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Communications of the **I**nterAssociation for **S**ystems

THE DESIGN AND THREE-YEAR REVIEW OF AN MS PROGRAM IN INFORMATION TECHNOLOGY FOR PREPARING SYSTEMS INTEGRATORS

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ABSTRACT

This paper presents the design and three-year review of the MS program in Information Technology (MSIT) at Bentley College. The first class entered in 2001 and graduated in 2003. Using the details of this program as a case study, the paper illustrates how the MSIS 2000 model for graduate curriculum in information systems was adapted to develop a program whose goal is to prepare systems integrators and whose courses have an architect focus. The three-year program review assessed the original design goals and whether the program implementation achieved those goals in terms of its orientation and positioning, its market, its architecture, the content of its courses, students learning and satisfaction, and faculty role in the delivery of the curriculum. This case study can serve as a framework for self assessment. It should benefit faculty interested in building new programs or considering adjusting and tweaking their existing programs using the MSIS 2000 model curriculum as a frame of reference.

Keywords: graduate curriculum in information system, graduate curriculum in information technology, curriculum assessment, MS program in information systems

I. INTRODUCTION

In 2000 when the revised model curriculum for graduate information systems programs, MSIS 2000 [Gorgone, and Gray, 2000], was published and some schools were evolving their Web-based applications development and Electronic Commerce (e-Commerce) courses into MS programs in Electronic Commerce [e.g., McCubbrey, 2000; Song, Trajkovski and Hong, 2004], the Computer Information Systems (CIS) Department at Bentley College decided to close its twenty year old MS program in Computer Information Systems (MSCIS) and replace it with a new MS program in Information Technology (MSIT).

The major factors influencing this decision were:

- In 1998 and 1999 the College introduced five new specialized masters degree programs¹, to serve the perceived new professional positions in the evolving information-age business arena. Three of these programs targeted many of the career-changers that were previously served by our MSCIS program.
- The knowledge requirements of the Information Systems (IS) work force were changing and were not being met by our MSCIS program, especially, the knowledge of Web technologies and e-Commerce and their impact on business practices.
- The CIS Department saw an opportunity for a new program that focused on enhancing the careers of people with significant IS/IT experience.

Thus the guiding vision for the new program was the preparation of IS professionals with at least two years of IT work experience for IT/IS leadership careers in consulting firms and large businesses. Specifically, we felt that we can take information systems and software professionals with two years of systems development experience and in one year of full-time study prepare systems integrators playing the roles of project managers, system architects, information architects, process architects, and/or technology architects in the Internet-enabled business world.

In 2000, we developed a new MS program in Information Technology (MSIT) using the MSIS 2000 model curriculum as a frame of reference. The new MSIT program was launched in 2001 and a three-year review of this program was performed in 2004. Using the design and review of our MSIT program as a case study, this paper illustrates how to:

- custom-fit the MSIS 2000 model curriculum to local needs
- assess a program in terms of
 - its orientation and positioning,
 - its market,
 - its architecture,
 - the content of its courses,
 - the student learning and satisfaction, and
 - the support needed to deliver the curriculum.

The paper is organized as follows. We review the MSIS 2000 curriculum in Section II and then present and review the systems integrator positioning of the MSIT program in Section III. Section IV contains a detailed review of the MSIT program's architecture and courses using the MSIS 2000 model curriculum as a frame of reference. Section V presents our findings, learning, and conclusions

II. THE MSIS 2000 PROGRAM

Since the MSIS 2000 model curriculum represented the best thinking of the IS academic community, we started the MSCIS program assessment with the view of re-structuring the program requirements based on this curriculum. In brief, the mission of MSIS 2000 program is to prepare students for leadership careers in the information systems field. Its objective is to instill skills, knowledge and values in

- The core of the IS field

¹ Information Age MBA, MS in Global Financial Analysis, MS in Information Age Marketing (IAM), MS in Accounting Information Systems (AIS), and MS in Human Factors in Information Design (HFID),

- Integration of IS and the business function
- Business and the real world
- Communications, interpersonal relationships, and team work
- Analytical and critical thinking

CURRICULUM ARCHITECTURE

The architecture of the MSIS 2000 model curriculum is shown in Figure 1.

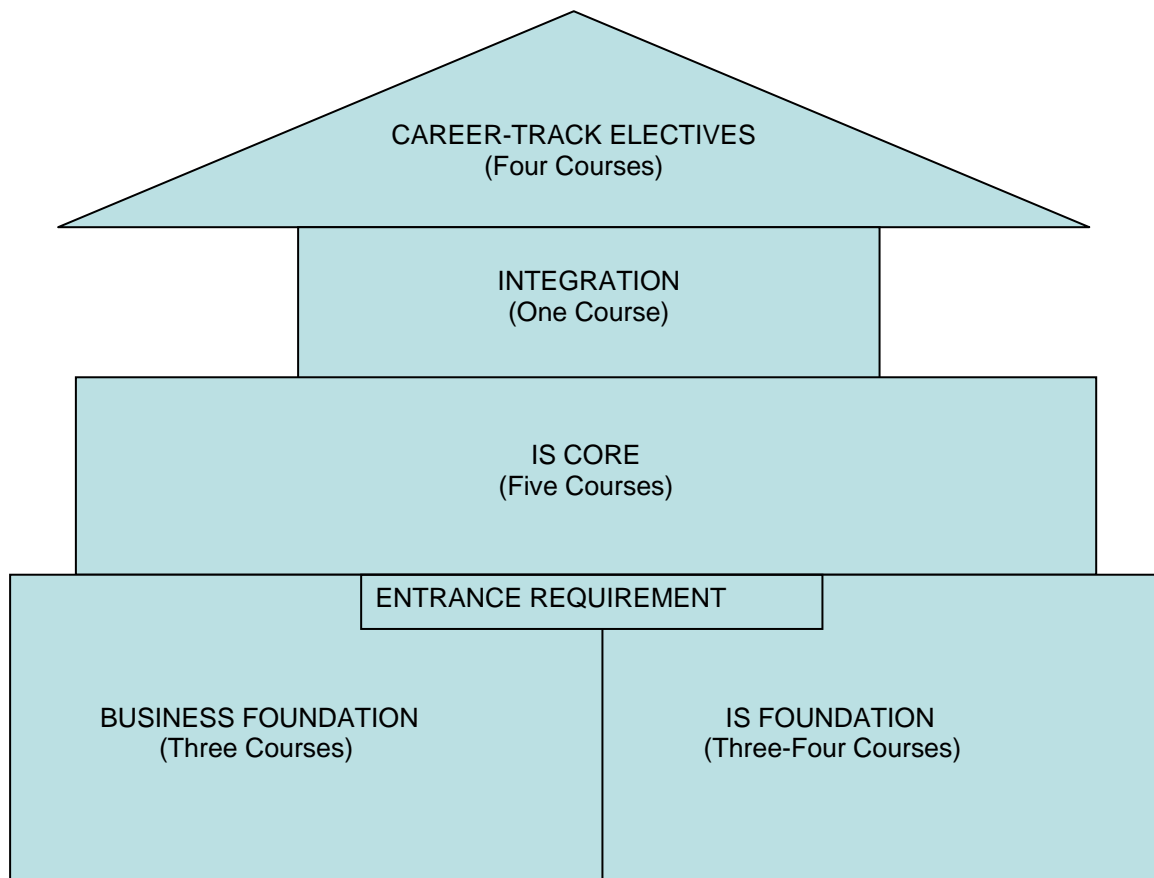


Figure 1. MSIS 2000 Architecture

ENTRANCE REQUIREMENTS

The entrance requirement for the MSIS 2000 curriculum consists of the material taught in undergraduate courses in Accounting, Marketing, and Organizational Behavior in business studies and Programming, Hardware and Software Technology, and IS theory in computer studies. The recommendations allow an institution to substitute professional experience for certain foundation courses.

IS CORE

The IS core knowledge is both technical and managerial in flavor. The following five required courses² define the IS core.

- Data Management
- Analysis, Modeling, and Design
- Data Communications and Networking
- Project and Change Management
- IS Policy and Strategy

The first three courses (data management; analysis, modeling and design; and data communications and networking) were included in ACM '82 curriculum. They still remain the foundations of the field, but their contents changed drastically with the evolution of new technologies and processes. Project and Change management is included in the IS core because it is essential for success in all IS endeavors. The last IS core course is IS policy and strategy, which was also part of the ACM '82 curriculum.

SYSTEM INTEGRATION

A key innovation of MSIS 2000 is the new required course on integration that synthesizes the material learned in the core. The MSIS 2000 report provides three perspectives for this integration course and each perspective may merit a course of its own. The three perspectives are³:

- Integrating the Enterprise
- Integrating the IS Function
- Integrating IS Technologies

The inclusion of this integration as a required course is a recognition that systems integration is a pervasive aspect of IS practice. The curriculum recommends that schools should offer an integration course based on any one of these three perspectives or combinations of these views. The choice would depend on the capabilities of the school's faculty, the needs of the regional industry, and the objectives of the students.

CAREER-TRACK ELECTIVES

The notion of career-track oriented electives is another innovative recommendation of MSIS 2000. It consists of four or more related electives that prepare a student for a specialization. The elective tracks provide schools a way to develop centers of excellence and they offer the student a more focused, professional education to meet their career objectives and organizational needs. The MSIS 2000 report identifies a broad range of career tracks varying from systems analysis and design, project management and technology management to decision making and consulting. It recommends that schools should only select a small number of tracks for their curriculum, based on the capabilities of the school's faculty, the needs of the regional industry,

² Courses are assumed to be 3 credit hour semester courses or 4 credit hour quarter courses.

³ Integrating the Enterprise perspective is oriented toward what to build, and not how to build. It focuses on organizational and managerial issues at the level of the enterprise as a whole. Integrating the IS Function course focuses on managing the IS functions on a day-to-day basis, and Integrating the IS Technologies perspective is concerned with how to develop an integrated IS enterprise architecture.

and the objectives of the students. It suggests that tracks should be multidisciplinary, involving courses in two or more departments, depending on the nature of the track.

III. PROGRAM POSITIONING, FOCUS, AND NAME

The career-track electives in the MSIS 2000 recommendations led us to look deeply into how IS careers were being impacted by e-Commerce and evolving Web technologies. We noted that Internet-enabled business practices were changing both the issues involved in building enterprise-wide business systems and the intellectual discipline that supports that activity. For example, the primary design drivers in traditional systems development are correctness, reliability, and modifiability. However, in building of enterprise-wide business systems, additional significant design drivers are robustness, scalability, security interface with the Web, and interoperability. Furthermore, whereas the intellectual discipline of traditional systems development is rooted in the architecture of the Von Neumann machine, structured analysis and design, relational databases, and information engineering, the intellectual discipline of enterprise-wide web-centric business systems is rooted in Java, object, and distributed systems technologies. We concluded that to be effective, tomorrow's systems professionals need to understand the new business paradigms and develop deep expertise in Java-based object-oriented and distributed systems technologies. In addition, we knew that to be successful, technical expertise needs to be complemented with understanding and skills in project management, process management, quality management, change management, team building and business re-engineering as they relate to software and information systems work.

THE ROLE OF SYSTEMS INTEGRATORS

This analysis led us to define the preparation of systems integrators, who are called upon to architect IT solutions for Internet-enabled business processes, as the stake⁴ of the new MSIT program. By systems integrators we mean IS professionals who can play the roles of project managers, system architects, information architects, process architects, and/or technology architects in the Internet-enabled business world. The responsibilities and work activities of these roles are summarized in Sidebar 1.

SIDEBAR 1 TYPES OF ARCHITECTS

Systems architects work with business professionals and systems analysts to arrive at technical requirements for business scenarios. They handle the issues of integrating multiple sources of information across heterogeneous platforms and they understand the architectures of legacy software so that they can assemble integrated solutions.

Information architects are the guardians of corporate information models. They understand cross-functional flow of information and assume responsibility for managing the logical details for implementing the conceptual enterprise data and object models. They influence design level changes in projects to comply with enterprise information model and modeling standards.

Process architects facilitate defining work processes and standards. They monitor the effectiveness of the defined processes. They are also responsible for improving and architecting the development processes.

Technology architects ensure that technology resources are aligned with business requirements. They handle the issues of selecting and implementing new technologies.

⁴ By stake we mean a post that provides direction to the program.

In summary, by selecting enterprise and inter-enterprise integrators as the stake for the MSIT program we committed to producing graduates who could architect IT solutions requiring the integration of business processes, Web applications and legacy systems using a variety of network, voice and mobile computing technologies. Since architecting solutions is different from giving shape to user needs, which is the key focus of a systems analyst, it became clear that we need to re-direct the focus of our curriculum and courses from traditional systems analyst to systems architect [Boster, Liu and Thomas, 2000; Garlan, 2000; Mills, 1985].

The Bentley faculty concluded that the preparation of future systems integrators requires instilling a thorough and deep understanding of the underlying theories, best practices, and hands-on exposure to up-to-date software tools in the following areas:

- Emerging business models such as B2B, B2C, Many2Many and m-Commerce
- Internet-based software tools for building e-business solutions
- Systems analysis and design methodologies for analyzing and designing enterprise-wide distributed e-business applications
- Computing infrastructure planning and methods for assessing the impact of e-business application on computer system performance
- Network components and network products that are driving the evolution of e-business applications
- Telecommunication networks modeling and methods for assessing bottlenecks and performance
- Methods, models and technologies for implementing appropriate levels of security
- Data mining, data warehousing and database design

THE CONTINUING ROLE OF E-COMMERCE

Since the investor-fueled dot com phenomenon went bust in 2000-2002, it is important to ask whether e-Commerce is still an important business channel. Gupta [Siliconindia, 2004] observes

“The Internet is coming back – more sanely this time. A lot more people are online, shop online and believe in its convenience.”

BUSINESS IMPERATIVES

Reich and Nelson (2003) investigated CIOs view of the changes driving their IT organizations. Their results suggest that the key business imperatives for IT management are managing customer interaction, building a real-time enterprise, and facilitating globalization. Each of these business imperatives involves an integration of e-Commerce tools and technologies with the traditional infrastructure hardware and software.

- *Managing Customer Interaction* means addressing the organization’s desire to manage customer interactions consistently across multiple channels. For example, a customer can place an order over the Web, ask questions about the order over a telephone, and exchange merchandise at a physical store.
- *Building Real-Time Enterprise* means providing real time management information,

“The business philosophy itself has changed. From viewing ourselves as a pure manufacturing company pushing our products in the seemingly unending capacities of our retailers, we have changed to becoming a sensitive, real-time

responsive supply partner." Sumnatra Sengupta⁵, CIO of Scotts Company [Siliconindia, 2004]¹

Another example of real-time enterprise is General Electric where its managers monitor mission critical operations across the company's 13 different businesses around the world by viewing real-time data on their digital dashboard.

- *Facilitating Globalization:* Expansion, outsourcing, and offshoring accentuate the need for real-time access to shared information from multiple locations and systems around the world. This requirement, in turn, fuels the trend to develop enterprise portals that provide front-end role-based integration. Sengupta [Siliconindia, 2004] observed that, to meet global reporting requirements of marketing teams to slice data on the fly and react to business intelligence in real time, requires tools for content management, portals and data warehousing..

These observations suggest that the IT workforce should be capable of taking enterprise integration to the next level. The "next level" means delivering quality services at competitive prices in the context of a globally distributed work environment. We conclude that, from a job market perspective the enterprise/ inter-enterprise integration goal of our MSIT program is more pertinent in 2004 than it was in 2000.

NAMING THE PROGRAM

There is still the issue of why we selected IT as the name of our new program. As suggested earlier, enterprise/inter-enterprise integration involves architecting IT solutions, and an architect-focus is a necessary orientation for a curriculum whose goal is to produce systems integrators. Since systems analyst is the career-orientation of most IS programs, we concluded that we could not use any of the traditional names, such as IS, CIS or MIS, for a program designed for preparing systems integrators whose courses focus on architectures and system architecting. We also felt that although Electronic Business is a key business driver, it is not an appropriate name for an IS program. We selected IT as the name of our degree program to emphasize the heavy technology orientation yet distinguish it from traditional computer science and software engineering programs. During our review we observed that IT designation for degree programs and department names is becoming popular. We also found that Anthony had studied the various computer curricula and proposed a Computer Domain Continuum Model (CDCM), shown in Figure 2 [Anthony, 2003]. This model positions the IT programs to left of CIS/IS/MIS programs, indicating their more technical content. Thus the IT name for our MS degree happens to be consistent with IT programs positioning on Anthony's CDCM.

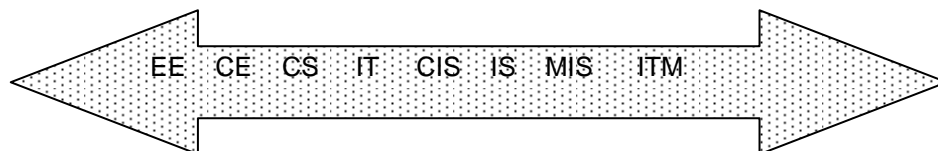


Figure 2. Anthony's Computer Domain Continuum Model

IV. PROGRAM REVIEW

This section discusses and reviews the design and content of the MSIT program. To illustrate the distinguishing characteristics of the MSIT program, we compare the architecture of the MSIT program with the MSIS 2000 model curriculum.

⁵ August 2004, p.39

The MSIT program architecture is shown in Figure 3 and, like the MSIS 2000 model curriculum, it consists of three layers:

- pre-program requirements,
- core requirements and
- career-track electives.

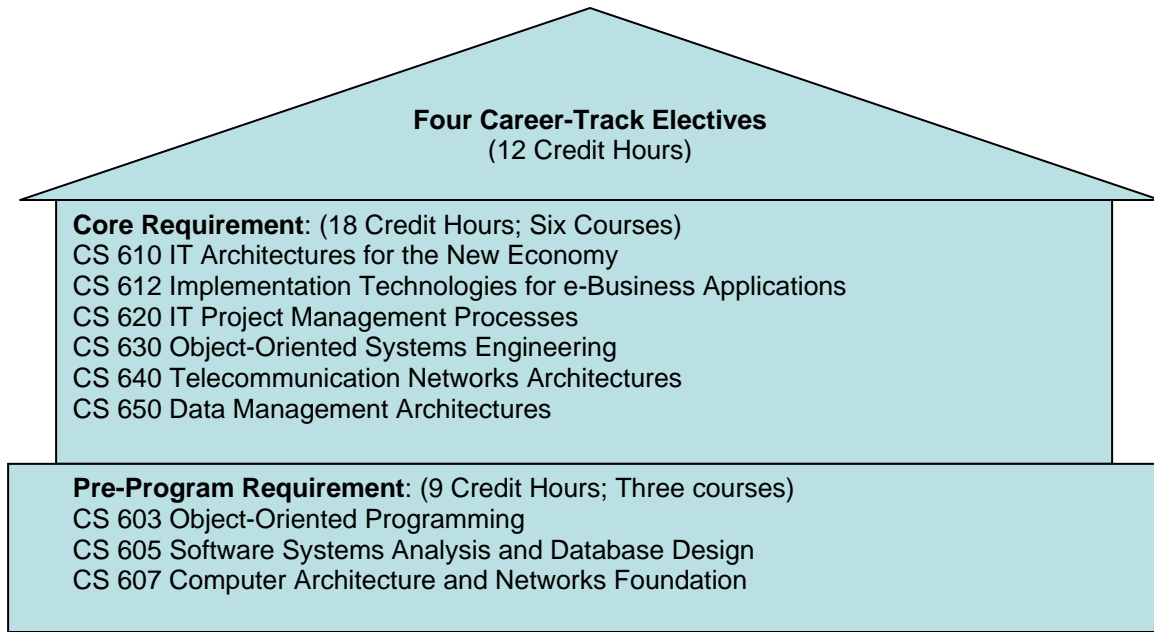


Figure 3. MSIT Curriculum

The courses in the MSIT program and their reviews are discussed in the MSIT foundation layer, MSIT core layer and the MSIT elective layer.

MSIT FOUNDATION LAYER

The purpose of the Foundation Level is to ensure that entering MSIT students possess the base knowledge and skills that are needed to pursue courses in the Core. As summarized in Table 1, the MSIS 2000 model curriculum recommends six pre-program courses, three in the IS area and three in the business area.

Table 1. Foundation Layer

MSIS 2000 Recommendation		MSIT Program
IS Foundations	Business Foundations	Pre-Program Requirements
Fundamentals of IS	Financial Accounting	Object-Oriented Programming
IT Hardware & Software	Marketing (Customer Focus)	Computer and Network Foundations
Program, Data & Object Structures	Organization Behavior	Software Systems Analysis and Database Design

The MSIT program pre-program requirement consists of three courses that package the material that is usually taught in six undergraduate courses in a typical BSCIS program. For example, for

our BSCIS graduates in the MSIT program the pre-program requirements are waived because as part of their BSCIS degree program they have to successfully complete equivalent pair of undergraduate courses, listed in Table 2.

Table 2. Undergraduate Equivalence

Pre-Program Requirements	Undergraduate Courses
CS 603: Object-Oriented Programming	CS 180: Programming Fundamentals CS 280: Object-Oriented Application Development
CS 605: Software Systems Analysis and Database Design	CS 350: Database Management Systems CS 360: Business Systems Analysis and Modeling
CS 607: Computer and Network Foundations	CS 240: Business Processing & Communications Infrastructure CS 480: Advanced Net-Centric Computing

It should be noted that the pre-program requirements of the MSIT program differ from the MSIS 2000 recommendations in two ways. First, since the MSIT program is designed for IS professionals with at least two years of IS/IT experience, we chose to substitute the business foundation pre-program requirements of MSIS 2000 model curriculum with business experience. Second, the MSIT foundation requirements are both deeper and broader than the pre-program IS requirements of the MSIS 2000 recommendation. They cover basic procedural programming, object-oriented programming, software systems analysis, database design, and computer systems and telecommunications fundamentals.

Review of the MSIT Foundation Layer

Our three years experience suggests that students who took our foundation courses performed better in the core courses than those who waived the foundation courses. In addition, students who took CS 603, 605 and 607 indicated high satisfaction with the learning they acquired in these courses. This result was achieved even though each semester some students struggled to master the object-oriented programming skills in CS 603,⁶ and a few students had to repeat it.

Evolution of the Waiver Policy and Process: In Fall 2001 we had a rather liberal policy for waiving foundation courses. The MSIT director granted a waiver if a student offered an equivalent academic course or industry certification course, or had extensive practical experience in the subject matter. This process did not work well; hasty judgments were made right before registration day. In spring 2002, we started granting foundation course waivers at the time of admission which is inline with the Graduate School policy. In fall 2002, we backed away from industry certification courses because we were unable to verify their quality. We also made proficiency exams available to students who appealed waiver decisions. We believe that our stricter waiver policy is a success and we are considering tightening it further.

MSIT CORE LAYER

The program architecture shows the relationships among the foundation layer, the core layer and the electives layer, but it does not reveal the order in which these layers are crafted. In practice, once the program goal is specified, the core layer is specified next. Table 3 summarizes the core layer of the MSIS 2000 model curriculum and the MSIT program. Although both curricula list six

⁶ Computer science and information systems programs always experienced 20 percent failure rate in the first programming course. Since CS 603 is a leveling courses, its rigor and content is more advanced than a Java programming course

Table 3. The Core Layer Courses

MSIS 2000 Recommendation	MSIT Program
	CS 610: IT Architectures for the New Economy
	CS 612: Implementation Technologies for E-Business Applications
Project and Change Management	CS 620: IT Project Management Processes
Analysis, Modeling, and Design	CS 630: Object-Oriented Systems Engineering
Data Communications and Networking	CS 640: Telecommunication Network Architectures
Data Management	CS 650: Data Management Architectures
IS Policy & Strategy	
Integration	

required courses, two among these are quite different. Furthermore, there are other substantial differences. For example,

1. The MSIS 2000 curriculum recommends to integrate the knowledge of the IS functional areas of IT project management, systems analysis and design, telecommunications, data management and IT policy with an explicit integration course. In contrast, the MSIT program opens with a holistic course, CS 610 that serves as a “window” to the courses in the rest of the curriculum.
2. The IT policy and strategy course is in the core layer of the MSIS 2000 model curriculum but it is in the electives layer of the MSIT curriculum.

Review of the MSIT Core Layer

A distinguishing feature of these courses is the hands-on use of appropriate tools and an architect focus. Our review showed hands-on use of following tools.

- CS 612: Java Server Pages, Java Beans
- CS 620: Microsoft Project, and demonstration of requirements management, size estimation, testing, software configuration management, and team communication tools
- CS 630: Borland Together⁷
- CS 640: Students build, monitor, and maintain local and wide area networks using switches, routers, servers and other advanced equipment donated by manufacturers
- CS 650 Oracle 9i

Although the MSIT program is not in the business of providing technology training, the Bentley faculty believes that hands-on work with appropriate tools is an effective method to help students understand and learn to apply complex concepts. Companies that recruit Bentley students seem to value this perspective.

A second distinguishing feature of the MSIT core is teaching of these courses with an architect focus. It was left for each faculty to implement the architect focus. The architect focus (Mills, 1985; Gore, 2000) means:

- Moving from managing the plan to managing the deliverables
- Changing from controlling the scope to controlling the interfaces

⁷ A UML-based CASE tool for object-oriented modeling/development

SIDEBAR 2. GOALS, ORIENTATION AND ASSESSMENT OF MSIT COURSES

CS 620: IT Project Management Processes: This course provides the technical knowledge and skills for planning and executing IT projects. Using the tools and methods introduced in the course, project teams develop a comprehensive project plan for an e-business application. In addition, student teams' research, identify, and demonstrate software engineering tools to support key software development processes.

CS 630: Object-Oriented Software Engineering: This course prepares the student for systems development in the object-oriented paradigm. Students learn to perform requirements analysis, systems analysis, and domain analysis, and how to document them in standard object-oriented specification tools. The hands-on modeling assignments illustrate the role of patterns, class libraries, and object-oriented project management. Students learn how to architect systems suitable for extensive reuse.

Our review showed that three out of fourteen weeks are devoted to reuse. This is a manifestation of our architect-focus, where the emphasis of the model and solution shifts from a now-view of the system to a future-view of the system

CS 640: Telecommunications Network Architecture: This course provides students with the conceptual knowledge to design, procure, and manage network infrastructures for advanced e-business solutions. Students use a hands-on laboratory to learn how network components are integrated into working solutions. The focus of the laboratory assignments is on protocols and network technologies essential for architecting corporate infrastructures seamlessly integrated with the Internet.

CS 650: Data Management Architectures: This course examines the architectures of current database systems with particular importance on object oriented database systems and Web-connected database systems. The course uses Oracle 9i database systems for developing, designing, and managing large corporate database systems.

- Re-defining success from meeting schedule and budget to meeting user expectations
- Emphasizing industry and professional protocols and standards
- Emphasizing reuse and changing the design focus from now and this system to future and other systems.
- Moving from correctness and readability to coupling and cohesion analysis to assess the goodness of program architecture.
- Emphasizing interoperability such as developing applications in Microsoft Windows environment and adapting them to run correctly in a shared Lenox server as required in CS 612.

MSIT CAREER-TRACK LAYER

The courses in the Career-Track layer enable the students to align their objectives better. Students must take four elective courses; two must be CS and two are unrestricted. Although students are free to select electives, their choice need the approval of the MSIT program director. Sidebar 3 shows how electives offered by the Information Systems department relate to IT careers.

SIDEBAR 3. CAREER TRACK ELECTIVES

CS 660 (Object-Oriented Application Development) and CS 670 (Distributed Systems Architecture): During the design of the MSIT program in 2000, we observed that integration, visibility and management across hardware platforms, operating systems, programming languages, data structures, applications and business entities was becoming a priority for IT organizations. Since enterprise integration is not just a solution but a journey, we recognized that companies will need to continually evolve and optimize their architecture and infrastructure to meet changing conditions. CS 660 and CS 670 were designed for students interested in positions involving enterprise integration.

Whereas CS660 is implementation focused, CS 670 targets designers, architects, and integrators. Although taught without a heavy programming component, students probe into the various framework technologies like RMI, EJB, XML, CORBA and JMS to grasp the general principles and structure of distributed systems. A broad coverage of technologies and capabilities gives the students a good understanding of what facilities are available within the J2EE framework and when to use them.

CS 732, Advanced Topics in Systems Analysis and Design: Students interested in starting their careers as systems analyst, team leaders or engagement managers take this course. The course looks at the characteristics, strengths and weaknesses of development methodologies, ranging from highly systematic or “disciplined” to ad hoc or “agile.” These methodologies include Rational Unified Process, extreme programming, Web applications development, offshore development, open source collaboration, soft systems methodology, Multiview, participatory design, and contextual design.

CS 743, Advanced Topics in Computer Networks: Students interested in careers as network consultants or network managers take CS 743 to deepen their understanding of the organizational communication technologies. Currently, the course centers on wireless technologies and their role in the corporate IT infrastructure. The course also provides in-depth coverage of selected technical security, network design, and network management issues.

CS 753, Data Warehousing and Data Mining: Students pursuing careers in data administration, database management, and advanced data analysis take this course, which addresses key concepts and skills in data management, with a focus on the data warehousing function and the methods and tools for data mining.

CS 723, Computer Security, Controls and Ethics: This course on computer security supports all four career tracks of systems integrator, systems consultant, and network analyst and data warehouse architect. CS723 covers key information security risks facing businesses today and helps students understand how to protect data, networks, and application software. It helps students think critically about the local, national, and global information security issues in our highly networked society.

CS 801, IT Policy and Management: Our capstone elective is designed for experienced IT students who aspire to senior level career positions, such as VP for IS, CIO, or CTO. It addresses challenges in managing the IS function in complex organizations, from the point of view of the CIO. Although this subject is denoted as a required course in the Model Curriculum, but we chose to position it as an elective.

CS 795, Special Topics Seminar: This course number is available for offering experimental, special-topics or directed-study courses. Several students used it to learn how to pursue IS research in faculty-led directed studies – in some cases, to discover whether to pursue an academic career⁸. Recently several students also used this course as an opportunity to pursue a directed study on Microsoft's .Net platform.

CS 881, CIS Internship: This course enables students to pursue IT internships and acquire experience with regional companies. For international students, it opens up opportunities to work in the US.

⁸ We know of two MSCIS graduates who joined doctoral programs at MIT and UCLA, and several other MSIT students applied or intend to apply to Ph.D. programs

Unrestricted electives: The MSIT structure allows a student to take two courses outside the CS area. Although many MSIT students take CS courses as their unrestricted electives, those who take electives outside CS usually have good reasons, such as:

- To improve entrepreneurial and negotiation skills, many students take ES 600, Entrepreneurship and/or MG 635, Negotiation.
- To make them attractive to accounting/consulting companies students take the auditing courses AC 747/748 and AC 761/762.
- To broaden their knowledge in human factors, students take HF 730, Visualizing Information, and HF 770, Prototyping theory and practice.

To summarize, we believe that the MSIT electives structure is sound for the following reasons:

- The 2/2 break between CS and unrestricted electives ensures that the student takes career-based CS courses beyond the core.
- There are advanced CS electives in all the key IT career areas.
- CS 795 provides the ability to add a new course as needed.
- The choices of unrestricted electives choices are extensive and address students' unique career requirement.

Suggestions for Improvement

Based on our experience during the last three years, we are considering the following suggestions for improving our offerings.

We should consider offering additional electives that would improve students' marketability. Possibilities include courses on Management of Emerging Technologies, IT and Global Coordination, Managing Virtual Teams and Virtual Organizations, and Supply-Chain Technologies.

Since several students chose to do directed studies in .NET technology in 2004, we should either add a new .Net elective or find a way to incorporate .NET into an existing CS elective.

V. SUMMARY, LEARNING AND CONCLUSION

Using the design and three-year review of our MSIT program as a case study, this section attempts to extract the principles and insights that others can use. The benefits can be to both audiences, namely those who are new to MSIS 2000 and want to see what an MSIS 2000-program and department might look like in reality and those who are considering adjusting or tweaking their programs that already follow MSIS 2000.

The following are our major findings:

1. Our experience suggests that custom-fitting MSIS 2000 to local needs requires defining the stake clearly. For example, in Bentley's case the preparation of systems integrators was the key driver. This driver can be any IT career position such the preparation of systems analyst, preparation of project managers, or preparation of CIOs. This stake is not the goal of the program but it serves as a compass for the design of the program.
2. Our three years of experience shows that the urge to violate the MSIS 2000 architecture of 60% required courses and 40% career-track electives should be resisted. For example, our systems integrator focus initially yielded eight required courses. Since at Bentley the program length of all specialized MS programs is 10 courses or 30 credit hours, we were faced with a choice of eight course core and two electives. Although at the time of the program design we may not have fully appreciated the 60% required and

40% elective architecture of the MSIS 2000 model curriculum, fortunately we ended in defining a six course core and moving two courses (CS 660 and CS 670) to electives. Our review showed that we needed four elective courses to meet the diverse needs and goals of our students.

3. The MSIS 2000 curriculum recommends that schools should select a small number of career-track choices for their curriculum. Furthermore, the career tracks should be multidisciplinary, involving courses in two or more departments, depending on the nature of the track. We felt that in a fast changing field such as IS, it is too risky to predefine a selected number of career tracks and instead we chose to constrain the elective choices as follows:

- Among the four elective choices, two must be from courses with a CS designation and remaining two are unrestricted;
- The MSIT program director must approve the selection of the elective courses. Meeting with the program director to select the electives ensured that the elective choices are made with care and practical considerations of career goals and the scheduled offerings.

The review showed that the two CS and two unrestricted choices worked well. In summary, we feel that our 2/2 policy and approach where the MSIT program director approves the choice of electives is an effective way for implementing the MSIS 2000 career-tracks philosophy.

4. The MSIS 2000 recommendations suggest that data management, systems analysis, data communications, IT project management and IS Policy are the foundations of the field and must be part of the core curriculum of a graduate IS program. In our program, IS policy is in the elective layer. However, to ensure that we are meeting the spirit of MSIS 2000 recommendations we offer the IS policy twice each year and offer every other elective once a year.

5. A key recommendation of MSIS 2000 is the inclusion of an integration course in the core requirements. In our MSIT curriculum the first core course, CS 610 is a 'window' to the rest of the curriculum, and it is our implementation of the concept of the MSIS 2000 integration course. Furthermore, since our systems integrator focus required hands-on experience with the technologies used for building distributed systems, we needed a JSP and server side programming skills course in our core. We could have extended the core to seven required courses but instead chose to move the IS policy course to the electives layer.

In summary, although the core of our MSIT program does not match one to one with the MSIS 2000 core, it is aligned in spirit with the recommendations of MSIS 2000 core curriculum.

6. Since the purpose of the foundation layer is to ensure the students possess the background necessary to handle the courses in the core and elective layers of the curriculum, it is important that the foundation courses are built to meet this goal and, at the same time, match typical courses taught in the undergraduate curriculum. We chose to package two undergraduate courses for each of our three foundation courses⁹. Our experience is that the waiver policy must not be too liberal. We found that installing proficiency exams in each of the foundation courses is worth the effort to maintain quality and bring consistency in the decision process.

The MSIS 2000 model curriculum also recommends a basic foundation in financial accounting, marketing and management. Since our curriculum targeted IS professional with at least two years of applications development experience and 70% of our students

⁹For example, CS 603 is composed of our programming principles and object-oriented programming courses, CS 605 combines the content of the systems analysis and design course and data management course, and CS 607 is a combination of our undergraduate courses on computer systems and data communications

in our MSICS program had undergraduate degrees in a business discipline, we chose not to implement the prerequisite business foundation. Our experience is that a lack of business understanding among a few students does affect the classroom dynamics. This deficiency could become a problem if we succeed in attracting more than 30% of our students with undergraduate degrees in computer science, mathematics, and engineering.

In summary, our experience and the above review suggests that the systems integration preparation and the architect focus of the courses that guided the design of the program in 2000 are still valid. Indeed, it could be argued that integrating platforms, systems, applications and technologies is even more crucial as organization become more global. The Foundation layer is effective in terms of providing the IS foundation but our decision to skip the business prerequisites can become a problem if the number of students with no formal business education exceed the 30 % threshold. Courses in the Core layer of the MSIT curriculum are well conceived, designed, and delivered. The use of state-of-the-art technologies in these courses is a distinguishing feature of our program, but this creates a substantial burden on the faculty. Our Elective courses provide students an opportunity to develop a distinguishing capability. As discussed above, the structural aspects of the Elective layer (4 electives, of which 2 must be CS and 2 are unrestricted) are sound, but further faculty review of the topical coverage of our electives is warranted.

In conclusion, using the MSIT program as a case study this paper shows how MSIS 2000 can be adapted to meet local needs. The three year review has shown that the preparation of system integrators and architectural orientation of the MSIT program is well aligned with the market for graduate level IS education in our region.

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