tools.

First, implementation strategies and methodologies are studied. ERP systems are modular in design. For example, the Financials Module can be implemented first, followed by the Procurement module, and then the Manufacturing Module. etc. Also, ERP systems are designed for multi-national organizations. So there are many different strategies used for unrolling an ERP system throughout an organization. There are no hands-on exercises associated with this module but this discussion is generally enhanced if students have had hands-on exposure to an ERP system.

The *traditional approach* to ERP implementation gained the reputation of being reengineering intensive in large part due to the early target audience of ERP vendors: large, multi-national firms with annual revenues exceeding 2.5 billion dollars. When the large firm market for new implementations dwindled and smaller firms complained that ERP was too costly, ERP vendors were forced to reduce cost. Cost cutting was accomplished by creating lean implementation methodologies that are based on the experiences and best practices of previous implementations and that permit less process reengineering and more ERP system conformance. These new methodologies often are associated with names that imply fast, rapid, or accelerated implementations. Students study various ERP implementation strategies that have been adopted by consulting firms and by the vendors themselves. For example, they study the implications of the accelerated implementation approach on various implementation threads (project management, technology, security and audit, change management, training and education (see Figure 6)), and the over-all ERP/BPR effort and the impact on the organization.

The second part of this KnowDule takes a more hands-on approach by first looking at the available ERP implementation tools and then by engaging in the mechanics of configuring the ERP system based on user requirements. A project management tool is available to initiate, facilitate, and maintain the information flow between organizational units during an implementation. This tool

provides detailed plans and ‘work packages’ to guide the process throughout the

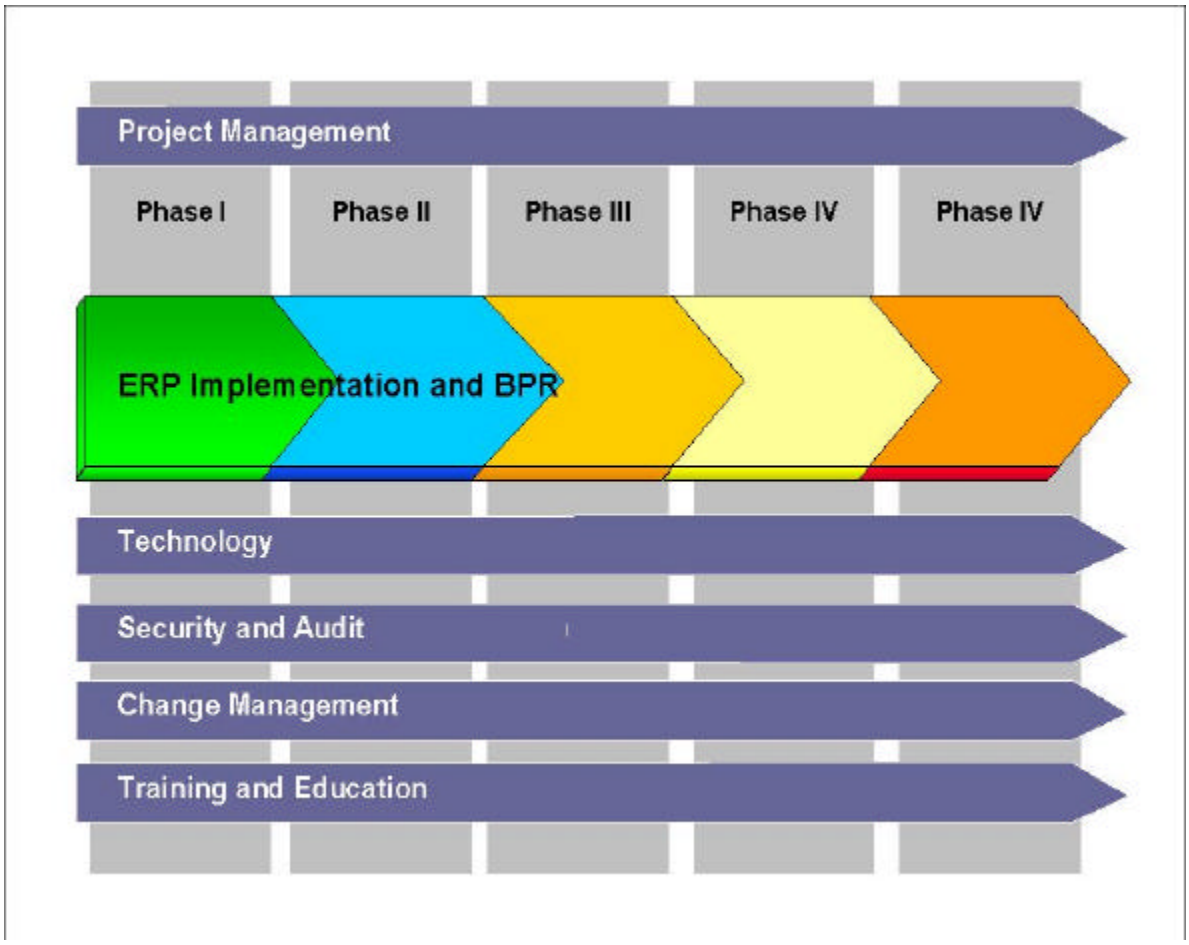

Figure 6: ERP Implementation Threads Cross Project Phases

project life-cycle (from concept past implementation to maintenance). The business models are used to define and to communicate the to-be processes from multiple views (e.g., functional view, process view, data view, organization view, and information flow view). Essentially, "in order to engineer business processes, and according to standard software requirements, the implementation of customized software determines who may execute which functions, with which data and according to which processing logic" [Kirchmer, 1998]. An important part of the implementation process is how to *configure* a software system based on the business to-be model.

An implementation tool is available to demonstrate this configuration process. Also, since most companies require some non-configurable extension to the software package, a discussion of *customization* and *source-code modification* follows. An introduction to the ERP development environment is provided but students are not required to gain familiarity with the development process at this time.

Case studies and notes are often used to support further discussions on project management and risk management. Another approach that the authors are currently evaluating involves the implementation of an ERP system for an entire company. Student teams are formed for each core process associated with the predefined organization (e.g., order management, procurement, production, financials, human resources). Each team identifies the user requirements, develops the to-be business blueprint, customizes the ERP system to represent these processes, and processes a single week of transactions. To avoid conflicts with the students using the hypothetical business database in other courses, a separate instance of the system must be used in the implementation.

KNOWDULE 5 (1-2 SESSIONS PER PROCESS): REENGINEERING & CHANGE MANAGMENT

All ERP implementations involve some level of business process reengineering and change management. This is viewed as an important part of the ES education. Often in parallel with the study of ES business processes, students study process-oriented reengineering case studies. A number of Harvard Business School case studies that are closely aligned with core business processes case be used in this KnowDule. Students have the opportunity to analyze a broken process and to propose process improvements. An improvement may or may not involve a customized software solution. For a deeper look at process innovation and reengineering, a book by Davenport [1993] is used. This KnowDule is usually used to support KnowDule 2 on *Process-Centered Systems*.

KNOWDULE 6 (4 SESSIONS): ERP SECURITY, CONTROLS, AND AUDIT

The security of an enterprise system is controlled in large part by how access privileges for users are defined and maintained. Executing certain tasks in the system will require certain authorizations that can be assigned to a specific profile (or function) which can then be assigned to specific users. The systems administrator is typically responsible for ensuring that the implemented controls provide adequate security. These issues are studied in this KnowDule.

The roles and responsibilities of a systems auditor are also studied. Besides the enterprise system itself, security must exist for the network system, the operating system, the database and the front door. Students engage in exercises to define and test secure user profiles, and to conduct simulated audits of the system by preparing extensive reports. Any time data moves in the system, there is the potential for a security leak. Version management and change management are processes that the students can engage in and study in order to experience first-hand the difficulties with designing a secure system.

KNOWDULE 7 (4 SESSIONS): SYSTEMS ADMINISTRATION

The systems administration function for an enterprise system is extremely large. The presence of a real system to study is perhaps the single most valuable learning instrument. A number of administration concepts are covered. Hands-on exercises support most of these concepts:

- Technical Architecture: Three-tier and client/server, Logical units of work, services, servers
- ERP directory structure and files: Initialization and control files and their uses, ERP directories and their uses, Correction and Transport System (CTS), Setting up CTS and the workbench organizer, Making and releasing change and transport requests, Using tp to run transports
- Data Dictionary: Fundamentals of relational data model, What are domains and elements, Changing and creating tables, structures,

domains and elements, Managing the database through the Data Dictionary

- User Administration: Creation and maintenance of authorizations, profiles, and users; Understanding the overall ERP security scheme.
- Client Maintenance: Creation of clients; Running client copies, imports, exports, deletes; Setting up clients to be locked or open for changes
- Computer Management System: Maintaining profiles; configuring and assigning operation modes; monitors; system alerts
- Database Administration: Overview of underlying database structure (extents, segments, blocks, etc); Redo logs and mirrored redo logs; ERP DBA capabilities; table space administration – extending and creating new table spaces; database reorganization; database backup and restore procedures
- Performance monitoring and tuning: Checking system performance and dialog response time; buffer swapping; finding database errors; changing system profiles to alleviate performance problems

A separate Systems Administration group, consisting of students, essentially runs the on-site ERP implementation and ensures that the system is up and running for each course.

KNOWDULE 8 (4 SESSIONS): DEVELOPING ENTERPRISE APPLICATIONS

The ERP development environment is unlike any programming environment the student will be exposed to in a traditional IS curriculum. Students often have the impression that they can install a compiler on their home computer and start developing applications for a large enterprise. In the SAP System, for instance, creating a program often means creating more than just a program. It frequently involves the creation of development objects to support the

program. Also, programs never work independently but are in integral part of the business application.

The ERP development environment is (in general) a fully integrated set of development tools, functions, programming languages, and a data dictionary that requires a knowledge of the system internal structure in order to develop applications. Enterprise systems are very much based on standards for user interface, database development, programming and communications, with an underlying data model that contains the relationships between the business applications. The development environment contains significant development tools for programming (e.g., editor, data dictionary, user interface, function libraries, menu system), navigational features, debugging tools, and development management. Important concepts introduced in this KnowDule include:

- Programming Editor: Program attributes; source code editor; downloading and uploading source code; special features; checking and generating code
- Screen Painter: Screen flow logic; developing, testing and verifying dynamic screen painter programs
- Menu Painter: Menu painter objects; creating a GUI title; testing and generating GUI Status; function library; function library structure
- SQL trace tool: Creating a SQL trace; analyzing a SQL trace;
- Debugger: Elements of the debugger; breakpoints; displaying and modifying values; internal tables
- Object Browser: Object lists; maintaining development objects;
- ABAP/4 Language: Variable and data types; flow control elements; operational elements; event elements; functions and subroutines; interpreted vs. compiled programs; Event-driven logic.

A hands-on exercise is used in this KnowDule to provide an overview of enterprise data modeling and application development. The components of an enterprise development environment are introduced: data dictionary, editor, function

library, screen painter, menu painter and object browser (which provides the programming context). The exercise is broken up into six lessons as summarized in Table 3. Students are lead through these exercises in a tutorial fashion. In this manner students are required to gain familiarity (not expertise) with the programming language and environment. Therefore, a major time commitment is not required and the process is generally clean.

These lessons prepare the student for more advanced work in enterprise modeling and application development. The exercises are most effective if preceded by a lecture to clarify the objectives of the assignments with an overview of the enterprise systems and enterprise development concepts. Teamwork is also required.

KNOWDULE 9 (12 SESSIONS): PROGRAMMING ENTERPRISE APPLICATIONS

This KnowDule is intended for the student that is interested in gaining some level of proficiency in a specific ERP application environment. This KnowDule requires that students already be proficient programmers (our students have received formal education in C, Visual Basic, and Internet development). After 4 sessions of introductory material, students are required to work throughout the semester on extensive tutorials that are available through the ERP System.

Although students are graded independently, they generally work in teams, in close collaboration with an instructor. During the semester, this group of students meets weekly with the instructor to discuss difficult concepts. In previous semesters, students were graded based on their ability to complete the assignments provided in the on-line tutorials. In coming semesters, instructors will solicit industry projects for students to work on.

Table 3. Database Design Lessons

Lesson	Objective	Tasks
1	A basic understanding of the available development tools	• Identify concepts underlying the Workbench • Open the Workbench in the SAP window • Exit the Workbench. • Identify the Workbench tools and their functions. • Navigate through a program. • Create a new program. • Create a new transaction.
2	Introduces tables in the ERP system. A good understanding of how to work with tables is needed before going on to design and create complex tables	• List the steps needed to create a table. • Recognize the key components of a table. • Identify the tool that creates tables. • Create a table from the Object Browser. • Activate a table. • Add a field to a table. • Define a value list. • Specify how the system should handle a table.
3	Uses the Screen Painter to create a screen where an end-user can enter data	• Identify major concepts associated with an ABAP/4 screen. • Create an initial screen. • Arrange a screen's elements. • Characterize screen elements. • Run a prototype of a screen.
4	Uses the Menu Painter to create a GUI status and its accompanying menu bars. Menus are added to the screens that were created in lesson 3	• Define the concepts underlying menus. • Create a menu bar for a screen. • Define function keys. • Create a tool bar for a screen. • Specify window titles.
5	Uses the Editor tool to enter the code to complete the application. The coding of the instructions tell the ERP system how to process information the users enter	• Identify underlying coding concepts. • Create screen flow logic. • Generate a screen interface. • Create code modules. • Copy code modules from existing modules. • Check syntax. • Create messages**.**
6	Involves the design of the database using the database query functions and explains how to create query templates.	• Utilize above concepts to demonstrate the functionality of the application and the utilization of the query tool.

KNOWDULE 10 (3 SESSIONS): NETWORK RESOURCE PLANNING

Part of the reason Enterprise Systems have been popularized and implemented so rapidly is that many vendors offered a Client/Server (C/S) enterprise computing alternative at a time when the Client/Server concept became a much desired alternative to mainframe computing for organizations in the early 1990s. Having an enterprise system that runs on a C/S platform provides instructors with the opportunity to show first hand how such systems work [Buck-Emden & Galimow, 1996; Hernández, 1997; Cook, 1996]. This KnowDule deals with the issues related to the planning of an ERP implementation from the point of view of the network infrastructure required to support that implementation. The actual ERP system implemented on the University network becomes the experimental test bed for this KnowDule. Knowledge of the ERP Applications and how they are used is important when designing a network architecture to support such processes. The study of communication patterns between the ERP GUI and ERP application servers across the organization's network provides interesting hands-on exercises. The design of this KnowDule was based on a popular trade book [Clewett, et al., 1998] and from experiences with the LSU University network. Topics covered in this KnowDule include:

- Determining system objectives
- Evaluating current systems and establishing a baseline
- Collecting valid traffic demand data
- Evaluating performance of alternative capacity planning ("what-if") scenarios
- Running network simulations
- Designing networks to meet capacity requirements
- Limitations of network resource planning techniques
- Evolution of network resource planning processes and tools

CURRENT DEVELOPMENTS

The opportunities for curriculum enrichment seem boundless, especially as ERP vendors incorporate additional functionality into their ever-expanding enterprise systems. The following list identifies other opportunities that are currently under development at LSU:

- Data Warehouse: Data warehouse solutions in the past have typically been home-grown, or third party initiatives independent of the ERP solutions. Within any data warehouse, data must first be extracted from diverse sources and mapped to the specific data structures required for analysis and reporting. Organizations are moving towards data warehouse solutions that are an integral part of the ERP system (thus alleviating many connectivity problems), and many ERP vendors are providing this solution. In this KnowDule we intend to study the design and operation of a data warehouse solution that is an integral component of the ERP system.
- Supply Chain Management and Optimization: ERP vendors are either buying or building a supply chain optimization component for their ERP solution. This provides many opportunities to study supply chain dynamics and how the supply chain affects standard ERP business processes.
- Electronic Commerce and Internet-based Application Development: ERP system vendors are aggressively pursuing the electronic commerce market and are providing E-commerce solutions for many business processes (electronic procurement and web-based employee self-service schemes, for instance). This KnowDule will study the evolution of Internet solutions for ERP systems, with a specific emphasis on the development of Internet-based applications for ERP systems.

- Enterprise Project Systems: ERP systems often have an integrated project management module that is used to manage efficiently the stages of a project from planning to completion. The valueadded by this type of system over other project planning systems for education is that it is an integral component of the ERP system and can therefore produce more relevant data in a more timely fashion.

III. GETTING STARTED

After evaluating the potential value added by an ERP system can make to the current curriculum, it is important to determine approximate costs associated with this initiative. In this section we first look at the cost considerations associated with IT architecture and training. We also suggest a way to minimize system administration costs. We close this section with a look at some critical success factors and additional benefits that might be considered when developing a plan for ERP deployment in a curriculum.

THE COST COMPONENT

Start-up costs involve three basic categories of costs: hardware, software, and training. The assumption made is that the enterprise system will be implemented in a client-server environment. Furthermore, we assume a single-server houses both the database and the applications (i.e., a distributed presentation environment). This is a reasonable, perhaps least cost, start-up architecture (see Figure 7). Note that remote logon for all students may alleviate the need for a computer lab. On the other hand, remote logon may pose a liability for the academic unit if a computer hacker (through the use of the ERP GUI) gains access to a corporate database stored with the ERP software. The assumption made here is that a student computer lab is required for student access.

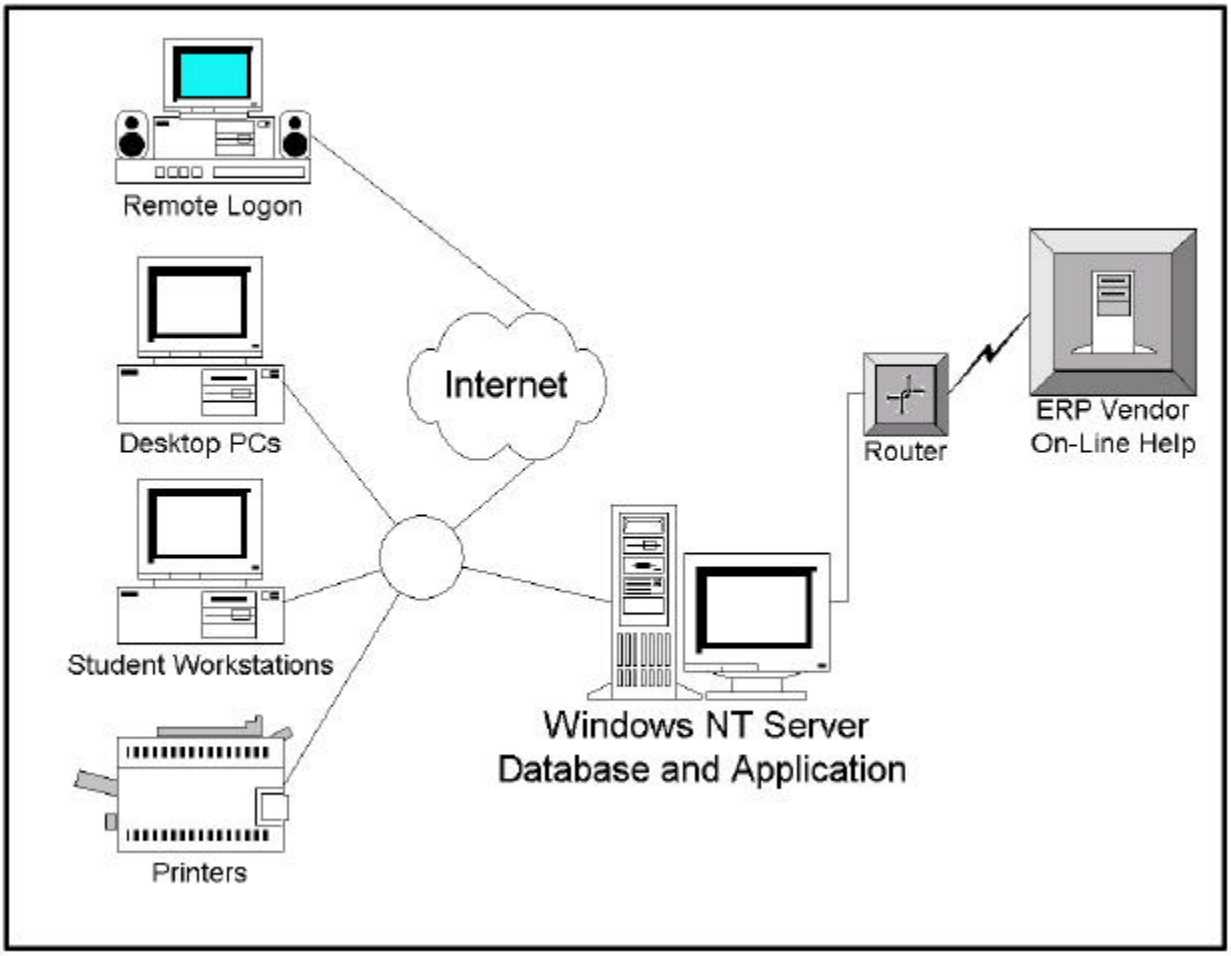

Figure 7: Simple Architecture to Support an ERP Education Installation

HARDWARE (SERVERS, WORKSTATIONS, PRINTER, PLOTTER, NETWORK)

Server: The server will house a large database and many business applications that may be used by many simultaneous users (in a classroom environment, for example). For this reason a 2-, or 4-processor system, with 1 to 2 gigabytes of random access memory, and 50-100 gigabytes of hard disk space is well justified. Exact requirements, of course, depend on how many simultaneous users will be logged on. Also, faculty may share data sets or may

require independent environments in which to work. These considerations affect disk requirements.

Workstation: Desktop, or laptop PCs will run the ERP GUI. Workstations should be available for student access, faculty access, and classroom access. The requirements to run an ERP GUI are minimal. It is reasonable to assume that a basic configuration common in a computer today is adequate. Hence, if current PCs are outdated then a memory or processor upgrade may by necessary. Specific requirements will depend on how much hands-on is expected. Otherwise, computer labs that are current to modern standards should be sufficient to run an ERP GUI. Remote access to the ERP Server, over the Internet, may be an option that is desirable to students and faculty. In this case, computer lab requirements may not be an issue.

Printer/Plotter: The demand for printing and plotting may be significant especially since 'real-world' business models are available. As a result, there may be heavy printing of text (e.g., on-line help) and graphics (e.g., business blueprints).

Network: The network requirements are typical of university environments. It may be desirable to access the ERP server from either the Internet, or from a university's LAN.

SOFTWARE (OPERATING SYSTEM, DATABASE, ERP)

Besides the Enterprise System itself, an operating system and database are required. The operating system required most likely will exist in the current environment. A commercial database will be required (e.g., Oracle or SQL Server).

TRAINING (FACULTY, STAFF)

The cost of attending training (for a limited number of days) is usually covered in the initial fee. The traveler must cover the travel expenses associated with attending training. The number of days required depend on the number of

faculty and staff involved, the capacity of faculty and staff to learn independently, and the degree to which the enterprise system will be used in the curriculum. It is reasonable to assume that faculty in an ERP initiative should receive 1-2 weeks of training over the course of a year. Scheduling training when school is in session is often difficult.

ANNUAL MAINTENANCE AND SUPPORT

Maintenance costs include upgrades and delta training (i.e. training required to stay current on the functionality of the new releases). Again, where training is involved, travel costs may result.

On-site support is important during the initial installation of the system. Also, access to remote support is recommended to avoid major problems. Most ERP contracts will acknowledge this need and support it as part of the contract. Perhaps the most valuable 'support' resource to the program at LSU has been LSU alumni that play a significant role in their organization's ERP initiative. These ERP experts are generally more willing to lend a hand in desperate situations than others that have no vested interested in the academic unit.

The greatest costs may be attributed to opportunity cost. Faculty spend a significant amount of time and effort to learn the system and develop a curriculum that uses the system. This time may or may not be better spent elsewhere. Hence there is an opportunity cost that is difficult to measure.

The scalability of a client/server environment provides flexibility in determining how to grow the system. An additional server would allow a three-tier environment where the database has a dedicated server and the applications have a dedicated server. It is questionable whether a three-tier C/S is necessary in a training/education environment. Another option is to create multiple 'instances' (i.e., an administrative unit) of the enterprise system so that, for instance, both servers are setup up as independent distributed presentation environments where the first server supports training requirements and the second server is a 'sandbox' for developers and administrators. In any case,

there will be more opportunities to experiment when multiple servers are available. For example, data and program transports between development, test, and productive environments can be practiced on the system when multiple instances are available.

GETTING THE IMPLEMENTATION RIGHT

There is a definite and measurable cost for getting the implementation right, or at least to the point of where the system is ready to be used. This cost can be significant and may vary widely depending on the specific implementation. Below are a list of "pitfalls to avoid" when planning your implementation:

- Don’t expect your local hardware sales team to understand the first thing about sizing an ERP system. You should contact the national ERP competency center for the specific hardware vendor that you are pursuing and ask them to provide you with appropriate specifications.
- Be aware that you may be installing an ERP system *and* a training database. In many cases, you will require specific versions of an operating system, a database, and the ERP system in order to use the training database.
- Don’t assume that your first-rate, highly competent support staff can handle ERP implementation support and maintenance like they handled everything else in the past. The ERP beast is unlike anything that came before. The most valuable asset to our program has been real-life ERP consultants who, for some reason or another, are happy to give a helping hand in desperate situations (e.g., alumni, friends, family). Endless hours of diagnosing a system to identify a problem by a first-rate staff can be accomplished by an ERP consultant in minutes. Note that good ERP consultants are always on the road and are often difficult to track down.

- If you don't have a first-rate highly competent support staff, proceed cautiously.
- Make sure your support staff spends wisely every minute of the ERP system consultant's time on the premises. And make sure your staff takes good notes. (The assumption here is that the ERP vendor will provide a consultant to install the ERP system on your site).
- Contact faculty and staff from other University Alliance members to learn more about what to do or what not to do.
- During implementation, keep in touch with faculty and staff from other universities to bounce problems and ideas off of.
- Don't let your ERP system vendor leave the premises prior to demonstrating that the system is up and running.
- Try to avoid being one of the first three schools to implement a particular type of ERP system.
- Avoid an Alliance that is not supported by at least one full-time person from the ERP vendor.

SYSTEMS ADMINISTRATION RESOURCES

A major concern when installing a system of this size are the ongoing duties of the systems administrator. In today's market, people with these skills are in high demand and often move from company to company to take advantage of salary raising opportunities. Many companies provide incentives to employees in an attempt to keep them.

Academic units are often not able to match the salaries of these valued employees. An alternative to employing an administrator full-time is to train students to play the role of system administrator. This option is very much supported by students eager to learn skills that will increase their career opportunities and marketability. For this reason, a student-run environment may

be more enthusiastic, open, and productive than an environment run by an in-house full-time support staff. Another point to consider is that the ERP software from an IS teaching perspective is intended to be crashed, ripped apart, and put back together by students. Traditional IS support staffs may not view such an environment as desirable. This requirement supports the need for multiple *environments* or *instances* of the system. For example, a training environment should run smoothly all the time, whereas a development/test environment (i.e., a sandbox) should be at the mercy of the 'scientists'.

Most universities currently have a legacy administration function in the college or university. A good middle ground is to train the full-time administrator as the super-user responsible for the administration of the operating system, database, network, computer lab, and core enterprise system. Students can then begin by taking care of the day-to-day administration and maintenance activities such as creating user accounts and user profiles.

OTHER BENEFITS TO CONSIDER

A few other relatively smaller benefits are associated with an ERP University alliance. Such an alliance may be the best way to expose faculty to state-of-the-art ERP systems, short of actually working with the system in industry. Besides the on-line system documentation and tutorials, numerous technical and business conferences are available that may be otherwise unavailable to the public. Add to this the many books, manuscripts, CDs and publications that are also available.

Recruiters that are eagerly searching for talented graduates are often an excellent source of guest speakers. The speakers will often work to develop valuable content, not just sales or marketing presentations. For example, ERP consultants can share valuable real-world experiences dealing with business issues from a number of industries and a number of organizations, such as choosing the appropriate implementation strategies, methodologies, and tools; designing information technology architectures for organizations, developing

enterprise applications, auditing enterprise implementations, identifying and dealing with change management issues in a large organization, supporting the supply chain needs of an organization, and utilizing ERP business models during an implementation.

Besides full-time employment opportunities for recent graduates, an ERP program is sure to elevate the enrollment of the internship and co-op program. On-site seminars, workshops and training, besides providing financial rewards, are an excellent way to build industry ties.

CRITICAL SUCCESS FACTORS

An academic unit should expect to expend considerable time and resources to plan, install, and deploy an ERP system. An action plan should be developed early that emphasizes a number of key critical success factors.

- Executive sponsorship implies that high-ranking administrators are committed to this initiative.
- An ERP Faculty Team is responsible for learning the system and using it wisely.
- Students play an important role by assisting the curriculum development efforts.
- An ERP Industry Advisory Group will assist in the usual fashion, though this advisory group will consist of members with specific ERP experience in their company.
- A faculty training program ensures faculty receive the necessary information and knowledge about the ERP product. An in-house study group should disseminate important information and engage in necessary mindshare.
- A physical facilities plan ensures that appropriate resources (e.g., computer hardware, networks, communications, etc.) are allocated to the initiative, especially as it grows over time.

- A pilot implementation should be considered to minimize any unanticipated disruptions in the academic environment.

V. SUMMARY

Many learning experiences occurred from almost 2 years of experience working with the ERP systems in the classroom. Despite the significant time, effort, and money resources required to ensure a success, it is believed that the benefits far exceed the costs. LSU's students are developing a deeper and broader understanding of how an enterprise works. From the basic business processes to the development and administrative activities of an enterprise system, there are many valuable hands-on learning experiences. A major benefit of an ERP initiative, in this decade, is the ability to attract key recruiters to the campus. When ERP systems reach the end of their life, as indeed they must, the recruiting benefit will end. When this happens, it is perhaps realistic to imagine that ERP-based education will continue to excite the students and enrich the IS program. Until, at least, the next killer application takes the business world by storm.

Editor's Note: This paper was received on December ___ 1998 and published on ____ 1999. The paper was with the author for approximately 2 months.

REFERENCES

EDITOR'S NOTE: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that

1. these links existed as of the date of publication but are not guaranteed to be working thereafter.
2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
3. the authors of the Web pages, not CAIS, are responsible for the accuracy of their content.
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APPENDIX A: SAP UNIVERSITY ALLIANCE PROGRAM

The SAP University Alliance is the first alliance of its kind known to the authors. SAP AG was founded in Germany and has for many years been closely associated with German universities (e.g., University of Mannheim). Many

German professors played an important role, and continue to play an important role, in product development. SAP AG is heavily staffed by PhD's from German universities. SAP Labs, Inc. (formerly SAP Technology, Inc.), headquartered in Walldorf, Germany, develops software and add-ons for the SAP R/3 System. SAP Labs has other PhD intensive locations across the globe including Palo Alto, California.

SAP America, the American subsidiary, initiated the University Alliance program in 1997, though the software was used at two Universities prior to 1997 (namely the California State University at Chico and the University of California at Irvine). Currently there are over 50 U. S. Universities that are involved in the SAP University Alliance. The University Alliance in the U.S. served as a role model for other universities around the world because of the unique and successful manner in which SAP R/3 is being integrated in the curricula.

This appendix provides some information about the SAP University Alliance Program. LSU chose SAP for a number of reasons:

- SAP is the market leader with nearly 40% of the ERP market. The closest competitors in this market (PeopleSoft, Baan, J.D.Edwards, Oracle) reportedly have 4% to 12% of the market and struggle to keep up with SAP's pace.
- SAP reportedly puts 20-25% of annual revenues into R&D. SAP is known to staff many PhDs and to maintain strong ties with universities. We believe that SAP will continue to redefine business computing faster and better than anyone else for many years to come.
- SAP supports a healthy work environment and a strong work ethic. SAP offices are often better than campus environments.
- SAP has the most mature and well-supported University Alliance program known to the authors.

- The SAP R/3 System is the most comprehensive ERP System available and can be used by business, engineering and computer science programs.
- SAP supports a competitive grant program for Universities. In 1998, over $2,000,000 worth of cash, hardware and software was awarded to Universities.

DESCRIPTION OF THE SAP UNIVERSITY ALLIANCE

SAP America, Inc. sponsors a University Alliance program that provides universities with a complete version of its R/3 system and a training database that is based on a hypothetical manufacturing company (Motor Sports International, or MSI) along with associated documentation, technical support and faculty training. The university, in turn, integrates SAP R/3 into its curriculum and provides the support necessary to maintain systems and curricula. In addition, academic units share their experiences with SAP and other University Alliance Program members.

SAP established its University Alliance Program to support faculty in the development and delivery of creative and innovative curricula that teach students the concepts associated with ERP. Alliances that have been formed with academic units at various Universities (e.g., LSU, UT Austin, California State University at Chico, University of California at Irvine, Central Michigan, Indiana University, Georgia Tech, Drexel, and University of Florida, to name a few) are each interesting and unique. Common among the alliance members is that creative and innovative curricula are being developed and delivered. Attributes that make each program unique include:

- Which aspects of R/3 are emphasized,
- Which programs/departments support the Alliance,
- How R/3 is actually used in existing programs,

- Which students are affected (undergraduate, MBA, business, engineering, computer science)
- How extensively R/3 is used,
- How many faculty are actually involved in the nuts and bolts of R/3.

As of the end of 1998, there are over 50 academic units that are members of the SAP University Alliance.

The MSI Training Database, provided with the R/3 system consists of R/3 data from a hypothetical company which has "gone live". The training database can be used to:

- execute transactions (e.g., post journal entries, assign costs to cost centers, place purchase orders, issue invoices, etc.),
- analyze company performance (e.g., product line profitability, actual vs. planned sales analysis, financial reporting), and
- evaluate the business structure of the overall company.

Examples of the training database information include:

- *Financial Accounting*: definition of and data for the company's organizational structure (subsidiaries, group units, business areas, functional areas, consolidated areas), general ledger chart of accounts and subledgers, customer credit limits.
- *Treasury*: Cash budgeting and management data.
- *Controlling*: Definition of controlling areas and operating areas for purpose of cost and profitability analysis. Cost and sales data, overhead and labor rates, actual costs.
- *Logistics General*: Definition of and data for inventory, plants, product lines.
- *Sales and Distribution*: Definition of and data for sales organization, customer master records, distribution channels (wholesale, retail, VAR's, etc.) shipping, quotations, and order processing.

- *Materials Management*: Definition of and data for manufacturing components, sub-assemblies, finished goods, bills of material, work centers (station on a production line), routings (sequence of production operations). Master production schedule, capacity planning, plant maintenance.
- *Human Resources*: Definition of and data for personnel areas, employee groups, personnel master records, payroll, benefits administration, organizational development.

Additional information about the SAP University Alliance is available at http://www.sap.com.

ABOUT THE AUTHORS

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