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Enterprise Systems Education: Where Are We? Where Are We Going?

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ABSTRACT

Enterprise systems are used by companies worldwide. As the importance of enterprise systems has increased in the corporate world, so have their importance increased in IS education. As a result, enterprise systems education impacts the IS curriculum of many universities. The maturity of enterprise systems education has developed over the years, however, when compared to other maturity models, enterprise systems education has a long way to go. As part of its mission to support Information Systems (IS) education, **JISE** is pleased to publish this special issue devoted to enterprise systems education. A Teaching Tip, a Teaching Case, and eight papers on varying enterprise systems education topics are presented.

Keywords: ERP, enterprise systems, maturity model

1. INTRODUCTION

Industries worldwide have continued to invest in enterprise systems and the expansion of these systems to sustain a competitive advantage. As educators, we must bring the issues and practices of industry to the classroom. The implementation of enterprise systems curricula over the past 8-10 years in universities worldwide has been full of ups and downs. While some universities seem to flourish with the implementation of enterprise systems education, many are floundering. It is clear that universities worldwide are in varying stages of enterprise systems education deployment. In this paper we examine the industry maturity models and provide a framework of an enterprise systems education maturity model. We also introduce the next wave of enterprise systems education based on industry trends.

2. MATURITY MODELS

While the concepts that underlie Enterprise-wide systems or Enterprise Resource Planning (ERP) Systems can be traced back to at least 1965, their wide use in business is only about 15 years old. In an article by Robert Head, the conceptual foundation of a "management information system" that had all the data needed by an organization was really the framework of what is now called ERP systems [Head 1967]. Head talked about the database "soup in which numerous data elements are floating around..." (Head, 1967, p.23). At the time it was thought that the number of data elements in a particular organization that constitutes the ERP system was in the hundreds or thousands. It was not until the 1980s that data base products evolved to a place where what turned out to be millions of data elements could be stored and not until the early 1990s that full ERP systems were commercially viable.

Today the concepts of ERP, capability, or process maturity are continually being utilized in many aspects of organizations as a means of assessment and as part of a framework for improvement (Fraser et al., 2002). The notion of measuring an organization's maturity with respect to IT has been the subject of academic papers for about as long as people have been writing about integrated enterprise systems. In 1974 Nolan and Gibson presented the first maturity model based on IT expenditures (Gibson and Nolan, 1974). The four-stage model classified systems into categories that more or less mirrored the changes in the IT industry from 1960 into the mid-1970s (Corbitt and Connolly, 2004). Nolan modified his model in 1979 to include 6 stages (Nolan, 1979)

The premise is that by understanding a maturity model, organizations can use this to help not only assess their current maturity level but also help efficiently advance them to a higher level of maturity. The ERP Maturity model described by Holland and Light (2001) has three phases (see Figure 1). Stage 1 indicates the initial planning of an ERP system implementation while managing existing legacy systems. Stage 2 represents a post ERP implementation where there is eventually widespread adoption of the ERP system throughout the organization. When an organization advances into Stage 3, there is evidence of strategic use of the core ERP system and in addition ERP data is extended to the utilization of value added functionality and capabilities such as Supply Chain Management or Customer Relationship Management.

A historical analysis of organizational evolution of ERP systems indicates changes in industry focus over time (see Figure 2). Originally ERP systems allowed organizations to track the business. As organizations matured in their use of ERP systems, they were able to use the systems to understand the business, and eventually improve the business with a focus on business processes. Extensions to ERP systems known as ERPII (as coined by the Gartner Group), gave organizations the ability to predict the business. While ERP allows organizations to track, understand, and improve internally, ERP II provides an extension to inter-organizational environments.

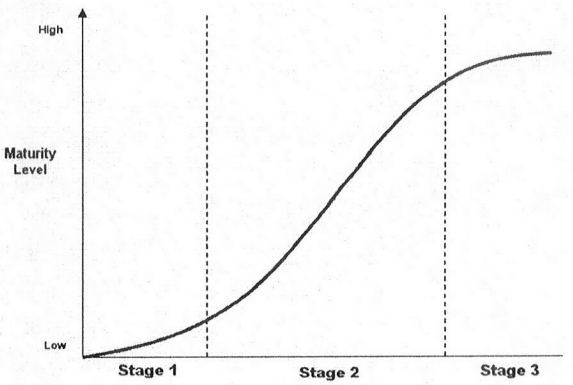

Figure 1: ERP Maturity Model (adapted from Holland and Light, 2001)

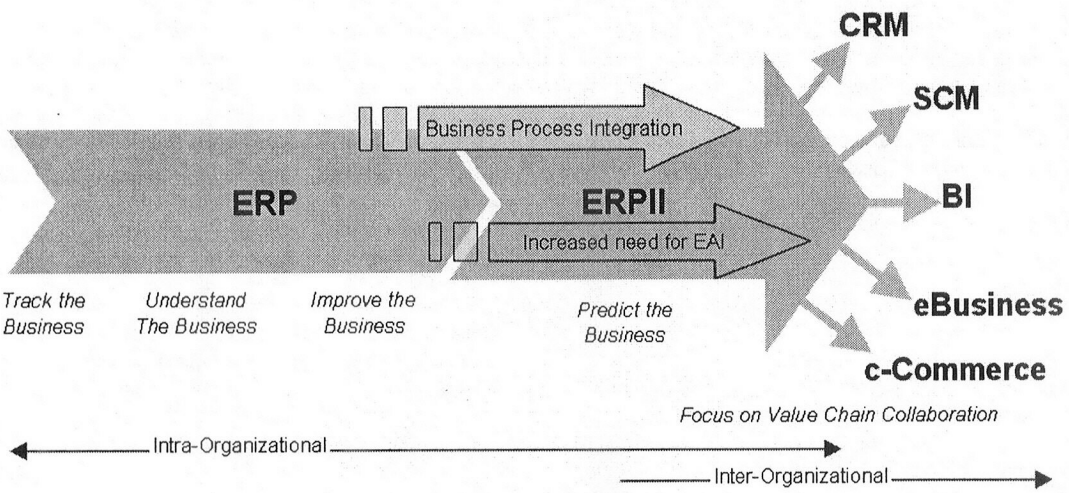

Figure 2: ERP Evolution

Currently the challenge is to capture the necessary data and analyze it to advance to a predictive inter-organizational maturity level, enabling organizations to not only analyze, but to quickly react to indicators and improve inter-organizational value chains, thereby sustaining a continued competitive advantage. While the ERP system remains at the core, the focus shifts from the system to the business processes. This is the basis of the Process Maturity Model, which is based on the Capability Maturity Model (CMM) developed by Carnegie Mellon University's Software Engineering Institute. This model contains five stages of process awareness and automation; (BPTrends 2004; Mentisys, Inc., 2003);

(1) Level 1: Initial - processes are ad-hoc and chaotic; system not well defined; Success is based on the ability of key individuals to get the job done, often through heroic efforts; organization has little, if any, process awareness.
(2) Level 2: Repeatable - small scale processes are understood and can be repeated; Relationship between processes not defined well – value chains not well defined; Typically, the "big picture" of business processes are not understood, instead some processes (or sub-processes) are understood.
(3) Level 3: Defined - processes are documented and standardized across the organization; Relationship between processes (ultimately value chains) is well defined.
(4) Level 4: Managed - processes are measured and controlled.
(5) Level 5: Optimized - feedback is incorporated for continuous process improvement; processes are well managed and optimized; Process teams exist that constantly work to improve the effectiveness, efficiency, and consistency of organization.

A similar business process maturity model utilized by BearingPoint (Fisher, 2004) is also described as having five stages;

(1) Siloed - Processes not defined well; Implementation is departmental, functional silos - no integration across departments.
(2) Tactically Integrated - Some cross-functional integration of processes.
(3) Process Driven - Transformation from functional to process focus – multiple departments; Process-focused – not discipline focused.
(4) Optimized Enterprise - Extended Enterprise Systems concepts are introduced; Focus on BPM tools for monitoring and controlling of processes; How to optimize organizational processes.
(5) Predictive Extraprise – Business Processes are well managed and optimized; Inter-enterprise focus; Total process integration across Extraprise; Using BPM tools to monitor and automate process execution across extraprise.

Three distinct "Waves" of ERP development in the effort to sustain competitive advantage seems to have emerged over the past few years. The first wave, ERP, focuses internally on streamlining operations. The second wave, ERPII, focuses on improving business processes and increasing value through the value chain. The Third Wave involves Business Process Management (BPM) in an E-collaborative environment [Smith and Fingar, 2002]. In order to compete in this third wave, organizations need to establish successful B2B collaborations that require an understanding of a process-centric business enabled by enterprise systems. The organization is process-centric, focusing on predictive Extraprise (see Stage 5 above).

3. ERP EVOLUTION IN HIGHER EDUCATION – PROPOSED ERP MATURITY MODEL FOR EDUCATION

Many universities, just as companies, are in varying stages and waves of enterprise systems education deployment. This indicates that the industry identified maturity models can be applied to enterprise systems curriculum deployment. The comparison of the ERP Maturity Model (Holland and Light, 2001) with enterprise systems education reveals universities are in Stage 1 during the initial awareness and investigation of introducing ERP concepts or utilization in their curriculum. As universities progress through Stage 2, their curriculum evolves from utilizing portions of ERP modules to integrating curriculum across disciplines. Stage 3 represents the universities maturity of ERP systems and the ability to add value to their curriculum by extending the curriculum to ERPII, thereby adding components such as Supply Chain Management (SCM) or Customer Relationship Management (CRM) to the curriculum. The adaptation of the Process Maturity Model to Enterprise Systems Education provides a more detailed checklist of criteria in each of the maturity levels as described in Table 1.

It is interesting to note that by providing a central repository of curriculum materials, vendors such as SAP are helping universities to progress through the initial levels of maturity at a faster pace. However, in order to progress to level 4, the university curriculum teams must have a level of experience.

As companies are refocusing from ERP systems implementation to managing and predicting processes, the challenge for enterprise systems education is to also refocus and evolve their curriculum. This presents a challenge of evaluating the maturity focus of an enterprise system curriculum. The adaptation of the Business Process Maturity Model (Fisher, 2004) provides a checklist for this evaluation as described in Table 2.

4. ISSUE OVERVIEW

In this issue, the teaching tip by Fedorowicz et al. provides twelve tips for universities in the initial stage of enterprise systems curriculum development. These tips provide successful guidelines to assist universities to stage 2 successfully and include practical tips for deploying ERP education that actually mirror business best practices, such

Table 1: Checklist for Assigning a Maturity Level to an Enterprise System Curriculum

Level	Criteria
Level 1 Initial	Enterprise Systems Curriculum not defined well. University is just beginning to investigate possibilities. Success is based on the ability of key individuals to get the job done, often through heroic efforts. University (curriculum) has little, if any, process awareness.
Level 2 Repeatable	One or more Courses are defined with ERP concepts or using ERP modules. Relationship between Courses, concepts, or modules not defined well – value chains not well defined. Typically, the "big picture" of ERP systems is not understood, instead some module parts (or sub-processes) are understood and implemented into a course.
Level 3 Defined	Several courses, concepts, or modules defined. Relationship between courses, concepts, or modules (ultimately value chains) is well defined. "Big picture" of ERP systems is understood. Curriculum is maintained.
Level 4 Managed	Curriculum integrates concepts, modules. Extended Enterprise Systems concepts are introduced. Curriculum implemented in more than 1 business discipline
Level 5 Optimizing	Curriculum is well managed and optimized. Curriculum team exists that constantly work to improve the effectiveness, efficiency, and consistency of curriculum. Curriculum implemented across all business disciplines

Table 2: Checklist for Assigning a Maturity Focus to an Enterprise System Curriculum

Focus	Criteria
Siloed	Curriculum not defined well. Courses are departmental, discipline specific, functional silos – no integration across disciplines. Often only one functional area of the University adopts ERP based concepts, modules or courses.
Tactically Integrated	Some cross functional integration of ERP concepts and/or modules. Leveraging ERP curriculum for cross-functional integration. More than one functional area of the University adopts ERP based concepts, modules or courses.
Process Driven	Transformation from functional to process focus – multiple departments (disciplines) involved in curriculum development and deployment. Process-focused – not discipline focused
Optimized Enterprise	Extended Enterprise Systems concepts are introduced. Focus on BPM tools for monitoring and controlling of processes. How to optimize organizational processes.
Predictive Extraprise	Curriculum is well managed and optimized. Inter-enterprise focus. Total process integration across the Extraprise. Using BPM tools to monitor and automate process execution across the Extraprise.

as "outsource non-core competencies" and manage expectations.

The teaching tip is followed by two business cases: 1) "A customized ERP/SAP Model for Business Curriculum Integration" by a group of faculty from Northern Arizona University, and 2) "Choosing an ERP-type System for a Belarus Enterprise". The first case is a hands-on case designed to demonstrate business processes such as sales and production operations execution. It includes information based on a US based company called Sun Ocean Sand, Inc., a manufacturer of recreational vehicles. This case study approach provides an innovative classroom practice that moves past the industry silos level of maturity to integration. The second case is more strategic in nature, providing various facts concerning 3 different ERP options, and asking the students to determine what ERP system option to choose for an international company based in the Republic of Belarus.

Following the two cases are a series of papers that provide different levels of active learning models for learning about business processes via ERP concepts. For the most part these are contributed by schools who are well into levels 2 and 3 of the maturity models. For example, the paper by Draijer and Schenk at the HES School of Business in The Netherlands, offers a model for building business processes and for completing projects via SAP's R/3 system. The focus of learning is on the business processes, such as order to cash, across a variety of companies that the students "create" and/or maintain. The businesses in this simulation conduct business transactions with each other so the students begin to experience business relationships between customers and suppliers, as well as between businesses and their banks.

Similarly the paper by Hajnal and Riordan is designed to give second year business students an understanding of the

role that technology plays within and between businesses in an e-business scenario. The authors of petPRO start with students who have different functional business roles, such as VP for Finance, so students can learn about integrated business processes within the company. The company then goes through a merger and the students learn how technology supports the extended business into a more integrated process scenario. The authors provide a method of introducing the process nature of an organization by exposing the students to various functions of a business and having them participate in extensive data sharing and decision-making in a company simulation.

Grendi and Hull provide a framework for using traditional systems analysis and design concepts with ERP-specific concepts, providing universities in the early stages of maturity a method of how to teach enterprise systems within a curriculum. The paper by Davis and Comeau, provides a good example of how to adapt a developed curricula from another school to the environment of an e-business program. The authors of this paper take the Dolphin curricula, currently called Business Process Integration, provided through the SAP Academic Alliance and create a business process oriented course for senior undergraduates in the e-business program at the University of New Brunswick. Students in this course not only complete the configuration exercises detailed in the curricula but also have the students complete their own application of a business case and complete some basic literature summaries. This paper provides a description of how to acquire cross-functional business process management understanding rather than just functional specific operational skills, moving to a process driven focus.

The final paper that presents hands-on curriculum ideas extends the business processes from business to engineering. In "Integrating Enterprise Decision-Making Modules into Undergraduate Management and Industrial Engineering Curricula", the authors use ERP within the context of decision making. The paper describes how to use Oracle's ES-based (Enterprise Decision-making) modules for both product development (Engineering) as well as order to cash and order to pay business scenarios. The two decision making modules in two separate classes are described along with a framework for integrating curriculum across colleges in 3 separate roll-out phases. This paper provides a process-focused innovative use of enterprise systems to help students understand the integrated nature of enterprise decision making.

The last 2 papers in the issue 1) "Appropriating Advanced Information Technologies in Business Education:.." and 2) "Second Wave ERP Education", relate more to the big picture of ERP education as opposed to more day to day activities associated with teaching via ERP concepts. The first of these applies Adaptive Structuration Theory (AST) to the process(es) of deploying ERP curriculum in academic environments. The authors include an extensive literature review and models as they apply to ERP use within Colleges of Business. The model presented in this paper is expanded and used as a foundation for concepts of ERP educational maturity discussed in the current paper.

Table 3: Factors Used to Determine ERP Education Deployment Maturity Model Stages

Level	Functions	Process Integration	Level of Curriculum Development
Initial/ Siloed	Single discipline, 1-3 courses	Limited to processes within the discipline	None - Uses curriculum provided by others
Adaptive	More than one discipline uses ERP	Processed still within discipline but begin to explore affects on other disciplines	Take exercises developed by others and adapt them to school's curriculum
Developing	Every discipline has at least one course using ERP	Processes begin to cross disciplines and extend in functionality within discipline, i.e. introduce CRM, BW, SCM, etc.	Curriculum developed in house or extensively adapted to fit curriculum requirements
Shared	Every discipline has multiple courses using ERP	Processes and information begin to integrate curriculum; students see same data from multiple perspectives	Curriculum that has been developed in house is made repeatable in and extensible to other schools
Optimized	Nearly every course in the curriculum has at least a reference to ERP systems	Processes are fully integrated and have depth in every major discipline (processes and information are ubiquitous within the programs)	Curriculum continues to evolve with industry changes and readable shared with others.

Finally, the authors of "Second Wave ERP Education" begin to address what comes next. Hawking, McCarthy,and Stein describe some problems and

approaches associated with traditional ERP curriculum deployment as well as offer solutions to the problems. The ideas in this paper also form the basis for extending an ERP maturity model for organizational implementation to ERP as used by educational institutions.

5. CONCLUSION – CHALLENGE

Looking at the dimensions of the models summarized in Tables 1 and 2 there appears to be three factors that define each category; 1) the number of different disciplines or functions represented in the ERP curriculum, i.e. Accounting, Production Management, Sales, etc. 2) the depth or integration of the process either within or across disciplines, and 3) the level of curriculum development actually done at the school. For example, a school that is introducing ERP concepts in one accounting course, using exercises from the "plug and play" curriculum bank provided by some ERP providers is less mature than a school that has developed a series of exercises used across several accounting classes. Thus these categories can be used to determine the level of maturity across the 3 dimensions.

Thus Table 4 summarizes each stage in a proposed ERP Educational Maturity Model and categorizes the schools submitting papers to this special issue into one of the five stages. By applying the criteria to schools submitting papers to this special issue, we get a preliminary glimpse of where enterprise resource education is in higher education. Figure 3 represents the various dimension distributions of the maturity levels that these schools appear to embody.
While it is unknown how many schools that teach some type of ERP-related classes fall into each of the categories, it is safe to say that most schools are in the first 2 levels. The most urgent need, as evident from the papers in this issue, is for empirical evidence. Now that many universities have one or more courses with ERP, there is a need for evaluation results of what worked and what didn't. Not just reports on what was done (which can be useful), but now is the time to have empirical results. In addition, perhaps an assessment of where education is with respect to each of the maturity stages can be useful. These data and the resulting analysis can lay the foundation for extended enterprise education.

While some still say that ERP is a fad or something relegated to MIS programs only, it is clear that ERP systems are becoming foundational for business. Most business decisions and strategies rely on data and/or information and ERP is as basic to producing business information as networks and database systems. Even small businesses are using ERP products as evidenced by Microsoft's Great Plains market strategy and SAP's Business One product.

Similarly, ERP is one foundation for BPM, the next wave of process innovation. In order to have a full understanding of the impact of this next wave on organizations, a basic understanding of ERP is needed. Enterprise systems prepare students for this changing process-centric e-collaboration world it is important to provide them with resources and curriculum that emulates the process-centriceducation extends past the ERP foundation. In order to understanding of ERP is needed. Enterprise systems prepare students for this changing process-centric e-collaboration world it is important to provide them with resources and curriculum that emulates the process-centric business practices of this new century. This learning environment must transcend traditional organizational and business boundaries to embrace the integrated business practices of process-centric enterprises. As educators, are we ready for this next wave?

Table 3. Factors Used to Determine ERP Education Deployment Maturity Model Stages

Stage/Level	Percentage of Schools	Description/Characteristics
Initial/ Siloed	26.32%	Uses curriculum developed by others in single subjects that are not integrated across disciplines – Plug and play exercises are used exclusively
Adaptive	42.11%	Curriculum from others is adapted to the environment of the school. Some integration across courses within disciplines is evident. ERP curriculum is repeatable and sustainable within the schools environment
Developing	24.56%	Curriculum is developed within the school and is specific to courses within the school's environment. Integration across disciplines is also evident.
Shared	7.02%	Developed curriculum is made repeatable across multiple school environments. Developed Curriculum is shared with other schools either as "plug and play" courses (used by schools in the first 2 levels) or as visiting teaching engagements
Optimized	0%	Developed repeatable curriculum is extended to in-depth processes that cross-functional silos. Processed based curriculum is pervasive throughout the school's program(s)

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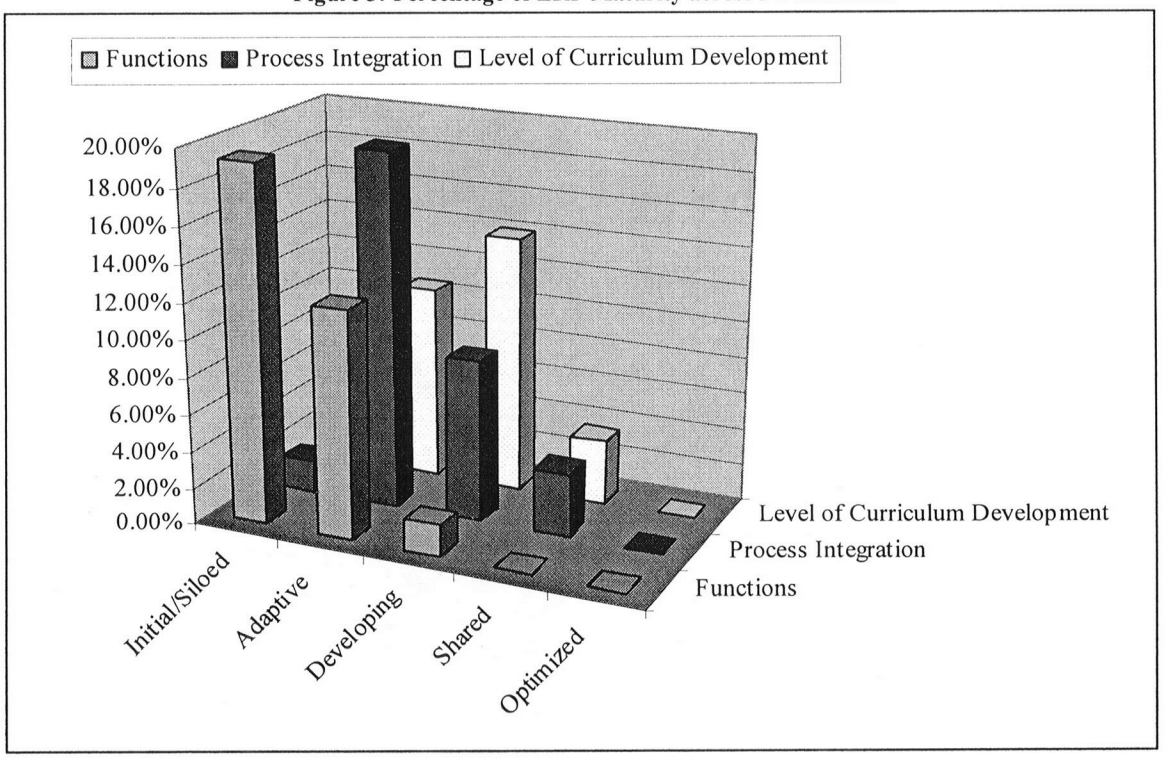
Figure 3: Percentage of ERP Maturity across 3 Dimensions



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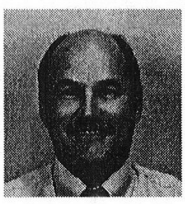

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