IS 2010

Curriculum Guidelines for Undergraduate Degree Programs in Information Systems

Association for Computing Machinery (ACM)
Association for Information Systems (AIS)

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FOREWORD

The IS 2010 report is the latest output from model curriculum work for Information Systems that began in the early 1970s. Prior to this current effort, the most recent version of the IS undergraduate model curriculum is IS 2002 (Gorgone et al. 2003), published in early 2003. IS 2002 was a relatively minor update of IS'97 (Davis et al. 1997). Both IS 2002 and IS '97 were joint efforts by ACM, AIS, and DPMA/AITP (Data Processing Management Association/Association of Information Technology Professionals). IS'97 was preceded by DPMA'90 (Longenecker and Feinstein 1991) and ACM Curriculum Recommendations 1983 (ACM 1983) and 1973 (Couger 1973). IS 2002 has been widely accepted, and has also been the basis for accreditation of undergraduate programs of Information Systems. This report represents the combined effort of numerous individuals and reflects the interests of thousands of faculty. It is grounded in the expected requirements of industry, represents the views of organizations employing the graduates, and is supported by other interested organizations.

This report is one of the undergraduate curriculum volumes that have been produced for the core computing disciplines (see the CC2005 Overview Report; Shackelford 2005). In addition to IS 2010, curriculum recommendations exist for computer science (CS 2008), computer engineering (CE 2004), software engineering (SE 2004), and information technology (IT 2008) [http://www.acm.org/education/curricula-recommendations]. All of these reports are under the control of separate committees; updates are published as they are completed.

All aspects of the global computing field continue to face rapid and frequent change. As a result, university-level Information Systems (IS) curricula need frequent updating to remain effective. Since most academic units have mechanisms to maintain currency of curricula, what is the role of professional society curriculum committees? If an IS academic unit were providing graduates solely to local business and government, the input on program contents could be derived from representatives of local organizations that hire the graduates. However, local employment is not the sole objective for undergraduate majors in Information Systems. Students from IS programs accept jobs in widely dispersed geographic areas. Therefore, the availability of curriculum models enables local academic units to maintain academic programs that are consistent both with regional, national, or global employment needs and with the common body of knowledge of the IS field. The first IS curriculum models were introduced in the early 1970s. This early work was followed by model curricula developed by ACM and AITP. Details of this history are reviewed in Appendix 1: Background of IS Curricula and Related Disciplines.

Professional society curriculum reports serve several other objectives. One important use is to provide a local academic unit with rationale to obtain proper resources to support its program. Often, the administration at a local institution is not aware of the resources, course offerings, computing hardware, software, and laboratory resources needed for a viable program. The administration may be unaware of the specialized classroom technology, library resources, or laboratory assistants essential for proper education of IS undergraduates. Finally, the administration might not recognize the rapid turnover of knowledge in the field and the need for resources to support constant retooling of faculty. Curriculum reports provide recommendations in these resource areas as well as recommended content for the body of knowledge to be taught.

This document has incorporated the comments and suggestions based on feedback from senior scholar, numerous panels, presentations, and solicitation, in many forms, to the IS committee at large. We are very grateful for these contributions, which have significantly improved this report. Further, we encourage you to get engaged in the ongoing curriculum development process on blogsandwikis.bentley.edu/iscurriculum that has been launched in the context of this curriculum revision project. We believe these efforts can be truly successful only if the broad global IS community participates widely.

The editors of IS 2010 thank those who have helped in this project. We also acknowledge with gratitude the permission we received from Communications of the AIS to include material in this report from the two CAIS papers that the task force published during the course of this project (Topi et al., 2007; Topi et al., 2008). We hope this ongoing cooperative curriculum development effort will continue to serve your needs. We are interested in your input and encourage you to let us know how you are using these materials and how they might be improved.

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EXECUTIVE SUMMARY

IS 2010 is the latest in a series of model curricula for undergraduate degrees in Information Systems. It builds on the foundation formed by this earlier work, but it is a major revision of the curriculum and incorporates several significant new characteristics. IS 2010 is the third collaborative effort by ACM and AIS. Both organizations have worldwide membership, and therefore, IS 2010 includes elements that make it more universally adaptable than its predecessors. IS 2010 is not directly linked to a degree structure in any specific environment but it provides guidance regarding the core content of the curriculum that should be present everywhere and suggestions regarding possible electives and career tracks based on those.

There are several reasons motivating this revision. The work leading to the previous significant revision, IS'97, took place more than 10 years ago, and in a rapidly changing field this alone is an important reason to re-evaluate the curriculum. There has been a great deal of change in technology and industry practices, including the globalization of IS development processes, introduction of Web technologies, emergence of a new architectural paradigm, widespread utilization of large-scale ERP systems, ubiquitous availability of mobile computing, and broad use of IT control and infrastructure frameworks, such as ITIL and COBIT. This curriculum is also introduced after a period when the interest in studies in Information Systems has significantly declined, and the field has to be able to reverse this trend. This curriculum revision also represents an effort to re-evaluate the core principles of the discipline through a very careful specification of the degree learning outcomes. Finally, new social networking technologies made it possible to attempt to include the IS community as broadly as possible.

This revision has four broad key characteristics that have shaped the outcome significantly. First, the curriculum reaches beyond the schools of management and business. Previous versions of the IS curriculum have been targeted to a typical North American business school; this model curriculum is, however, guided by the belief that even though business will likely continue to be the primary domain for Information Systems, the discipline provides expertise that is critically important for an increasing number of domains. Second, the outcome expectations of the curriculum have been very carefully re-evaluated and articulated first in the form of high-level IS capabilities and then in three knowledge and skills categories: IS specific knowledge and skills, foundational knowledge and skills, and domain fundamentals. Third, the curriculum is structured so that it separates the core of the curriculum from electives with the intent of supporting the concept of career tracks. Finally, the design of this curriculum includes enough flexibility to allow its adoption in a variety of educational system contexts.

The high-level IS capabilities that the curriculum specifies as the highest level outcome expectations are as follows:

- Improving organizational processes
- Exploiting opportunities created by technology innovations
- Understanding and addressing information requirements
- Designing and managing enterprise architecture
- Identifying and evaluating solution and sourcing alternatives
- Securing data and infrastructure, and
- Understanding, managing and controlling IT risks.

These high-level capabilities are translated into knowledge and skills in three categories:

1. IS specific knowledge and skills, including
    a. Identifying and designing opportunities for IT-enabled organizational improvement
    b. Analyzing trade-offs
    c. Designing and implementing information systems solutions, and
    d. Managing ongoing information technology operations
2. Foundational knowledge and skills, including
    a. Leadership and collaboration
    b. Communication
    c. Negotiation
    d. Analytical and critical thinking, including creativity and ethical analysis, and
    e. Mathematical foundations
3. Domain fundamentals, including
    a. General models of a domain
    b. Key specializations within a domain and
    c. Evaluation of performance within a domain.

The curriculum itself is designed to educate graduates who are prepared to enter the workforce equipped with the knowledge and skills specified in these three categories. As discussed above, it separates the core from career track electives and includes seven core courses: Foundations of Information Systems, Data and Information Management, Enterprise Architecture, IS Project Management, IT Infrastructure, Systems Analysis & Design, and IS Strategy, Management, and Acquisition. It is obviously not possible to offer a complete collection of career track electives in a model curriculum document, but we include a number of elective course descriptions as examples. Notable changes in the included courses are as follows: a) application development is no longer included in the core of the curriculum; b) data networking and computer architecture are covered at a higher level of abstraction in an IT Infrastructure course; c) enterprise architecture and IS project management are now part of the core; d) the personal productivity tools course has been removed from the curriculum, and e) the prerequisite structure has been simplified. Notably, both data & information management and systems analysis & design have maintained their central roles in core of the curriculum. In addition to the core curriculum, we provide examples of possible career tracks and career track electives; in addition, we illustrate the use of the model curriculum in three different academic contexts with varying general degree requirements.

The task force believes that the outcome expectations, structure, and content of the new curriculum make it significantly more broadly applicable than the previous IS model curricula were. We hope that this document demonstrates that Information Systems as a discipline can make significant contributions to a number of domains, including but not limited to business, and that its core areas of expertise are highly valuable and even essential for the best practices and further advancement of a variety of collaborating domains.

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1. USE OF THE IS 2010 CURRICULUM REPORT

The Information Systems undergraduate model curriculum report has several intended classes of users who have a stake in the achievement of quality IS degree programs:

- academic executives to whom the Information Systems program reports
- academic heads responsible for Information Systems programs
- accrediting bodies
- Information Systems faculty
- non-Information Systems faculty in the school or college where the Information Systems program resides
- Information Systems practitioners
- students in Information Systems programs

In this section, the uses of the report by these intended stakeholders are described and its value explained. First, a detailed explanation of resources is discussed. This included information about faculty needs, classroom needs and computing needs. Next, responsibilities for the stakeholders are discussed.

For Academic Executives to Whom the Information Systems Program Reports

The IS discipline contributes in a significant way to a number of domains, including business and government. Information systems are complex systems requiring both technical and organizational expertise for design, development, and management. They affect not only operations but also the organization's strategy.

The nature of this rapidly changing field requires a unique set of resources. The minimal level of resources required to provide a viable undergraduate degree program in Information Systems is outlined below. Specifics of the resource requirements are detailed elsewhere in the document. Additional resources are necessary to support the service courses provided by the IS faculty to other academic units of the university.

1. Faculty Resource Requirements

   The number of faculty will depend upon the number of students majoring in Information Systems. At a minimum, a critical mass of faculty is needed to provide the degree of specialization essential for the proper coverage of the curriculum. The interests, qualifications, and scholarly contributions of the faculty members must be sufficient to teach the courses, plan and modify the courses and curriculum, and remain abreast of current developments in Information Systems. The rapid increase and change in knowledge in the Information Systems field require that faculty continuously upgrade their skills. Thus, all faculty members must remain current in the discipline. Further, the inclusion of pertinent research would also benefit students and the faculty alike. It is recommended that a significant part of each faculty member's workload be spent in receiving training in new technologies and acquiring new knowledge and skills. The changes in the field place heavy demands on IS faculty who are required to tailor the curriculum to meet local and regional conditions, develop up-to-date instructional materials, and manage student projects and internships while also maintaining their own scholarly productivity in a way that is compatible with local university expectations.

2. Physical Space Requirements

Physical space requirements for the Information Systems program are often similar to those of engineering, biological and physical sciences. The facilities should include:

a. Access to specialized software (such as integrated development environments, modeling tools, etc.) either by making the software available to the students so that they can install it on their laptops or in sufficiently equipped laboratories.

b. Laboratories to provide experience in designing, installing, and running networks.

c. Project team laboratories to accommodate team projects essential to the IS program.

d. Classrooms equipped with computer projection, Internet, and local network access, and appropriate computing and software infrastructure, so that the entire curriculum can be adequately delivered.

3. Computing Infrastructure Requirements

Computing infrastructure consists of hardware, software, and technical support. Because of the need to keep abreast of the rapidly changing technology environment, Information Systems students and faculty must have access to computing facilities at least equivalent to those used in a typical organization operating within a program's domain. This is necessary to prepare the students for their profession and for the faculty to contribute to the creation of new knowledge in the field. The rate of change in technology suggests a rapid replacement cycle, with some technologies reaching obsolescence in less than 12 months. While some of the general university or school computing laboratories may meet some of the needs of Information Systems, special infrastructure resources are necessary to support the requirements of the curriculum, including systems development, network infrastructure, and other advanced and emerging technologies. In addition to software and hardware, it is paramount to the success of Information Systems programs that adequate technical support is provided.

For Academic Heads Responsible for Information Systems Programs

The report provides the rationale for adopting the curriculum recommendations for an undergraduate degree program in Information Systems. The curriculum recommendations are based on an assessment of industry expectations for entry-level professional employees in the Information Systems field. As discussed at a detailed level later in the report, the outcome expectations for Information Systems graduates have changed significantly with many schools increasing the emphasis on the design of domain solutions, such as the implementation of business processes using information technology. Written and oral communication skills and team skills continue to be important: graduates need to be able to interact effectively with clients and to work effectively in teams. This report gives the specific recommendations necessary to successfully implement and maintain a program in Information Systems stressing technical, behavioral, and organizational elements. A summary of the resource requirements necessary to support a viable Information Systems program is outlined later in the document.

For Accreditation Bodies that Accredit Information Systems Programs and Others Interested in Program Assessment

Accreditation of IS programs and other processes that assess the quality of these programs require a widely accepted definition of the discipline and curriculum. This report, developed by the major professional and academic societies in Information Systems, provides the basis for the curriculum criteria employed in IS accreditation. This report provides a significantly more detailed discussion regarding educational outcomes of IS programs than the previous versions did, which is fully compatible with the recent direction in program assessment and accreditation.

For Information Systems Faculty

The IS model curriculum is intended to provide flexibility in designing IS curricula to satisfy various local requirements. IS faculty may be affiliated with schools of business, schools of public administration, stand-alone schools of Information Systems, or other variations. To better serve the diversity of IS programs, this model curriculum is the first IS curriculum to separate core and elective courses and explicitly acknowledge the significant local differences in the requirements for IS curricula. As a practical illustration of the flexibility this provides, we later present an IS Specific Course Matrix to provide examples of curriculum solutions that can be developed within the framework that this document provides.

The guidance and the structural flexibility that this curriculum provides enable faculty members to tailor and experiment with curriculum design. Based on local conditions, the desired number of core and elective courses with tailored depth of coverage for appropriate topics may be fashioned. This allows faculty to flexibly design IS curricula to meet career track expectations for graduates.

At the course level, this model curriculum continues to follow the tradition of IS curriculum recommendations and provides descriptions for core courses and a subset of key electives. These descriptions include a catalog description, learning objectives and topics for each of the courses. This material will be helpful for both individual faculty members who are working on course design and for departments that are making decisions regarding the direction their curricula should take.

For Non-Information Systems Faculty

The use of information technology is pervasive in society. The requirement of the workforce to utilize this technology is increasing. Users of information technology are now expected to take personal responsibility for much of what has been handled in the past by a centralized computing services unit. While many organizations provide some user training in information technology, graduates who have an in-depth understanding of the opportunities IT capabilities can provide to their organization are in a stronger position compared to their peers without this understanding. A strong, capable Information Systems program can benefit all students in a school and provide special benefits to non-majors who desire more competence in information technology and its application to their areas of interest.

IS 2010 identifies prerequisite skills needed by all students in basic personal productivity software. Students in all majors should have a working knowledge of how to effectively utilize software for word processing, electronic mail, Web browsing, spreadsheet modeling, database management, presentation graphics, statistical analysis, and external database retrieval. Although these skills are prerequisite and not part of the exclusive domain of Information Systems, the Information Systems faculty can provide useful competence for managing the self-study modules, course modules, and testing-out examinations for the prerequisites.

The IS 2010 curriculum specifies a general course (Foundations of Information Systems) to provide an understanding of and skills related to Information Systems suitable for all students. This course establishes a foundation for specialized courses related to functional area information systems.

Students majoring in other subjects may wish to have a minor in Information Systems. The IS 2010 curriculum defines a subset of the courses in the major suitable for a minor. The courses include IS Strategy, Management & Acquisition, Enterprise Architecture, and Data and Information Management.

For Information Systems Practitioners

The report provides a basis for practitioner interaction with IS academic units in at least three ways: to gain an understanding of the model curriculum and therefore, the competencies of the graduates of the program, to identify opportunities for enhancing the educational experience for the students (for example, guest speakers, internships, advisory board memberships, and so forth), and to enable a continuous dialogue to improve the curriculum and the educational experience of students.

For Information Systems Students

For students who are enrolled in an IS program, this report can add to their understanding of the breadth and depth of the IS field and the career opportunities. Information in this report can prepare students for discussions with academic advisors as to options and choices in the program and strategies for entering the job market. Further, IS programs can prepare students for advanced IS studies. This can include both research-oriented and practitioner-oriented advanced programs.

Other Stakeholders

The primary audiences for this report are the stakeholders listed above. Other constituents may also find value in this report and should not be precluded. These groups include parents, career advisors, potential applicants and so on.

2. INFORMATION SYSTEMS MODEL CURRICULA

IS 2010 Curriculum Guidelines for Undergraduate Degree Programs in Information Systems is the latest report on the model curriculum work in the Information Systems field. The work of IS curriculum task forces began in the early 1970s and has continued for the past 30+ years. The Association for Computing Machinery (ACM) has been a major organizer for these task forces including the first efforts in the 1970s. Other organizations, including AIS (Association for

Information Systems), AITP (formerly DPMA) and IFIP (International Federation for Information Processing), have contributed significantly to model curriculum development.

IS 2010 is the third collaborative effort by ACM and AIS. Both organizations have worldwide membership. ACM has both professional and academic members in the broad field of computing. Through its Education Board, it supports a wide range of curriculum development including Computer Engineering, Computer Science, Information Systems, Information Technology, and Software Engineering. AIS, established in 1994, is primarily composed of faculty members in Information Systems. The partnership of ACM and AIS, therefore, combines the breadth of pedagogical and curriculum interests of these organizations.

Since ACM and AIS are worldwide organizations, IS 2010 includes elements that make it more universally adaptable than its predecessors. The separation of the core courses from the electives makes it easier to create curricula that both are compatible with the model curriculum and address local requirements that vary widely. IS 2010 is not directly linked to a degree structure in any specific environment but it provides guidance regarding the core content of the curriculum that should be present everywhere and suggestions regarding possible electives and career tracks based on those.

IS 2002 (Gorgone et al. 2003) was a relatively minor update of IS'97, the latest comprehensive revision of the IS model curriculum. IS 2002 included new material related to the explosive growth of the Internet and electronic business, to the extent that it included a new course specifically targeted to this topic area. The previous curriculum model, IS '97 (Couger et al. 1997; Davis et al. 1997) was circulated in draft form in 1994 (Gorgone et al. 1994; Longenecker et al. 1994) and 1995 (Couger et al. 1995) and finalized in 1996. Therefore, a significant revision of the model curriculum is clearly needed and overdue. These reasons will be discussed at a more detailed level in Section 4.

The next sections present the principles guiding the curriculum revision and provide further motivation for updating IS 2002. This is followed by a review of guiding assumptions about the IS profession that helped to shape the curriculum design and evolution. A summary of key differences between IS 2002 and IS 2010 will follow. Next, the report provides a description of Information Systems as a field of academic study. The relationship of the IS courses and programs at various levels is explained. This document presents an entirely new, significantly expanded section on outcome expectations for the Information Systems graduates. This is followed by a brief presentation of the curriculum architecture, the resources needed for IS degree programs, and courses shared with other computing disciplines. Finally, the report concludes by providing high-level course descriptions of the IS 2010 model curriculum and appendices for reference.

3. PRINCIPLES GUIDING THE CURRICULUM DESIGN

The key principles that guided this effort were as follows:

1. The model curriculum should represent a consensus from the Information Systems community.

2. The model curriculum should be designed to help Information Systems programs to produce competent and confident entry-level graduates well suited to workplace responsibilities or

further studies of Information Systems.

3. The model curriculum should guide but not prescribe. Using the model curriculum guidelines, faculty can design their own courses and schools can design their own programs.

4. The model curriculum should be based on sound educational methodologies and make appropriate recommendations for consideration by Information Systems faculty.

5. The model curriculum should be flexible and adaptable to most Information Systems programs.

6. The model curriculum is not restricted to a specific domain; all Information Systems programs are, however, linked to some domain.

7. The model curriculum has a core of content that is common to all Information Systems programs.

8. The model curriculum has career targets that require both core and elective content.

9. The model curriculum does not focus on specific issues related to pedagogy. This is not a reflection of our understanding of the importance of pedagogical decisions; we simply believe that these highly significant issues are outside the scope of this document.

4. MOTIVATION FOR REVISING IS 2002

There are several factors motivating the IS curriculum revision. This section will provide an overview of the reasons why it was critically important for the IS community to go through the curriculum revision process.

The first, and most obvious, reason is the time elapsed since the previous revision. As discussed above, the last comprehensive undergraduate curriculum revision was IS'97 (Davis et al. 1997);. Most of the work done on IS'97 was completed in the mid-1990s, making the curriculum elements closely linked to a specific set of technologies quite antiquated.

Second, there has been a great deal of change in technology and industry practices. This major contextual change has several factors driving it, including:

1. Complex globally distributed information systems development – The full extent of the distributed nature of IT development was not fully visible during the development of the previous curriculum. The skills needed by IS graduates have, consequently, changed significantly. Increasingly, many IS jobs require skills in working with colleagues and development team members around the world. Further, for business school graduates capabilities in the management of globally distributed development resources are increasingly in demand.
2. Web technologies and development – Mature modeling, management and development platforms for the web environment have become a core part of IS development.
3. Emergence of a new architectural paradigm. Service-oriented architecture, web services, software-as-a-service, and cloud computing are all important elements in the new way of organizing the fundamental architecture for computer-based systems and solutions that is gradually becoming the dominant paradigm of organizational computing.

4. ERP/packaged software – Information systems and business processes have become closely integrated, and increasingly often, core infrastructure applications are based on large-scale enterprise systems so that the focus has shifted from development to configuration.
5. Ubiquitous mobile computing – Global organizational life using a variety of devices has become dependent on mobile and ubiquitous platforms.
6. IT control and infrastructure frameworks – Frameworks and standards such as COBIT, ITIL, and ISO 17799, have become very important sources of guidance for IT/IS practices in organizations. We have to at least ask the question about what their role is in IS curricula.

Clearly, the professional context in which our graduates do their work has changed considerably over the past decade, and this change should be reflected in the curriculum. Not only should the new concepts be covered in the curriculum but also the new model they collectively specify for computing in organizations has a profound impact on the capabilities that Information Systems graduates need.

Third, the interest in the study of IS as a field has dramatically declined among students at most institutions. Therefore, it is imperative that the IS community as a whole addresses this problem from several different perspectives, including curriculum design. The response to the enrollment crisis cannot only be based on curriculum changes; however, an outdated curriculum can be a sufficient reason to turn a prospective student away from the discipline.

Fourth, the IS discipline must address its core principles and values within and through the curriculum. By doing so, the importance of clearly articulating the identity of the IS discipline can be established and strengthened. The recent approval of the model curriculum for the emerging IT discipline has made this reason particularly important.

Finally, the revision process was seen as a mechanism to engage the IS community in a more comprehensive way than was possible during earlier update efforts. The task force believed that the Internet and, specifically, Web 2.0 technologies would provide a strong set of technical capabilities to enable and encourage collaboration among IS academics and practitioners around the world.

Of course, this list cannot be inclusive of all motivations for the curriculum revision. We hope, however, that these issues clearly stress the importance of substantially and systematically overhauling the current curriculum.

5. GUIDING ASSUMPTIONS ABOUT THE INFORMATION SYSTEMS PROFESSION

In conceptualizing the role of information systems in the future and the requirements for IS curricula, several elements remain important and characteristic of the discipline. These characteristics evolve around four major areas of the IS profession and therefore must be integrated into any IS curriculum:

1. IS professionals exist in a broad variety of domains, including, for example, business, health care, government, and non-profit organizations. Students must therefore understand that:

- IS professionals are enablers of successful performance in a multitude of organizations
- IS professionals span and integrate all organizational levels and functions
- IS professionals need both an excellent understanding of the domain within which they work and appropriate technology knowledge for their organizational role
- Information systems in organizations are increasingly of strategic significance because of the scope of the organizational systems involved and the role systems play in enabling organizational processes and strategies.

2. IS professionals must have strong analytical and critical thinking skills to thrive in a competitive global environment. Students must therefore:
   - Be problem solvers and critical thinkers
   - Use systems concepts for understanding and framing problems
   - Be capable of applying both traditional and new concepts and skills
   - Understand that a system consists of people, procedures, hardware, software, and data within a global environment.
3. IS professionals must exhibit strong ethical principles and have good interpersonal communication and team skills. Students must understand that:
   - IS professionals should be the able to critically evaluate and possibly act on current ethical issues in the IS field
   - IS professionals should be able to apply professional codes of conduct
   - IS professionals should be able to collaborate with other professionals as well as perform successfully at the individual level
   - IS professionals should have excellent communication skills (oral, written, and listening)
   - IS professionals should be able to demonstrate persistence, curiosity, creativity, risk taking, and a tolerance of these abilities in others.
4. IS professionals must design and implement information technology solutions that enhance organizational performance. Students must therefore:
   - Possess skills in understanding and modeling organizational processes and data, defining and implementing technical and process solutions, managing projects, and integrating systems within and across organizations.
   - Be fluent in techniques for acquiring, converting, transmitting, and storing data and information, including those related to data quality
   - Focus on the application of information technology in helping individuals, groups, and organizations achieve their goals within a competitive global environment.

6. KEY ELEMENTS OF THIS CURRICULUM REVISION

The Information Systems landscape has changed significantly over the past several years. Therefore, the foundations of the curriculum must be evaluated. There are four key elements of the revision:

1. **Reaching beyond the business school.**

There is an ongoing debate regarding the nature and identity of Information Systems as a discipline. At the center of this debate is whether Information Systems is exclusively a business discipline (i.e., exists only within a business domain), or whether Information Systems can exist in a variety of domains, including law, biology, healthcare, and so on. Earlier model curricula have clearly identified business as the domain in which IS was located. As shown in Figure 1 below (excerpted from IS 2002), business was the exclusive domain for prior versions of the model curriculum where domain content was shown as "business fundamentals." Although IS 2002 clearly acknowledges that IS programs could and do exist outside business schools, it also took the position that the primary (exclusive) domain for graduates was business and "technology-enabled business development" (further clarified as systems analysis and design, business process management, systems implementation, and IS project management).

No longer should the Information Systems paradigm be exclusive to the business school context. Even though business will likely continue to be the primary domain for Information Systems, the discipline provides expertise that is critically important for an increasing number of domains.

2. Revising the outcome expectations for IS graduates and proposing subsequent changes to the curriculum topics.

This category includes subsequent changes to the curriculum topics to reflect the changed outcome expectations. This change centers on the radical contextual change both in terms of technology and business discussed above. These actions are a critically important and natural part of the revision process.

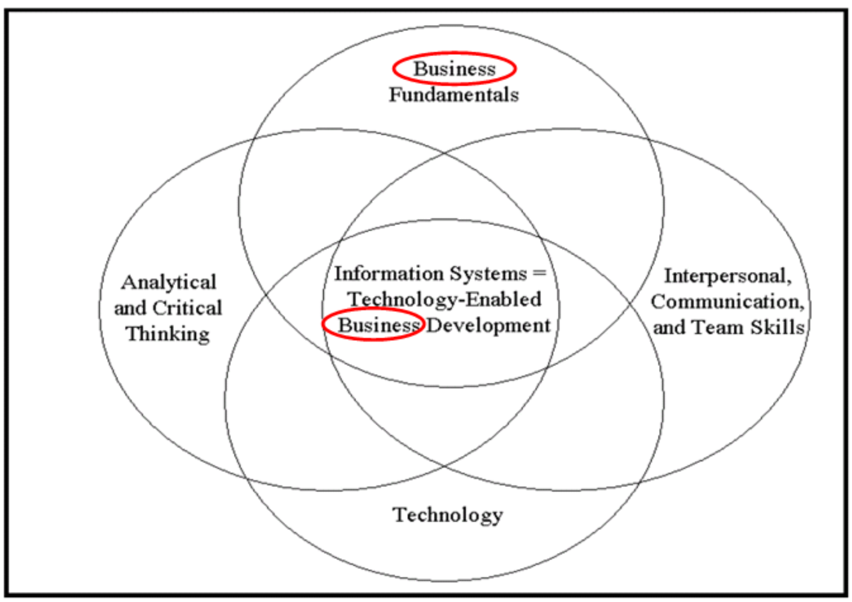

Figure 1: Demonstration of the close linkage between Information Systems and Business in IS 2002.

The IS 2002 curriculum had taken a "one size fits all" philosophy, whereby there is no separate core specified within the curriculum. In essence, all courses are required. Unfortunately, this model left little room for local innovation and adaptation in institutions that wanted to adopt the model curriculum in its entirety. For many schools, it was impossible to follow the curriculum guidelines because they had fewer courses in their program than the 10 specified in IS 2002. On the other hand, at other institutions there might be much more room available for IS courses, and again, the fixed-size model curriculum is an obstacle. As a result, many institutions did not find

IS 2002 to be responsive to their particular situations. To overcome this limitation of IS 2002, the task force wanted to introduce greater flexibility into the new curriculum. To do so, the task force identified a set of core courses that will be common to all Information Systems programs.

The seven core courses are:

1. Foundations of Information Systems
2. Data and Information Management
3. Enterprise Architecture
4. IT Infrastructure
5. IS Project Management
6. Systems Analysis and Design
7. IS Strategy, Management, and Acquisition

It is important to note that these seven courses in the model can be implemented in a specific local context as independent courses or as components within fewer courses if need be. The key point is that the task force strongly believes that there is indeed a core content that should be incorporated in every undergraduate Information Systems program, and that this content is captured in this list of core courses. In essence, the task force is making a strong statement regarding what defines Information Systems at the undergraduate level by specifying the core. The proposed model curriculum acknowledges that not all programs are able to cover all aspects of the core at the same level of depth, but some level of coverage of these topics is required for a program to be identified as an Information Systems program.

Particularly taking into account the radical contextual change both in terms of technology and business discussed above, these actions are a very important and natural part of the revision process.

3. Evaluating the assumptions underlying the curriculum structure and modifying it accordingly.

Past revisions have ended by providing a basket of classes that were recommended for IS programs. This curriculum revision process hopes to be more inclusive by providing a short list of core topics that are essential pedagogically to Information Systems, allowing programs to customize other topics by creating a list of electives.

This can be done by offering a curriculum that does not specify a single career objective (i.e., technology-enabled business development or career as a systems analyst) but will provide numerous career tracks. These career tracks will integrate a combination of the core courses and some set of career track electives. How the core courses are instantiated depends on the needs of a specific career track (e.g., either briefly or very comprehensively, depending on the needs of the target career track selected by a particular program). Career tracks, obviously, can be associated with one or several domains. For example, a database administrator career track is compatible with business, government, nonprofit, and healthcare domains (and many others).

4. Involving the global IS community

Traditionally, curriculum projects have been largely based on the work of a small task force that has shared its work at a variety of conferences and incorporated the feedback from the sessions to the model curriculum. In addition, written drafts have been shared widely and comments solicited. Also, surveys have been used to gather industry input. This process is driven by a few individuals with little input from the academy as a whole. We are using the wiki environment to allow for global community involvement in the revision process. This is critical if the new undergraduate Model Curriculum is to reflect the perspectives of the global Information Systems discipline.

Engaging the entire IS community will be a metric of success for this task force's work. One of the first tasks in the current curriculum revision project was to establish a feedback mechanism that is globally accessible. For this, the task forced turned to current thinking in system design, expressly Web 2.0 (O'Reilly 2005). Through the use of Web 2.0 technologies, we created a platform for discussion and harnessing the collective intelligence of the global IS community. The specific Web 2.0 platform selected was MediaWiki, an open source wiki platform originally written for Wikipedia. By using this Web-based platform, the task force believes that it can better engage the broader IS community to assist in developing and maintaining the curriculum. Despite its relative simplicity, ours appears to be a novel approach for developing curricula. It is our hope that the task force's work can help other academic disciplines find ways to improve their curriculum development processes.

The current version of the IS curriculum wiki is available at:
http://blogsandwikis.bentley.edu/iscurriculum .

Implementation of the Key Elements

In order to meet the goals outlined in the four key elements above, it was noted by the Joint AIS/ACM Curriculum Task Force early on in the process that the IS 2010 document would have to include a very different course structure than previous curriculum revisions. Therefore, the task force started the process of evaluating the target high-level capabilities of an IS graduate. By doing so, the committee believed that it could draw the knowledge and skills from the high-level capabilities and further draw the curriculum topic for the knowledge and skills. This process was very labor intensive and is described in detail in the outcome expectation section below.

This IS 2010 revision process required that we evaluated new ways the curriculum course structure could be offered. The first option was staying with a standard structure similar to that presented in IS 2002 and its predecessors. By doing so the task force would offer the IS committee a very rigid outline that included a basket of courses that could be implemented, in its entirety or in part, by IS programs. This was problematic for the committee as the rigid structure would not allow the IS 2010 curriculum to meet the needs of 1) global IS programs and 2) programs outside business schools. For this reason another approach was needed.

The task force proposed an innovative course structure to address the need of the different global constituents. By doing so, the revised curriculum could be tailored to the strengths and needs of any program around the world while also recommending a structured core that would standardize the foundational knowledge and skills for all IS graduates. This semi-flexible curriculum clearly met the goal stated in the key elements for IS 2010. For this reason, the task force proceeded to develop the structure of the core topics while also allowing for specializations in IS. The following will describe the need for Information Systems as a distinct academic field.

7. INFORMATION SYSTEMS AS A FIELD OF ACADEMIC STUDY

Computer-based information systems continue to be a critical part of the products, services, operations, and management of organizations. Indeed, information systems and information technology can be so critical as to disrupt classic business models, threatening traditional revenue streams and even driving industry sectors to extinction. The print newspaper industry, travel agencies, real estate agencies, and video rental stores represent industries that have been forced to change their business models and operations in response to the introduction of new information technologies and systems. The effective and efficient use of information and communications technologies is an important element in maintaining or achieving competitive advantage for business organizations and excellence in service for government and non-profit organizations. The information technology/information systems strategy is an integral part of organizational strategy. Information systems support management processes at all levels – operational, tactical, and strategic management. Information systems are vital to problem identification, analysis, and decision making. The importance of information technology and information systems to organizations and the need for well-educated professionals in the field is the basis for a strong link between educational programs and the professional community of IS practitioners (Bullen et al. 2009; Dick et al. 2007; Mawhinney et al. 1994; Trauth et al. 1993).

Information Systems as a field of academic study began in the 1960s, a few years after the first use of computers for transaction processing and reporting by organizations. As organizations extended the use of information processing and communication technology to operational processes, project management, decision support, and enterprise and industry strategy, the academic field also grew in scope and depth. An IS organization function emerged to manage computer and communications technologies and information resources within an organization. In the same way that universities have degree programs reflecting important organizational functions, such as financial resource management, marketing resource management, and human resource management, a degree program emerged for management of information technology and information resources. During this nearly half century of growth and change, different names have been used and the definition of the field has been enlarged. The simple term Information Systems (IS) has become the most commonly accepted, generic term to describe the discipline.

Differing Names for the Academic Field of Information Systems

Information Systems as a field of academic study exists under a variety of different names. The different labels reflect historical development of the field, different ideas about how to characterize it, and different emphases when programs were begun. The names of computer-related majors offered in undergraduate institutions accredited by the Association to Advance Collegiate Schools of Business (AACSB) in the United States, for example, are represented by the following terms) (Pierson et al. 2008):

Management Information Systems, representing 40.5% of programs
Information Systems, representing 20.6% of programs
Computer Information Systems, representing 18.0% of programs

The remaining 20.9% of programs are known by names such as:

Information Management
Information Systems Management
[Business] Information Systems
[Business] Computer Systems
[Business] Computer Information Systems
[Business] Information Technology Management
[Business] Informatics
Information Resources Management
Information Technology
Information Technology Systems
Information Technology Resources Management
Accounting Information Systems
Information Science
Information and Quantitative Science

The Scope of Information Systems

Information Systems as a field of academic study encompasses the concepts, principles, and processes for two broad areas of activity within organizations: (1) acquisition, deployment, management, and strategy for information technology resources and services (the information systems function; IS strategy, management, and acquisition; IT infrastructure; enterprise architecture; data and information) and (2) packaged system acquisition or system development, operation, and evolution of infrastructure and systems for use in organizational processes (project management, system acquisition, system development, system operation, and system maintenance). The systems that deliver information and communications services in an organization combine both technical components and human operators and users. They capture, store, process, and communicate data, information, and knowledge.

The information systems function in an organization has a broad responsibility to plan, develop or acquire, implement, and manage an infrastructure of information technology (computers and communications), data (both internal and external), and enterprise-wide information processing systems. It has the responsibility to track new information technology and assist in incorporating it into the organization's strategy, planning, and practices. The function also supports departmental and individual information technology systems. The technology employed may range from large centralized to mobile distributed systems. The development and management of the information technology infrastructure and processing systems may involve organizational employees, consultants, and outsourcing services.

The activity of developing or acquiring information technology applications for organizational and inter-organizational processes involves projects that define creative and productive use of information technology for transaction processing, data acquisition, communication, coordination, analysis, and decision support. Design, development or acquisition, and implementation techniques, technology, and methodologies are employed. Processes for creating and implementing information systems in organizations incorporate concepts of systems analysis and process design, innovation, quality, human-machine systems, human-machine interfaces, e-business design, sociotechnical systems, and change management.

Information systems professionals work with information technology and must have sound technical knowledge of computers, communications, and software. Since they operate within organizations and with organizational systems, they must also understand organizations and the functions within organizations (administration, accounting, finance, marketing, operations, human resources, and so forth). They must understand concepts and processes for achieving organizational goals with information technology. In addition to sound technical knowledge and organizational understanding, they must possess systems thinking, the ability to analyze business problems, communication skills, and teamwork skills (Overby 2006). The academic content of an Information Systems degree program therefore includes information technology, information systems strategy and management, information systems development and implementation, organizational functions, and concepts and processes of organizational management.

In recent years, Information Technology has emerged as a new academic discipline under the broad umbrella of computing. Its role has been recognized in two recent documents produced by the computing education community. CC 2005 Overview Report, a broad survey of five established computing disciplines (Computer Engineering, Computer Science, Information Systems, Information Technology, and Software Engineering) was the first published work to identify the formal role of Information Technology as a computing discipline (Shackelford et al. 2005). Based on published and draft curriculum documents, the overview report compares and contrasts computing disciplines, and it clearly positions Information Systems and Information Technology as disciplines that on one hand operate in the same space (focusing on organizational needs) but on the other hand address a very different set of questions. The document presents the contrast as follows:

> *Professionals in the [Information Systems] discipline are primarily concerned with the information that computer systems can provide to aid an enterprise in defining and achieving its goals, and the processes that an enterprise can implement or improve using information technology. … Information Systems focuses on the information aspects of information technology. Information Technology is the complement of that perspective: its emphasis is on the technology itself more than on the information it conveys. IT programs exist to produce graduates who possess the right combination of knowledge and practical, hands-on expertise to take care of both an organization's information technology infrastructure and the people who use it. (CC 2005, p. 14).*

The other recently published document that specifies the Information Technology discipline is the IT model curriculum, IT 2008. This document, approved in late 2008, defines the Information Technology Body of Knowledge and an undergraduate curriculum for the IT discipline. In comparing the curriculum specified in IT 2008 and the core of this IS curriculum, we can clearly see that the disciplines share areas of interest, such as Data and Information Management, IT Infrastructure, and Human Computer Interaction, but that there are also specific areas of distinction. Particularly important is the IS emphasis on Systems Analysis and Design (including Business Analysis and Business Process Design and Management), IT Strategy, Management, and Acquisition, and Enterprise Architecture. It is very likely that the discussion regarding the identities of the IT and IS disciplines will continue actively during the next several years.

8. RELATIONSHIP BETWEEN THE FOUNDATIONS OF IS COURSE, THE MINOR, AND THE MAJOR

Prerequisite Technology Skills: The prerequisite skills level provides a personal capability for student use of information technology. Several applications useful to students and graduates are covered, including: word processing, Web browsing, electronic mail, spreadsheet processing, database management, presentation graphics, and external database retrieval. Although word processing is included here, it is typically acquired prior to formal courses. Some institutions provide the prerequisite IS skills level via a course required of all students. Other institutions enable students to acquire this competency through laboratories with computer-based tutorial modules. Others assume proficiency gained at high school or based on personal experience. Competency tests may be used to ensure adequacy of prior knowledge. The Information Systems faculty may also have major responsibilities for remedial work relative to the prerequisite skills.

All Students: The Foundations of Information Systems course provides all students with an introduction to the purposes, uses, and value of information systems and information resources in organizations. It introduces concepts and methods by which IT professionals design and implement systems and explains the technologies and processes for providing information and communications resources. The course illustrates opportunities for business professionals to employ technology resources. Students can build on their prerequisite understanding to investigate useful concepts, functions, and capabilities provided by information systems. Exercises will assist students in understanding system development processes, effective use of information systems, and quality concepts in providing inputs and using outputs from systems.

Exercises may enable students majoring in functional areas to gain additional IS skills and system understanding through use of application packages in their major fields of study, such as accounting, finance or marketing. Team projects with actual clients demonstrate applied learning.

IS Minors: In addition to the courses all students take, an IS minor consists of a subset of the major courses that form a cohesive set of knowledge complementary to the student's major field of study. Individuals with a minor in IS often act as technology liaisons and as functional area representatives on teams to develop and enhance major applications. A minor may be tailored to these unique functional area requirements, such as marketing or accounting, or a second field, such as health sciences.

IS Majors: An IS major consists of the entire model curriculum targeted for a particular career track. Students proficient at this level are prepared to enter a career in the IS field. They have competencies in basic technical areas and apply these to business processes and project management. Graduates of IS programs can work for different industries such as manufacturing, financial services, health care, and others including information technology providers of hardware, software, and services.

Student Groups	Curriculum Model
All Students	IS 2010.1 Foundations of Information Systems
IS Majors and Minors	IS 2010.7 IS Strategy, Management, and Acquisition IS 2010.3 Enterprise Architecture IS 2010.2 Data and Information Management
IS Majors	IS 2010.6 Systems Analysis & Design IS 2010.5 IT Infrastructure IS 2010.4 IS Project Management

Figure 2: Representative IS 2010 Curriculum Design for All Students, IS Minors, and IS Majors

9. OUTCOME EXPECTATIONS FOR INFORMATION SYSTEMS GRADUATES

Overall Structure of Basic Concepts

The restructuring of the Model Curriculum is clearly driven by changes in high-level organizational needs and graduate capabilities. The work underlying the curriculum specification first identified the high-level capabilities needed by IS graduates. These overall capabilities, in turn, are based on knowledge and skills that have been categorized as IS-specific Knowledge and Skills, Foundational Knowledge and Skills, and Domain Fundamentals. By doing so, the revised Model Curriculum links curriculum content and structure to graduate capabilities in a well-defined and transparent way. Figure 3 shows how the high-level IS capabilities are extrapolated to the final curriculum topics delivered through courses.

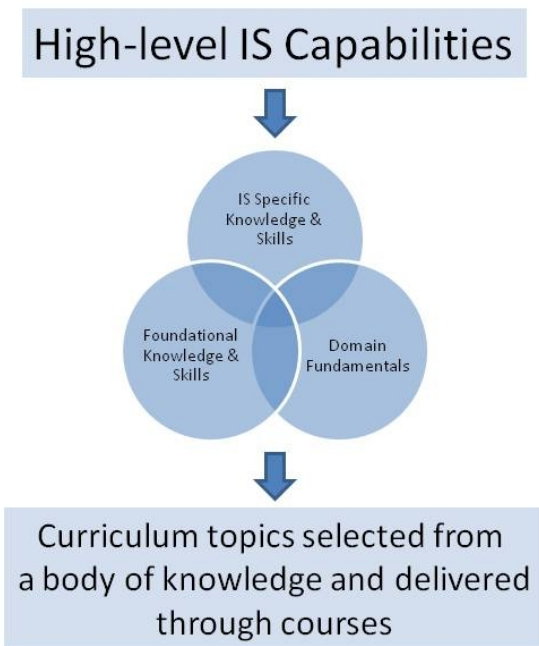

Figure 3: Overall Structure of the Basic Concepts.

High-level IS Capabilities

The new curriculum will be based on a significantly revised set of degree outcome expectations, that is, expectations regarding the capabilities of graduating IS students when entering the full-time workforce. The new capability set recognizes the change in the nature of the jobs IS graduates are likely to have by focusing on business analysis, organizational processes, enterprise architecture, sourcing options, and security/risk management. The curriculum acknowledges explicitly the contribution that the Information Systems discipline can make to domains outside business (such as governments, non-profits, health care, etc.) and, therefore, the high-level capabilities are not limited to a specific domain. They are, however, driven by organizational needs and more abstract and stable than knowledge and skills. The following will give a more detailed description of each capability.

Improving Organizational Processes

The new curriculum assumes that understanding and improving organizational processes is one of the key capabilities of all IS graduates. This requires the graduates to be functional in:

1. Understanding the fundamental concepts related to organizational processes
2. Understanding general principles of process analysis in order to apply them to specific situations
3. Analyzing existing processes based on interviewing, observation, documentation analysis, and other similar methods
4. Understanding how the very large amounts of data collected by modern organizations can be used to review, redesign, and improve processes
5. Identifying and capturing the essential findings from the large amount of data produced by the analysis process
6. Researching and applying industry reference models and best practices in order to improve process designs
7. Using the analysis results as a basis for designing revised processes based on the graduates' strong understanding of both organizations and information technology
8. Simulating a proposed process and revising it as necessary
9. Negotiating a solution that satisfies the political requirements for the new process
10. Understanding the limitations of what can be achieved with available technology, financial resources, and organizational capabilities.
11. Leading the implementation of new processes.

The specification of high-level IS capabilities does not include a particular set of process improvement methods or techniques, but the graduates are expected to be aware of and benefit from at least one such method.

Exploiting Opportunities Created by Technology Innovations

Graduates of Information Systems programs are experts in seeing how organizations can benefit from technology capabilities, converting opportunities created by information technology innovations into sustainable organizational value through systematic processes. An essential element of this high-level capability is the ability to understand both information technology and the needs of an organization within a specific domain at such a deep level that IS graduates see new opportunities to create value faster and with greater clarity during various analysis processes than their non-IS counterparts. Achieving a high level of performance related to this capability requires in-depth knowledge of technology and the domain, skills in analyzing problems and designing solution alternatives, ability to analyze the strengths and weaknesses of various alternatives, understanding issues related to the feasibility of possible solutions, as well as demonstrable skills in sourcing, designing, and implementing technology solutions.

Understanding and Addressing Information Requirements

Another key capability of all IS graduates is the ability to analyze and document organizational information requirements at various levels, starting from those of individual knowledge workers responsible for specific tasks and ending with very high level institutional requirements. IS graduates are experts in analyzing the information needs of an individual, organizational unit, or an organization in order to determine how information technology-based solutions can best be designed to support these information needs. Increasingly, the core capabilities in this area are related to effective utilization and integration of data that is generated in a rich variety of organizational systems and includes multiple types and formats.

Designing and Managing Enterprise Architecture

Information Systems graduates are experts in high level design and management of IT capabilities that are fully aligned with general organizational goals. Currently, these capabilities are typically organized and presented as an enterprise architecture, consisting of high-level internally compatible representations of organizational business models, data, applications, and information technology infrastructure. The capabilities of the graduates of undergraduate IS programs are typically at a level suitable for focusing on the component architectures. One of the knowledge and skill areas that is directly derived from this high-level IS capability is related to IT infrastructure, including networking technology, data centers, and so on. This high-level capability also requires an understanding of the IT management and control frameworks, such as ITIL and COBIT.

Identifying and Evaluating Solution and Sourcing Alternatives

Graduates of IS programs are capable of producing high-level design alternatives for various organizational IT-based solutions. There are always a large number of ways to achieve a specific set of organizational capabilities using information technology, but not all of approaches are feasible in a specific context. An essential high-level capability that IS graduates have is an ability to identify a small subset of realistic, financially and technically feasible solution alternatives and the mechanisms through which an organization can acquire these technology resources. Most projects require reusing or building on the existing components (such as modules, reusable objects, databases, information architectures, etc.) used in the current systems, and therefore, it is essential that graduates have the capability to understand a variety of technologies and their integration.

In particular, the globalization of the IS/IT supply chain has made the traditional "buy vs. build" questions significantly more complex to answer, but the core issues are still the same: once an IT capability need has been identified, what is its high-level design and how should an organization acquire this capability?

Securing Data and Infrastructure

It has been increasingly important for organizations to ensure that their data and IT infrastructure resources are protected from a variety of security threats, which can potentially create significant financial liabilities as well as damage the organizational image. Understanding these threats and identifying high-level solutions to protecting the organization are essential capabilities of all graduates of Information Systems degree programs.

Understanding, Managing and Controlling IT Risks

IS graduates should have strong capabilities in understanding, managing, and controlling organizational risks that are associated with the use of IT-based solutions (e.g., security, disaster recovery, obsolescence, etc.). At the undergraduate level, the emphasis should be on in-depth understanding of a variety of risks. Because IT solutions are so closely integrated with all aspects of a modern organization, it has become essential to manage the risks related to their use in a highly systematic and comprehensive way.

Knowledge and Skills of IS Graduates

Graduates of Information Systems undergraduate degree programs need a wide variety of specific skills and knowledge as a foundation for the high-level IS capabilities specified earlier. The high-level capabilities typically encompass skills and knowledge from various areas. For example, in order to determine and address information requirements, an IS graduate needs to understand and apply data management technologies, have excellent interpersonal, analytical, and problem solving skills as well as have a strong command of the organizational domain for which the information requirements are specified. The knowledge and skills that graduates in Information Systems are expected to have can be divided into three categories:

1. Information Systems Specific Knowledge and Skills
2. Foundational Knowledge and Skills
3. Knowledge and Skills Related to Domain Fundamentals

The category "Information Systems Specific Knowledge and Skills" includes elements that are in the core of the IS discipline. These knowledge and skills would not be developed by other types of educational programs; they are specific to Information Systems as a discipline. "Foundational Knowledge and Skills" are shared by many disciplines that educate knowledge professionals, and they include broad categories such as leadership and collaboration, communication, and analytical and critical thinking. Finally, "Domain Fundamentals" covers skills and knowledge related to the domain to which a specific Information Systems program applies computing. For most IS programs the domain is general business, but it could focus on a specific business specialty (e.g., finance), industry (e.g., health care), organization type (e.g., government, non-profit), and so on. As discussed above, undergraduate IS programs will develop knowledge and skills in each of these three categories. When combined over the course of a student’s studies, they will lead to the high-level IS capabilities.

Information Systems Specific Knowledge and Skills

Information Systems specific knowledge and skills are divided into four main categories (and subcategories), as follows:

1. **Identifying and designing opportunities for IT-enabled organizational improvement.** The integrating theme of this category is the focus on an organization and the ways it can develop its capabilities using information technology. In many ways, the specific items in this category are related to requirements analysis and specification at a high level of abstraction, including strategic alignment, the analysis of information needs, and the evaluation of user experience.
   These include:
   a. Ensuring alignment between IT strategy and organizational strategy
   b. Improving organizational processes with information technology solutions
   c. Understanding and designing the role of information systems in managing organizational risks and establishing controls
   d. Identifying and exploiting opportunities created by emerging technology innovations
   e. Understanding and documenting information requirements
   f. Improving various stakeholders' experience in interacting with the organization, including issues in human-computer interaction.

2. **Analyzing trade-offs.** One of the most important knowledge and skill categories for Information Systems graduates is the ability to design and compare solution and sourcing alternatives in a way that takes into account various sources of risks and dimensions of feasibility, including technology characteristics, availability of and organizational ability to utilize human resources, scheduling, organizational politics, regulatory issues, and return on investment. A particular strength of Information Systems graduates is the ability to integrate a variety of these perspectives and avoid analysis that narrowly focuses on only technology or business requirements. A key element of this capability is to be able to evaluate sourcing alternatives. Subcategories include:

    a. Identifying and designing high-level solution and sourcing options
    b. Analyzing and documenting the feasibility of various options
    c. Comparing solution options using multiple decision criteria
    d. Capital budgeting for IT-intensive projects; creating a financial justification for choosing between alternatives

3. **Designing and implementing information systems solutions.** Although the knowledge and skills that IS graduates need have recently moved significantly in the direction toward higher levels of abstraction, individual skills related to design and implementation are still essential for IS graduates. Those who can demonstrate the ability to integrate high performance in design and implementation, along with strong business capabilities, are typically the most highly sought after graduation. This category of knowledge and skills also includes the management of people and organizations that are used to develop IS/IT capabilities, whether internal or external, regardless of their geographic location. Knowledge and skills related to specific issues of IS project management are in this category. The specific subcategories include:

    a. Designing enterprise architectures
    b. Identifying, evaluating, and procuring detailed solution and sourcing options; configuring and integrating organizational solutions using packaged solutions
    c. Designing and implementing solutions that provide a high-quality user experience
    d. Designing secure systems and data infrastructures
    e. Designing and implementing applications, application architectures and integrated systems
    f. Managing and exploiting organizational data and information; designing data and information models
    g. Managing information systems development/procurement resources
    h. Managing information systems projects.

4. **Managing ongoing information technology operations.** IS graduates need knowledge and skills related to the management of the ongoing information systems operations within the organization, including the management, operation, and securing of the IT infrastructure. This can include:
    a. Managing the use of enterprise technology resources
    b. Managing application performance and scalability
    c. Maintaining existing information systems
    d. Managing relationships with technology service providers
    e. Securing data and systems infrastructure
    f. Ensuring business continuance

Foundational Knowledge and Skills

Foundational knowledge and skills are not unique to Information Systems as a discipline. Instead, most programs that educate knowledge professionals intend to develop some or all of these skills and capabilities. Still, they are very important for Information Systems programs because it is impossible for IS graduates to exhibit the required high-level IS capabilities without these foundational knowledge and skills. Individual IS programs typically implement educational experiences that develop these areas in an IS specific context.

1. **Leadership and collaboration.** The graduates of Information Systems programs will be required to act in various collaborative roles during their professional careers, and it is likely that most of them will be assuming leadership positions at various levels. Increasingly, these roles are performed in a genuinely global context. It is essential that programs prepare their graduates to be effective collaborators and inspiring leaders. Capabilities should include:

    a. Leading cross-functional global teams
    b. Managing globally distributed projects
    c. Working effectively in diverse teams
    d. Structuring organizations effectively

2. **Communication.** It is impossible for an IS professional to perform effectively in any organizational role without excellent oral and written communication skills. IS professionals work closely with colleagues in a variety of different organizational roles, and invariably, their job performance is partially dependent on their ability to communicate. Capabilities should include:

    a. Listening, observing, interviewing, and analyzing archival materials
    b. Writing memos, reports, and documentation
    c. Using global collaboration tools (such as wikis, blogs, shared collaboration spaces, etc.)
    d. Giving effective presentations

3. **Negotiation.** Related to the previous category, negotiation skills are also very important for IS professionals. In their organizational roles, they have to navigate carefully between different, competing interests within the organization. In these situations, excellent negotiation skills are essential. Finally, IS professionals increasingly play a role in the negotiations with external IT service providers and other vendors. Capabilities should include:

    a. Negotiating with users about funding, resources of time, staff, and features
    b. Negotiating with providers about service levels
    c. Negotiating with providers about quality and performance of deliverables
    d. Facilitating negotiations between competing internal interests.

4. **Analytical and critical thinking, including creativity and ethical analysis.** Strong analytical and critical thinking skills are a foundation for everything IS professionals do – it is essential that they are able to systematically analyze complex systems and situations, break them down into manageable components, understand deep connections within

systems, and create solutions based on the results of a systematic analysis. Problem solving is also omnipresent in the life of IS professionals. Capabilities should include:

a. Analyzing the ethical and legal implications of complex situations
b. Analyzing the risks associated with complex systems
c. Solving complex problems
d. Using quantitative analysis techniques appropriately and effectively
e. Enhancing innovation and creativity in oneself and others

5. **Mathematical foundations**. Even though IS professionals do not need the same level of mathematical depth as many other computing professionals, there are, however, some core elements that are very important for IS professionals (of course, these needs will vary depending on an individual's specialty). To support in-depth analysis of data, IS professionals should have a strong background in statistics and probability. For those who are interested in building a strong skills set in algorithmic thinking, discrete mathematics is important.

Knowledge and Skills Related to Domain Fundamentals

Domain Fundamentals is the third category of knowledge and skills. It is equally important as the other two, but different because its contents vary significantly depending on the domain that together with the other two categories forms the outcome expectations for an Information Systems degree. The most common domain for Information Systems is business in general, but many other domains are possible components, including business specialties (such as accounting or finance), government, health care, the legal profession and non-governmental organizations. Within each domain, it is typically possible to identify at least three subcategories of domain knowledge:

- General models of the domain. This subcategory refers to the general foundational material that provides an overall understanding of the domain at the level that is needed to both understand the general concepts within the area and form a basis for studying the key specializations within the domain.
- Key specializations within the domain. Within each domain, there is a core set of the most important specializations that are essential for understanding the domain and operating within it. It is, obviously, typical that with the domains there is vigorous discussion regarding what these specializations are, but, for example, within business it appears that few experts would dispute the need to include finance, accounting, marketing, and management (both organizational behavior and strategy).
- Evaluation of performance within the domain. Within many domains, issues related to performance analysis and evaluation are essential for understanding the domain fully, and, therefore, we include it as a separate subcategory. Performance evaluation also reveals important aspects of the philosophy of a domain. For example, both general models and key specializations might be essentially the same for businesses and non-profit organizations, but their key performance metrics could differ quite significantly.

Examples of these three subcategories within the general business domain are as follows:

General models of business
- Business models
- Business process design and management
- Organizational theory

- Business strategy

Key business specializations

- Finance
- Accounting
- Marketing
- Operations management; service science and management
- Organizational behavior
- Business law

Evaluation of business performance

- Analysis of organizational performance
- Analysis of individual and team performance
- Business analytics
- Business intelligence

10. ARCHITECTURE OF THE INFORMATION SYSTEMS CURRICULUM

Architecturally, IS 2010 is quite different from its predecessors. IS 2002 was largely organized around the concept of a course, and it simply consisted of ten courses without any opportunities to vary the curriculum depending on the local requirements or other contextual factors. The Body of Knowledge included in IS 2002 was largely unchanged from IS'97, and the linkage between the courses in the curriculum and the Body of Knowledge was relatively weak.

In this section, we first describe the key curriculum architecture concepts and the way they are applied in this curriculum implementation. We will follow with a description of the overall curriculum structure for the courses that focus on IS Specific Skills and Knowledge, followed by a more in-depth discussion regarding the core. Finally, we will discuss how Foundational Skills and Knowledge and Domain Fundamentals are typically covered in an IS undergraduate degree and illustrate the use of the model curriculum in three different academic degree requirement contexts.

Key Concepts

The structural architecture of IS 2010 is informed by the concept structure represented in Figure 4, which illustrates a proposed structure for a computing curriculum. This structure includes three major elements: Course, Learning Objective, and the three-level Knowledge Area – Knowledge Unit – Topic hierarchy that is used also in all other computing curriculum volumes (CS 2008, IT 2008, SE 2004, and CE 2004). The concept of Coverage represents the coverage of a specific Topic within a Course in order to support the achievement of a specific Learning Objective. Please note that Topics themselves can be organized hierarchically into multiple levels. A Level is specified for each Learning Objective, indicating the type of cognitive processing that the student is required to demonstrate in order to achieve the learning objective. A slightly revised version of Bloom's taxonomy described in Appendix 4 of IS 2002 and included in Appendix 3 of this document will be used for the Levels.

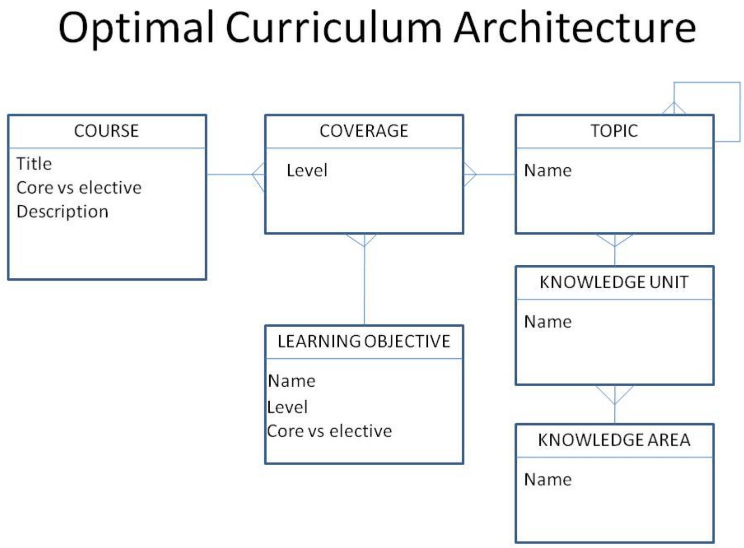

Figure 4: Proposed Curriculum Architecture

Fundamentally, the intent is to specify the goal state regarding the students' abilities in relation to a concept/topic: whether the students are required to be aware of a topic, understand it at a deeper level, use the concept in an analysis, or create new concepts or artifacts in the context of a learning outcome.

At the current time, the process of organizing IS knowledge is not, however, specified at a sufficiently advanced level to allow us to fully implement the curriculum using the optimal structure described above. Instead, IS 2010 uses a simplified model (see Figure 5) that links the Learning Objectives to Courses and Courses directly to Topics with a many-to-many relationship. The Knowledge Area – Knowledge Unit – Topic hierarchy is used for the first time in an IS model curriculum, which brings this document structurally closer to the other computing curricula. Each Knowledge Area, Knowledge Unit, and Topic is specified as either core or elective. The Level of coverage is specified at the course level.

The Core Information Systems Body of Knowledge is presented in Appendix 4 of this document. This Body of Knowledge organizes the IS curriculum core content into four different Knowledge Area categories: General Computing, IS Specific, Foundational, and Domain-specific. We believe that Information Systems as a discipline can effectively borrow content from other computing disciplines for the General Computing Knowledge Areas and that the content in Foundational and Domain-specific Knowledge Areas is largely determined outside computing. Therefore, the IS discipline will only have to develop and maintain a Body of Knowledge structure for the Knowledge Areas that are truly IS Specific.

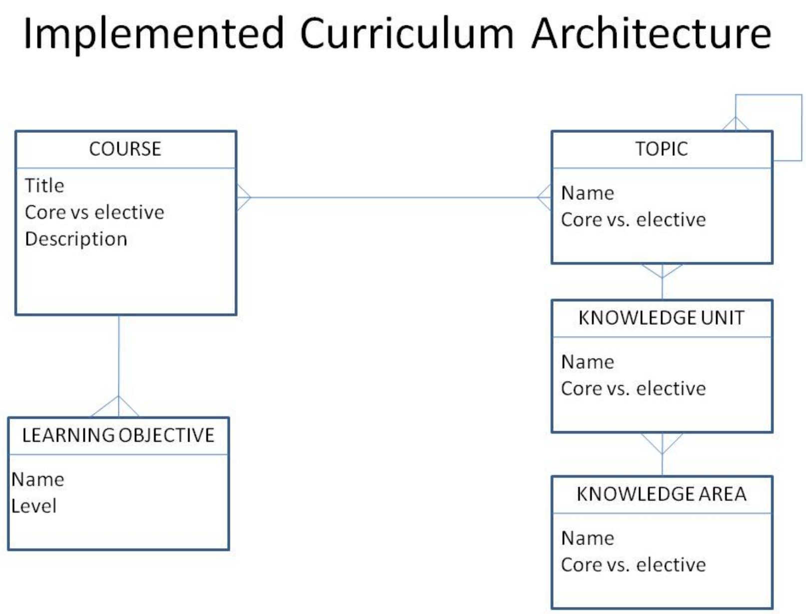

Figure 5: Simplified Curriculum Architecture Model

General Curriculum Structure for Courses focusing on IS Specific Skills and Knowledge

In this section, we discuss the general architecture for the courses that focus on the development of Information Systems specific skills and knowledge. The coverage of content that focuses on the development of Foundational and Domain-specific knowledge and skills is discussed later in this section (see p. 29).

As discussed earlier in this document, IS 2010 introduces a separation between core and elective courses. IS 2010 consists of seven **core courses**, which specify the required knowledge units and topics that have to be covered in every Information Systems program. We acknowledge that the time available to cover the core material and the needs of the program vary depending on the local context. Therefore, the depth and type of coverage of the core topics differ between programs, even though every core topic has to be covered in every Information Systems curriculum. Also, every instance of a Course is not always technically a separate course in the schedule; it is possible that an implemented curriculum may, for example, combine two instances of a Course into one.

In addition, the model curriculum includes examples of **elective courses**, which either expand on the coverage provided by the core course within a specific knowledge area or introduce new knowledge areas to the curriculum. The elective courses are essential building blocks of **career tracks**, which consist of the core and a set of elective courses. The matrix included in Figure 6 includes the core courses and sample electives mapped to a number of suggested career tracks.

Structure of the IS Model Curriculum:Information Systems specific courses

Career Track:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Core IS Courses:																	
Foundations of IS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Enterprise Architecture	○	●	○	○	○	●	○	○	○	○	●	○	○	○	●	○	○
IS Strategy, Management and Acquisition	○	●	○	○	○	●	○	○	●	○	●	○	○	○	●	○	○
Data and Information Management	●	○	○	●	●	○	○	●	●	○	●	○	●	○	○	○	○
Systems Analysis & Design	●	●	●	○	○	○	●	○	○	○	○	○	○	○	●	●	●
IT Infrastructure	○	○	○	●	○	○	○	●	●	●	○	○	●	●	○	○	○
IT Project Management	●	○	○	○	○	●	○	○	○	○	●	○	○	○	●	●	●
Elective IS Courses:																	
Application Development	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●
Business Process Management		●	●			○	○	○		○	●				○		
Collaborative Computing						○								○			○
Data Mining / Business Intelligence		●		●	●	○	○	○	●		○	○	○	○	○		○
Enterprise Systems		●	●	○	○	○	●	●	○		●	●	○	○			
Human-Computer Interaction	●					○	○				○					●	
Information Search and Retrieval		○		○	●								○				●
IT Audit and Controls	○		●	○	○	○	○	●		●	○		○	○	○		○
IT Security and Risk Management	○			○	○	○	○	●	●	○	○		●	●	○		○
Knowledge Management		●		○		○	○			○							
Social Informatics													○		○		

A = Application Developer
B = Business Analyst
C = Business Process Analyst
D = Database Administrator
E = Database Analyst
F = e-Business Manager
G = ERP Specialist
H = Information Auditing and Compliance Specialist
I = IT Architect
J = IT Asset Manager
K = IT Consultant
L = IT Operations Manager
M = IT Security and Risk Manager
N = Network Administrator
O = Project Manager
P = User Interface Designer
Q = Web Content Manager

Key:

● = Significant Coverage

○ = Some Coverage

Blank Cell = Not Required

Figure 6: Structure of the IS 2010 Model Curriculum

The IS Specific Course Matrix is structured based on career track outcomes. This approach allows a high level of local flexibility and variability while maintaining the core of the discipline. Students undertaking a program's course of study could be preparing for career tracks such as Application Developer, Business Analyst, Business Process Analyst, Database Administrator, and so on. Based on the career track focus of an IS program, recommendations for the relative importance of core and elective knowledge areas are provided in the IS Specific Course Matrix. Specific course implementations may thereby be tailored to include an emphasis on one or more knowledge areas, forming the required and elective courses, appropriate to the career track outcomes of individual instances of IS programs of study.

Further definition of each of the career tracks is provided on the website blogsandwikis.bentley.edu/iscurriculum. Included are a description of the career track, skills necessary to the career track, and coverage level for core and elective topics. Depth of coverage for the topics is specified as significant, some, and no coverage.

The core courses and their recommended sequence are presented in Figure 7 below. The IS 2010.1 *Foundations of Information Systems* course is a prerequisite for all the other courses, and the IS 2010.7 *IS Strategy, Management, and Acquisition* course is a capstone that should be either the last or one of the last courses that students take.

The elective courses can be offered in the curriculum at any point that fits course-specific prerequisite requirements.

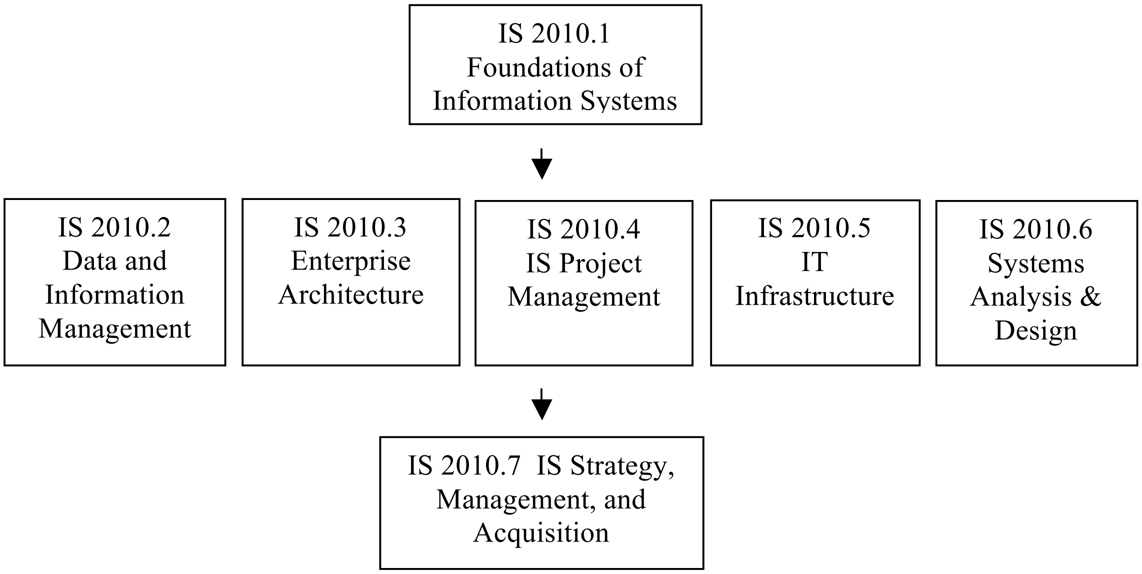

Figure 7: IS 2010 Core Courses

Core Course Changes in IS 2010

For those readers who know IS 2002 well and in order to illustrate recent changes in the field, this section will discuss the differences between this and the previous curriculum recommendation. There are several major differences between the course recommendations in these two independent volumes. The following will list these major differences while also describing in detail why these changes were implemented by the task force.

1. **Status of Application Development in the curriculum**. One of the more noticeable changes to the IS model curriculum is the removal of application development (IS 2002.5 Programming, Data, File, and Object Structures) from the prescribed core. It is important to understand that although application development is not included in the core, it has not been removed from the IS program, and the task force acknowledges that a strong case can be made for inclusion of programming, computational thinking, data structures, and related material in an IS program (see, for example, (Topi et al. 2008)). In fact, application development can still be offered in most IS programs. By offering application development as an elective the IS 2010 model curriculum increases its reach into non-business IS programs while also creating flexibility for curricula that choose to include an application development course. In addition, the programs that want to go even further and include a sequence of programming courses can choose from approaches introduced either in the Computer Science or in the Information Technology curriculum volumes (CS 2008 or IT 2008, respectively).

2. **Inclusion of both enterprise architecture and IT infrastructure** – The IS 2002 model curriculum includes both an IT Hardware and System Software course (IS 2002.4) and a Network and Telecommunication course (IS 2002.6) to edify the concepts and practices related to IT infrastructure. The IS 2010 model curriculum proposes a different approach, which integrates the material included in IS 2002 into IS 2010.5 IT Infrastructure course and introduces a new IS 2010.3 Enterprise Architecture course that focuses on concepts

at a higher level of abstraction. IT Infrastructure includes computer and systems architecture and communication networks, with an overall focus on the services and capabilities that IT infrastructure solutions provide in an organizational context. Enterprise Architecture focuses on organizational level issues related to planning, architecting, designing, and implementing IT-based solutions that utilize the platform technologies covered in the IT Infrastructure (IS 2010.5) course and the application and data & information management solutions covered in the Systems Analysis & Design (IS 2010.6) and Data and Information Management (IS 2010.2) courses, respectively. This course adopts a strongly integrative perspective related to the design and utilization of information and organizational processes across functional areas with a unified system view. IT Infrastructure covers the core technical foundations whereas Enterprise Architecture provides an integrated organizational perspective to planning and designing institutional solutions.

3. **Removal of Personal Productivity Tools Course –** The revised IS 2010 **c**urriculum recommends dropping the course focusing on personal productivity tools from IS programs. The task force has found that typically institutions now require all students to be proficient in personal productivity applications such as word processing, spreadsheets, and presentation software prior to enrolling in any major. Further, most high schools also are preparing students in this area before they reach a higher education environment.

4. **Sequencing –** The IS 2002 model curriculum recommended various levels of sequencing in the curriculum (e.g., Foundations of IS is a prerequisite to Analysis and Logical Design, IT Hardware and Systems Software was a prerequisite to Networks and Telecommunications and so on). By flattening the sequencing constellation of the curriculum, IS 2010 offers a flexible structure that can integrate electives easily. Also, the flattened curriculum structure allows students to pass more easily through IS programs avoiding possible sequencing bottlenecks.

Detailed descriptions of the seven core courses and a set of sample electives are included in the last section of this document.

Overall Degree Structures and Coverage of Foundational and Domain-specific Skills and Knowledge

This curriculum recommendation does not provide specific courses that address the outcome expectations related to foundational skills and knowledge or domain-specific skills and knowledge. As specified earlier in the document in the section related to IS program outcome expectations, these two areas are essential for IS graduates and need to be covered in every IS curriculum in a way that ensures that the high-level outcome expectations are met.

Fundamentally, there are two ways to accomplish this: either, the degree programs are offered in an environment (for example, a business school or a school of public policy) in which general curriculum requirements for the school as a whole ensure that these educational objectives are met or the school specifically designs and implements courses that are intended to develop capabilities in these two areas. Without sufficient coverage related to foundational skills and knowledge and to domain-specific skills and knowledge a curriculum is not compatible with this curriculum recommendation, even if this document does not specifically articulate how these requirements should be met.

For example, in a typical business school context, the foundational knowledge and skills would be covered in both general education and business core courses, whereas the business core would be used to develop the domain-specific skills and knowledge.

In order to illustrate the adaptability and flexibility of the curriculum structure and demonstrate how it can be used in different types of academic contexts, we will provide examples of three different degree requirement contexts in which undergraduate degree programs in Information Systems are offered. These are by no means exclusive but only provided as illustrations of how this model curriculum can be used in a number of different academic environments. The first example describes an instantiation of the IS curriculum at a North American AACSB-accredited business school. Next, we illustrate the IS curriculum within a non-business school environment (i.e., Information School or School of Informatics). Finally, we present an example of a typical European Business School that follows a three year Bologna degree structure.

AACSB-accredited North American Business School

Figure 8 illustrates a typical degree structure in the context for which IS 2002 and IS'97 were primarily developed: a North American AACSB-accredited business school. In these schools, it is still typical that 50% of the curriculum content is reserved for so called "general education" – mostly liberal arts courses in a variety of disciplines. From the perspective of the IS model curriculum, this part of the curriculum typically provides a strong basis for the development of foundational knowledge and skills, particularly those related to communication, analytical and critical thinking, and mathematical foundations. Eight courses or 20% of a 40 course[1] curriculum is a relatively typical number of courses reserved for the core business subjects (such as accounting, finance, marketing, organizational behavior, strategy, etc.). This portion of the curriculum addresses the domain fundamentals area of the IS curriculum, but also develops foundational knowledge and skills, particularly in leadership and collaboration, communication, and negotiation (and increasingly often, we hope, in ethical analysis).

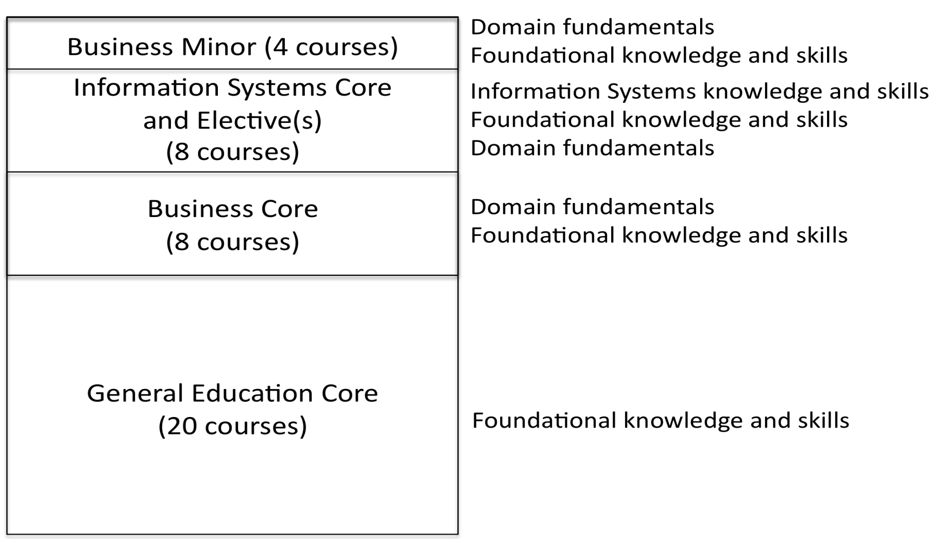

Figure 8: Undergraduate Information Systems Degree in a Typical AACSB-accredited North American Business School

[1] Please note that we are referring with the term "course" here to a three North American credit hour or six ECTS credit educational experience, which consists typically of 35-45 contact hours and 110 – 140 hours of work outside the classroom.

In this curriculum context, eight courses (20%) is often considered a generous allocation of courses to a major and thus, we will assume this for the Information Systems major. This curriculum component develops IS specific knowledge and skills, but also foundational skills (particularly in collaboration, communication, and analytical and critical thinking) and, taking the business school context into account, also domain fundamentals through business-focused IS material. Finally, there is typically room for a few business electives, which can be used for a minor or with a few additional courses a double major. Either one of these can be used to develop further in an important way domain fundamentals and foundational knowledge and skills. In this context, there is not much freedom to build alternative degree structures for the IS major – if there are eight courses available and the core requires seven, the available flexibility is minimal.

Non-Business School Environment in North America

Information Systems degrees are often quite different at other types of institutions, such as colleges and schools of computing or information technology. In Figure 9, we present an example that illustrates a realistic degree structure in this type of a context, which has significantly more space for courses that are intended to develop IS specific knowledge and skills. In our example, the IS major consists of 15 courses or 37.5% of the degree. With this curriculum structure, the department offering IS degrees has the opportunity to build on the core and offer (depending on the number of students) potentially a large number of career tracks and career track electives, as specified previously in Figure 6. The primary price that these degree programs pay is much less focus on the domain fundamentals (often covered in only a few courses). The purposes of the different elements are similar to those at the business schools, except that the IS major courses often have a weaker connection to a specific domain.

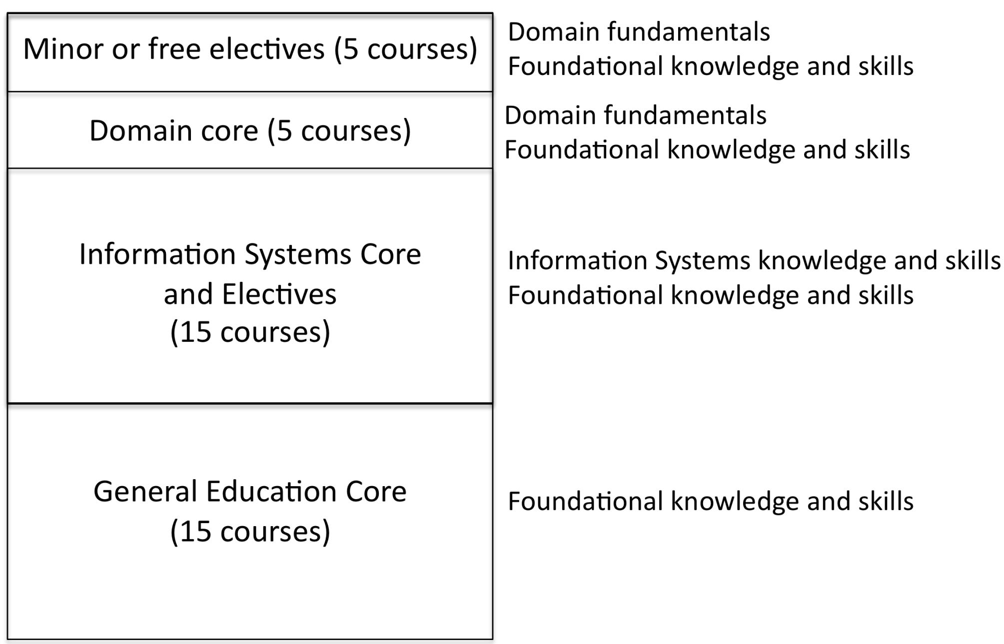

Figure 9: Undergraduate Information Systems Degree in a Non-Business School Environment in North America

A Three-Year Bologna Process Degree Structure at a European Business School

The final example illustrates the structure of a hypothetical three-year business school undergraduate program in a European country that follows the 3+2 Bologna process degree structure (three-year undergraduate followed by a two-year specialized master's degree). The most significant difference between this degree structure and the North American ones is significantly less focus on "general education," which is primarily based on the fact that much of this content is covered in these countries at the high school level. Otherwise, the degree structure provides about 25% more coverage for the IS major and the business core (focusing on domain fundamentals). Therefore, these programs are also able to provide their students with flexible options following the career track / career track elective structure described previously in this section. It is also useful to remember that many European students follow directly to a specialized master's.

Again, we would like to emphasize that these are just illustrations of a few possible ways in which an undergraduate degree program in Information Systems can be implemented. We believe that the curriculum model described in this document is adaptable to a wide variety of contexts and we are looking forward to learning more about the ways in which it will be adopted in the future.

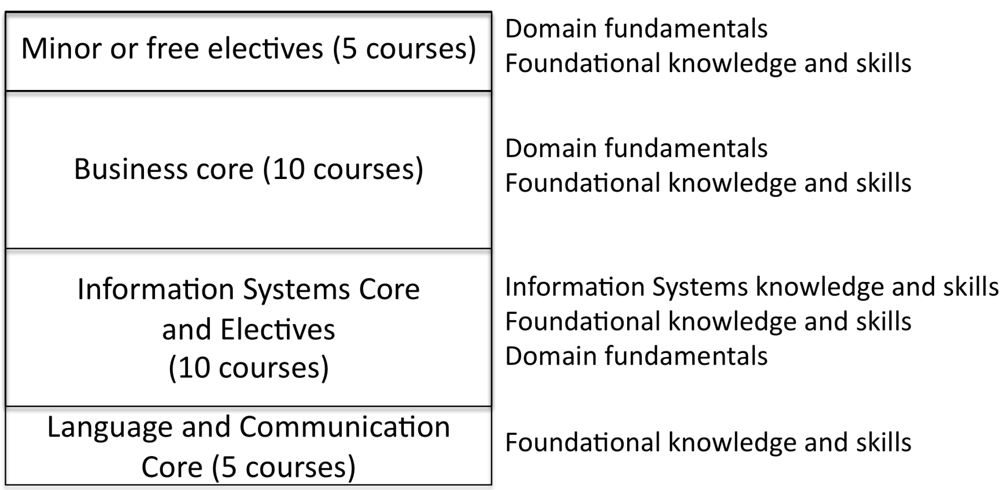

Figure 10: Undergraduate Information Systems Degree at a European Business School that Follows a Three-Year Bologna Process Degree Structure

11. RESOURCES FOR IS DEGREE PROGRAMS

The resources for the IS degree programs have changed substantially since the last curriculum revision. Similar to past curriculum revisions a capable faculty is the first required resource (Firth et al. 2008). In addition to faculty the resources needed for an IS degree program are Internet access, laboratories and library resources. In a rapidly changing technical environment, students should be exposed to a variety of up-to-date hardware and software systems that adequately represent the professional setting in which they will be employed.

Faculty Requirements

Faculty members are vital to the strength of an Information Systems program. Its faculty needs both academic training and practical experience (Looney et al. 2007). There must be enough faculty to provide course offerings that allow the students to complete a degree in a timely manner. The interests and qualifications of the faculty must be sufficient not only to teach the courses but also to plan and modify the courses and curriculum.

Faculty members must remain current in the discipline. Professional development and scholarly activities are a joint obligation of the institution and the individual faculty members. The school should support continuing faculty development. Given the rapidly changing technology, it is particularly critical that faculty members have sufficient time for professional development and scholarly activities. Resources should be provided for faculty to regularly attend conferences, workshops, and seminars, and to participate in academic and professional organizations. The program is enhanced significantly when faculty acquire practical experience in the profession through activities such as consulting, sabbatical leaves, and industry exchange programs. Faculty must also be equipped to develop teaching materials for their students. Faculty must have available technology at least equivalent to and compatible with that available to students so that they may prepare educational materials for use by students. In addition, faculty must be connected to the Internet in order to have access to students and to the larger academic and professional community.

The number of full-time faculty needed by the program is influenced by such factors as the number of students in the program, the number of required courses, the number of service and elective courses offered, and the teaching load of the faculty. A program should have a minimum number of full-time faculty with primary commitment to the Information Systems program in order to meet the teaching and advising needs of the program and to provide depth and breadth of faculty expertise. Courses must be offered with sufficient frequency for students to complete the program in a timely manner. The professional competence of the faculty should span a range of interests in information systems including computer systems concepts, information systems concepts, data management, telecommunications and networks, systems design and development, systems integration, and information systems management and policy. Additional faculty will be needed to teach the service courses that provide foundation-level knowledge across the campus.

Computing Infrastructure Requirements

Computing infrastructure consists of hardware, software, and technical support. Adequate computing facilities are essential for effective delivery of the IS program though the form in which this infrastructure is allocated has changed significantly. These formerly involved a blend of computer facilities of varying capabilities and complexity. Now with most freshmen entering college with computer resources, access plays a much more significant role (Lee 2009). Therefore, network access should be available for faculty and students to use with their own computers. Students at different levels in the curriculum have different needs. Substantial resources must be provided to support the courses targeted to all students. More sophisticated resources are necessary for Information Systems minors and majors who are developing skills in computing and IS fundamentals. Specialized laboratories or access to specialized simulation software is needed for advanced students where group and individual projects are developed. Contemporary and emerging software development tools should be available to create the most current enterprise solutions.

In addition to software and hardware, it is paramount to the success of the program that adequate technical support be provided. Modern computing infrastructure is highly complex requiring technically trained support staff to maintain the equipment. This is beyond the scope of faculty duties, a waste of precious faculty resources, and often outside their individual expertise.

Laboratory Requirements

Systems require hardware and software for structured, open/public, and specialized laboratories. Students must have an opportunity to use learning materials in both structured and unstructured laboratories.

Hardware and software are rapidly changing and improving. It is critical that faculty and students have access to facilities reflecting an environment that graduates will be expected to use professionally. All computing systems should be kept current. A plan should exist to continuously upgrade and/or replace software and equipment in a timely manner. The rate of change in technology suggests a rapid replacement cycle, with some technologies reaching obsolescence in less than 12 months.

Having said this, simulation software is becoming more prevalent for teaching advanced IS topics. This can include simulations for utilizations of applications to managing the single workstation to complex enterprise-level networks. Many companies including Microsoft, Cisco, and even the textbook companies have developed sophisticated simulation software that does not require the latest equipment.

Various courses and areas of study have their own specialized requirements, such as the large database with realistic sample data that are needed for effective work in the area of data management.

Students should be provided opportunities to work together on team-oriented projects. The group skills developed in this mode are critical to a successful information systems professional. Technological support, such as groupware, is expected for group and team activities.

All laboratories must have adequate technical support in terms of professional staff to provide for installation and maintenance of the equipment. The staff should be proficient in both the hardware and software applications. Complete documentation must also be available.

Laboratories should be able to support the following types of functions:

1. Structured Laboratories

   A structured laboratory is a closed, scheduled, supervised experience in which students complete specified exercises. An instructor who is qualified to provide necessary support and feedback to the students provides supervision. Exercises are designed to reinforce and complement the lecture material.

2. Open/Public Laboratories

   Student ownership of computers has continued to increase. However, laboratories remain essential for those students who do not own a computer and for providing additional resources not available on personal machines.

3. Specialized Laboratories

Laboratory facilities are necessary to support team projects and special computing environments. Special facilities may be needed for systems development, network infrastructure, and other advanced technologies.

Classrooms

Suitable classroom facilities, equipped with information technology teaching resources, should be provided. A computing system with multimedia facilities is necessary for demonstrating the development, implementation, and application of information technology as well as conducting walkthroughs and making presentations. Classrooms should have access to the Internet and extranet networks, either with port per seat or wireless networking capabilities.

Library

Library support is an important part of an academic program. It is especially important for disciplines with rapid development of knowledge such as the Information Systems field. Libraries should provide both traditional and digital access wherever possible to journals, proceedings, monographs, and reference books. The holdings should include access to digital journals and proceedings of the computing professional societies.

12. SHARED COURSES WITH OTHER COMPUTING DISCIPLINES

As explained earlier in the report, there is a close relationship between the academic fields of Information Systems and other computing disciplines, and there are also very significant differences. The context for Information Systems is an organization and its systems. In contrast, the context for Computer Science would typically include algorithmic processes for information processing and associated technical and technology issues. There are complementary strengths for these academic units in preparing graduates for information systems work in organizations.

An Information Systems academic unit is typically strong in preparing students for the organizational environment. This advantage is especially strong when the Information Systems program is within or closely tied to organizational or business studies. The challenge for an IS unit may be in maintaining adequate depth of instruction in some technology subjects. On the other hand, a Computer Science program sometimes reverses the comparative position of an IS unit. It is typically strong in teaching technology and related algorithmic processes, but organizational functions and systems may not be an area of emphasis for them.

Of course, there is so much variety in the actual organization of academic units that these remarks cannot be taken too literally. Even in the case of a single academic unit that covers multiple computing curricula, one often sees these complementary strengths among programs.

This high level perspective of complementary strengths suggests that there may be opportunities for courses taught by any computing area that also meets the needs of IS majors; similarly for courses taught by IS for students desiring more IS knowledge from other areas. It is also possible to conceptualize a common core for multiple programs, and in fact, such shared core courses are taught at a number of institutions. This report has not attempted a formal definition of such a course sequence because there is no fixed organizational model of the relationship between the varied programs to which such a definition could be addressed. If a common core sequence appears to be useful for an institution, a useful approach is for the institution to take the core requirements for IS as described in this report and, considering the local situation in terms of organization of academic units and distribution of strengths of faculty and laboratory resources, to design a common core sequence.

13. IS 2010 COURSE SPECIFICATIONS

In this section, we provide high-level course descriptions for IS 2010, including the seven core courses and a subset of the electives discussed above. Each course is described with a catalog description and a scope statement followed by a topic list. Finally, the explanations and expectations for each course are discussed.

The courses included are as follows:

Core Courses

IS 2010.1 Foundations of Information Systems
IS 2010.2 Data and Information Management
IS 2010.3 Enterprise Architecture
IS 2010.4 IS Project Management
IS 2010.5 IT Infrastructure
IS 2010.6 Systems Analysis and Design
IS 2010.7 IS Strategy, Management and Acquisition

Sample Elective Courses

Application Development
Business Process Management
Enterprise Systems
Introduction to Human-Computer Interaction
IT Audit and Controls
IS Innovation and New Technologies
IT Security and Risk Management

Title: Foundations of Information Systems
Core Course

Catalog description

Today, information systems are an integral part of all business activities and careers. This course is designed to introduce students to contemporary information systems and demonstrate how these systems are used throughout global organizations. The focus of this course will be on the key components of information systems - people, software, hardware, data, and communication technologies, and how these components can be integrated and managed to create competitive advantage. Though the knowledge of how IS provides a competitive advantage students will gain an understanding of how information is used in organizations and how IT enables improvement in quality, speed, and agility. This course also provides an introduction to systems and development concepts, technology acquisition, and various types of application software that have become prevalent or are emerging in modern organizations and society.

Learning objectives

Students will learn to

1. Understand how and why information systems are used today
2. Explain the technology, people, and organizational components of information systems.
3. Understand globalization and the role information systems has played in this evolution.
4. Understand how businesses are using information systems for competitive advantage vs. competitive necessity.
5. Understand the value of information systems investments as well as learn to formulate a business case for a new information system, including estimation of both costs and benefits.
6. Know the major components of an information systems infrastructure
7. Mitigate risks as well as plan for and recover from disasters.
8. Understand how information systems are enabling new forms of commerce between individuals, organizations, and governments.
9. Be aware of emerging technologies that enable new forms of communication, collaboration, and partnering.
10. Understand how various types of information systems provide the information needed to gain business intelligence to support the decision making for the different levels and functions of the organization.
11. Understand how enterprise systems foster stronger relationships with customers and suppliers and how these systems are widely used to enforce organizational structures and processes.
12. Understand how organizations develop and acquire information systems and technologies.
13. Understand how to secure information systems resources, focusing on both human and technological safeguards.
14. Evaluate the ethical concerns that information systems raise in society and the impact of information systems on crime, terrorism, and war.

Topics

- Characteristics of the Digital World
- Information systems components
    - Hardware
    - Software
    - Data
    - Networks
    - Facilities
    - Personnel
    - Services
    - Partners
- Information Systems in organizations
    - Characteristics of IS professionals
    - IS career paths
    - Cost/value information
    - Quality of information
    - Competitive advantage of information
    - IS and organizational strategy
    - Value chains and networks
- Globalization
    - What is globalization?
    - Technology enabled change
    - Digital divide
    - Global information systems strategies
- Valuing information systems
    - How information systems enable organizational processes
    - Making a business case for information systems
    - Productivity paradox of information systems
    - Investment evaluation
        - Multi-criteria analysis
        - Cost-benefit analysis
    - Identifying and implementing innovations
- Information Systems infrastructure
    - Hardware
    - Software
    - Collaboration and communication technologies
    - Data and knowledge
    - Faculties
    - Services
    - Personnel
    - Partnerships
- The Internet and WWW
    - E-business
        - B-to-C
        - B-to-B
    - Intranets, Internet, Extranets
    - E-government
    - Web 2.0
        - Technologies: e.g., wikis, tags, blogs, netcasts, self-publishing

        - New forms of collaboration: social networking, virtual teams, viral marketing, crowdsourcing
- Securing information systems
    - Threats to information systems
    - Technology-based safeguards
    - Human-based safeguards
    - Information systems security planning and management
- Gaining business intelligence from information systems
    - Organizational decision making, functions, and levels
        - Executive, managerial, and operational levels
        - Systems to support organizational functions and decision making
    - Information and knowledge discovery
        - Reporting systems
        - Online analytical processing
        - Data, text, and web mining
        - Business analytics
    - Application systems
        - Executive, managerial, and operational support systems
        - Decision support systems
        - Functional area information systems
        - Collaboration technologies
        - Intelligent systems
        - Knowledge management systems
    - Information visualization
        - Visual analytics
        - Dashboards
        - Geographic information systems
- Enterprise-wide information systems
    - Enterprise resource planning
    - Supply chain management
    - Customer relationship management
- Developing and acquiring information system resources
    - Systems development lifecycle
    - Alternative development approaches
    - External acquisition
    - Outsourcing
    - End-user development
- Information systems ethics and crime
    - Information privacy, accuracy, property, and accessibility
    - Computer crime
    - Cyberwar / cyberterrorism

Discussion

- Information systems have become pervasive in organizations in society. It is crucial for students to gain a comprehensive understanding of what information systems are, and how they are being used to facilitate organizational processes and societal change.
- Students must understand the various types of issues involved in building, acquiring, managing, and safeguarding information systems. They must also have an understanding of various types of systems and how they aid organizational decision making, business processes, collaboration, partnerships, and so on.

- Students with practical end-user knowledge will study systems theory and quality concepts as an introduction to information technology concepts and information systems development. Structure and functions of computers, telecommunications, and other infrastructure components will be examined.
- The concept that information is of significance in stating and attaining organizational goals will be used as the basis for exploring the need for various types of information systems. Information systems will be introduced as a method for not only processing information, but as a method for enhancing communication and collaboration within and outside the organization. The dynamic nature of organizations and the necessity for growth and re-design of the organization as well as its information systems will be presented and used as the motivator for understanding information systems development methodologies and approaches for technology acquisition.
- The development path for entry level to senior information systems professionals will be explained. Professional ethical expectations and obligations will be reviewed. The necessity for personal and interpersonal communications skills will be discussed.

Title: Data and Information Management
Core Course

Catalog description

This course provides the students with an introduction to the core concepts in data and information management. It is centered around the core skills of identifying organizational information requirements, modeling them using conceptual data modeling techniques, converting the conceptual data models into relational data models and verifying its structural characteristics with normalization techniques, and implementing and utilizing a relational database using an industrial-strength database management system. The course will also include coverage of basic database administration tasks and key concepts of data quality and data security. In addition to developing database applications, the course helps the students understand how large-scale packaged systems are highly dependent on the use of DBMSs. Building on the transactional database understanding, the course also provides an introduction to data and information management technologies that provide decision support capabilities under the broad business intelligence umbrella.

Learning objectives

Students will learn to

1. Understand the role of databases and database management systems in managing organizational data and information.
2. Understand the historical development of database management systems and logical data models.
3. Understand the basics of how data is physically stored and accessed.
4. Understand the fundamentals of the basic file organization techniques.
5. Apply information requirements specification processes in the broader systems analysis & design context.
6. Use at least one conceptual data modeling technique (such as entity-relationship modeling) to capture the information requirements for an enterprise domain.
7. Link to each other the results of data/information modeling and process modeling.
8. Design high-quality relational databases.
9. Understand the purpose and principles of normalizing a relational database structure
10. Design a relational database so that it is at least in 3NF.
11. Implement a relational database design using an industrial-strength database management system, including the principles of data type selection and indexing.
12. Use the data definition, data manipulation, and data control language components of SQL in the context of one widely used implementation of the language.
13. Perform simple database administration tasks.
14. Understand the concept of database transaction and apply it appropriately to an application context.
15. Understand the basic mechanisms for accessing relational databases from various types of application development environments.
16. Understand the role of databases and database management systems in the context of enterprise systems.
17. Understand the key principles of data security and identify data security risk and violations in data management system design.

18. Understand the core concepts of data quality and their application in an organizational context.
19. Understand the difference between on-line transaction processing (OLTP) and on-line analytic processing (OLAP), and the relationship between these concepts and business intelligence, data warehousing and data mining.
20. Create a simple data warehouse (“data mart”).
21. Understand how structured, semi-structured, and unstructured data are all essential elements of enterprise information and knowledge management. In this context, the students will learn the principles of enterprise search.

Topics

- Database approach
- Types of database management systems
- Basic file processing concepts
- Physical data storage concepts
- File organizations techniques
- Conceptual data model
    - Entity-relationship model
    - Object-oriented data model
    - Specific modeling grammars
- Logical data model
    - Hierarchical data model
    - Network data model
    - Relational data model
        - Relations and relational structures
        - Relational database design
            - Mapping conceptual schema to a relational schema
            - Normalization
- Physical data model
    - Indexing
    - Data types
- Database languages
    - SQL: DDL, DML, and DCL
- Data and database administration
- Transaction processing
- Using a database management system from an application development environment
- Use of database management systems in an enterprise system context
- Data / information architecture
- Data security management
    - Basic data security principles
    - Data security implementation
- Data quality management
    - Data quality principles
    - Data quality audits
    - Data quality improvement
- Business intelligence
    - On-line analytic processing
    - Data warehousing
    - Data mining

- Enterprise search

Discussion

- The course still has a strong focus on traditional data management: conceptual data modeling (using ER modeling as the primary technique), logical data modeling using the relational data model (including ER – relational conversion and normalization), and physical database implementation and manipulation using SQL.
- It is essential that the information requirements specification processes are firmly linked to the organizational SA&D processes and that students understand the role of conceptual data modeling as an integral part of the process of making sense of the domain.
- The focus on the physical data model and the DBA-level work on database implementation has been reduced to give more time on improved understanding of the role of databases in the enterprise application context and various business intelligence topics, including enterprise search. Still, the students should understand the basic nature of the DBA tasks and be able to make intelligent decisions regarding DBMS choice and the acquisition of DBA resources.
- It is critically important that the students will fully understand how dependent various large-scale packaged systems (including ERP systems) are on relational databases and how strongly success in maintaining them and in supporting their use in organizations is dependent on understanding data structures and data manipulation with SQL.
- The course should provide a practical understanding of how relational databases are used to support web-based applications.

Title: Enterprise Architecture[2]
Core Course

Catalog description

This course explores the design, selection, implementation and management of enterprise IT solutions. The focus is on applications and infrastructure and their fit with the business. Students learn frameworks and strategies for infrastructure management, system administration, data/information architecture, content management, distributed computing, middleware, legacy system integration, system consolidation, software selection, total cost of ownership calculation, IT investment analysis, and emerging technologies. These topics are addressed both within and beyond the organization, with attention paid to managing risk and security within audit and compliance standards. Students also hone their ability to communicate technology architecture strategies concisely to a general business audience.

Learning objectives

Students will learn to

1. Understand a variety of frameworks for enterprise architecture analysis and decision making.
2. Evaluate the total cost of ownership and return on investment for architecture alternatives.
3. Utilize techniques for assessing and managing risk across the portfolio of the enterprise.
4. Evaluate and plan for the integration of emerging technologies.
5. Administer systems, including the use of virtualization and monitoring, power and cooling issues.
6. Manage proliferating types and volume of content.
7. Understand the core concepts of data/information architecture and evaluate existing data/information architecture designs.
8. Plan for business continuity.
9. Understand the benefits and risks of service oriented architecture.
10. Understand the role of audit and compliance in enterprise architecture.

Topics

- Service oriented architecture
- Enterprise architecture frameworks
- Systems integration
- Enterprise resource software
- Monitoring and metrics for infrastructure and business processes
- Green computing

[2] Acknowledgement: This material is largely based on work by Dr. Bill Schiano, Bentley University.

- Virtualization of storage and systems
- The role of open source software
- Risk management
- Business continuity
- Total cost of ownership and return on investment
- Software as a service
- Enterprise data models
- Data / information architecture and data integration
- Content management
- Audit and compliance
- System administration
- IT control and management frameworks
- Emerging technologies

Discussion

- The course can be structured at varying levels of technical depth
- The course can be a relatively easy way to introduce newer technologies into the curriculum, e.g. Web 2.0.
- This course operates at a higher level of abstraction than a typical infrastructure course, and it includes significant coverage of business issues related to an enterprise's technology architecture.
- This is the context in which the students are introduced to modern enterprise IT concepts, such as SoS, green computing, and SaaS.
- This course would also cover the topics related to IT control and service management frameworks (COBIT, ITIL, etc.)

Title: IT Infrastructure
Core Course

Catalog description

This course provides an introduction to IT infrastructure issues for students majoring in Information Systems. It covers topics related to both computer and systems architecture and communication networks, with an overall focus on the services and capabilities that IT infrastructure solutions enable in an organizational context. It gives the students the knowledge and skills that they need for communicating effectively with professionals whose special focus is on hardware and systems software technology and for designing organizational processes and software solutions that require in-depth understanding of the IT infrastructure capabilities and limitations. It also prepares the students for organizational roles that require interaction with external vendors of IT infrastructure components and solutions. The course focuses strongly on Internet-based solutions, computer and network security, business continuity, and the role of infrastructure in regulatory compliance.

Learning objectives

Students will learn to

1. Understand key principles of data representation and manipulation in computing solutions.
2. Understand the principles underlying layered systems architectures and their application to both computers and networks.
3. Understand the differences and similarities between the core elements of an IT infrastructure solution, such as clients, servers, network devices, wired and wireless network links, systems software, and specialized security devices.
4. Understand how IT infrastructure components are organized into infrastructure solutions in different organizational environments.
5. Understand the principles underlying service virtualization.
6. Understand through practical examples how protocols are used to enable communication between computing devices connected to each other.
7. Configure an IT infrastructure solution for a small organization, including a network based on standard technology components, servers, security devices, and several different types of computing clients.
8. Apply the core concepts underlying IP networks to solve simple network design problems, including IP subnetting.
9. Understand the role and structure of the Internet as an IT infrastructure component and to design simple infrastructure solutions based on the use of the Internet.
10. Understand the components and structure of a large-scale organizational IT infrastructure solution at a level that allows them to utilize it effectively
11. Understand the role of IT control and service management frameworks in managing a large-scale organizational IT infrastructure solution
12. Negotiate with vendors providing design and implementation solutions.
13. Understand the opportunities that virtual computing service provision models, such as cloud computing, create for organizations.
14. Analyze and understand the security and business continuity implications of IT infrastructure design solutions.
15. Configure simple infrastructure security solutions.

16. Minimize the environmental and resource consumption impacts of IT infrastructure decisions

Topics

- Core computing system architecture concepts
- Core computing system organizing structures
- Core technical components of computer-based systems
- Role of IT infrastructure in a modern organization
- Operating systems
    - Core operating systems functionality
    - Internal organization of an operating system
    - Types of devices that require and utilize operating systems
    - Multitasking and multithreading
    - File systems and storage
    - User interfaces
    - Operating system configuration
    - Securing an operating system
    - Virtualization of computing services
- Networking
    - Types of networks
    - Core network components
    - TCP/IP model
    - Physical layer: wired and wireless connectivity
    - Data link layer: Ethernet
    - Network layer: IP, IP addressing and routing
    - Transport layer: TCP
    - Application layer: Core Internet application protocols
    - Network security and security devices
    - The Internet as a key networking platform
    - Network device configuration
- Organizing storage on organizational networks
- Data centers
- Securing IT infrastructure
    - Principles of encryption and authentication
    - Component level security: clients, servers, storage network devices, data transport, applications
    - Perimeter security: firewalls
    - Using public networks for secure data transport: VPNs
- The role of IT control and service management frameworks (COBIT, ITIL, etc.) in managing the organizational IT infrastructure
- Ensuring business continuity
- Grid computing
- Cloud computing, computing as a service
- System performance analysis and management
- Purchasing of IT infrastructure technologies and services

Discussion

- This course recognizes that Information Systems programs are increasingly preparing students for organizational roles that do not require in-depth skills in designing or configuring hardware and systems software solutions. The key focus is on helping the students understand the infrastructure issues at a level that is required for effective work as business and systems analysis.

- The course also forms the foundation for further study related to both computer architecture and communication networks. Specifically, it is important to recognize that many technically focused IT risk management, security, and forensics jobs require more in-depth understanding of technology issues than this single course can provide.
- Whenever possible, it is recommended that this course uses hands-on laboratory work and practical exercises to teach the complex concepts that are often too abstract to grasp without practical examples.

Title: Information Systems Project Management
Core Course

Catalog description

This course discusses the processes, methods, techniques and tools that organizations use to manage their information systems projects. The course covers a systematic methodology for initiating, planning, executing, controlling, and closing projects. This course assumes that project management in the modern organization is a complex team-based activity, where various types of technologies (including project management software as well as software to support group collaboration) are an inherent part of the project management process. This course also acknowledges that project management involves both the use of resources from within the firm, as well as contracted from outside the organization.

Learning objectives

Students will learn to

1. Initiate, specify, and prioritize information systems projects and to determine various aspects of feasibility of these projects.
2. Understand the foundations of project management, including its definition, scope, and the need for project management in the modern organization.
3. Understand the phases of the project management lifecycle.
4. Manage project teams, including the fundamentals of leadership and team motivation.
5. Manage project communication, both internal to the team, and external to other project stakeholders.
6. Initiate projects, including project selection and defining project scope.
7. Manager project schedules with appropriate techniques and tools.
8. Manage project resources, including human resources, capital equipment, and time.
9. Manage project quality, including the identification of the threats to project quality, techniques for measuring project quality, and the techniques for ensuring project quality is achieved.
10. Manage project risk, including the identification of project risk, and the techniques for ensuring project risk is controlled.
11. Manage the project procurement process, including understanding external acquisition and outsourcing, as well as the steps for managing external procurement.
12. Manage project execution, including monitoring project progress and managing project change, and appropriately documenting and communicating project status.
13. Control projects through information tracking and cost and change control techniques.
14. Close projects, including administrative, personnel, and contractual closure.
15. Understand the mechanisms for dealing with legal issues in complex project contexts.

Topics

- Introduction to Project Management
    - Project management terminology
    - Project failures and project successes
    - Unique features of IT projects

  - What is project management?
- The Project Management Lifecycle
  - What is the project management lifecycle?
  - Project management and systems development or acquisition
  - The project management context
  - Technology and techniques to support the project management lifecycle
  - Project management processes
- Managing Project Teams
  - What is a project team?
  - Project team planning
  - Motivating team members
  - Leadership, power and conflict in project teams
  - Managing global project teams
- Managing Project Communication
  - Managing project communication
  - Enhancing team communication
  - Using collaboration technologies to enhance team communication
- Project Initiation and Planning
- Managing Project Scope
  - Project initiation
  - How organizations choose projects
  - Activities
  - Developing the project charter
- Managing Project Scheduling
  - What is project scheduling?
  - Common problems in project scheduling
  - Techniques for project scheduling
- Managing Project Resources
  - What are resources?
  - Types of resources (human, capital, time)
  - Techniques for managing resources
- Managing Project Quality
  - What is project quality?
  - What are the threats to project quality?
  - How can we measure project quality
  - Tools for managing project quality
- Managing Project Risk
  - What is project risk?
  - What are the threats to project risk?
  - Tools for managing project risk
- Managing Project Procurement
  - Alternatives to systems development
  - External acquisition
  - Outsourcing
  - Steps in the procurement process
  - Managing the procurement process
- Project Execution, Control & Closure
  - Managing project execution
  - Monitoring progress and managing change
  - Documentation and communication
  - Common problems in project execution

- Managing Project Control & Closure
  - Obtaining information
  - Cost control
  - Change control
  - Administrative closure
  - Personnel closure
  - Contractual closure
  - Project auditing

Discussion

- The core course in information systems project management is primarily focused on initiating, planning, executing, controlling, and closing information systems projects. Project charters, schedules, resource assignments, communication, risk and quality control plans, as well as an understanding of leadership and group processes are all tools which can enhance effective project management. This course will teach the student methods that allow them to manage projects resources, including those internal and external to the organization.
- The course specification intentionally leaves discussion regarding specific methods and approaches unanswered. While there are common techniques to project management institutions, programs will still have the ability to make local decisions regarding specific tools and techniques based on the capabilities of their faculty, their available resources, and the needs of the companies hiring the students.
- Using a course project to teach the concepts in this course is highly recommended.

Title: Systems Analysis & Design
Core Course

Catalog description

This course discusses the processes, methods, techniques and tools that organizations use to determine how they should conduct their business, with a particular focus on how computer-based technologies can most effectively contribute to the way business is organized. The course covers a systematic methodology for analyzing a business problem or opportunity, determining what role, if any, computer-based technologies can play in addressing the business need, articulating business requirements for the technology solution, specifying alternative approaches to acquiring the technology capabilities needed to address the business requirements, and specifying the requirements for the information systems solution.

Learning objectives

Students will learn to

1. Understand the types of business needs that can be addressed using information technology-based solutions.
2. Initiate, specify, and prioritize information systems projects and to determine various aspects of feasibility of these projects.
3. Use at least one specific methodology for analyzing a business situation (a problem or opportunity), modeling it using a formal technique, and specifying requirements for a system that enables a productive change in a way the business is conducted.
4. Within the context of the methodologies they learn, write clear and concise business requirements documents and convert them into technical specifications.
5. Communicate effectively with various organizational stakeholders to collect information using a variety of techniques and to convey proposed solution characteristics to them.
6. Manage information systems projects using formal project management methods.
7. Articulate various systems acquisition alternatives, including the use of packaged systems (such as ERP, CRM, SCM, etc.) and outsourced design and development resources.
8. Use contemporary CASE tools for the use in data modeling
9. Compare the acquisition alternatives systematically.
10. Incorporate principles leading to high levels of security and user experience from the beginning of the systems development process.
11. Design high-level logical system characteristics (user interface design, design of data and information requirements).

Topics

- Identification of opportunities for IT-enabled organizational change
- Business process management
- Analysis of business requirements
    - Business process modeling
    - Information requirements
- Structuring of IT-based opportunities into projects
- Project specification
- Project prioritization

- Analysis of project feasibility
- Fundamentals of IS project management in the global context
- Using globally distributed communication and collaboration platforms
- Analysis and specification of system requirements
    - Data collection methods
    - Methods for structuring and communicating requirements
    - Factors affecting user experience
    - User interface design
    - System data requirements
    - Factors affecting security
    - Ethical considerations in requirements specification
- Different approaches to implementing information systems to support business requirements
    - Packaged systems; enterprise systems
    - Outsourced development
    - In-house development
- Specifying implementation alternatives for a specific system
- Impact of implementation alternatives on system requirements specification
- Methods for comparing systems implementation approaches
- Organizational implementation of a new information system
- Different approaches to systems analysis & design: structured SDLC, unified process/UML, agile methods

Discussion

- The focus of the core course in systems analysis & design is primarily focused clearly on analyzing and documenting business requirements as well as converting these requirements into detailed systems requirements and high-level design specifications (e.g., mock-ups of forms, reports, HCI, and so other user interface components), not on internal design or system implementation design. The course content is will explicitly be built on the assumption that most organizational systems are built based on various types of packaged systems, system components, or implemented by using outsourced development capabilities (whether on- or off-shore). The course will teach the student methods that allow them to specify requirements precisely and communicate effectively with both business stakeholders and developers, but it will not include material related to the design or /implementation of the technical structure of the system.
- The course specification intentionally leaves discussion regarding specific methods and approaches unanswered. Institutions have to make these decisions regarding the capabilities of their faculty and the needs of the companies hiring the students. It is, however, important that the course will provide some exposure to the structured SDLC, object-oriented analysis and design (some Unified Process variant using UML as a grammar) and agile methods.
- Using a course project is highly recommended.
- The course specifically emphasizes the importance of incorporating security issues and user experience from the earliest stages of the process.
- The course includes the first exposure to project management concepts and practice. The importance of this element will depend on the extent to which project management is covered elsewhere in the curriculum.

Title: IS Strategy, Management & Acquisition
Core Course

Catalog description

This course explores the issues and approaches in managing the information systems function in organizations and how the IS function integrates / supports / enables various types of organizational capabilities. It takes a senior management perspective in exploring the acquisition, development and implementation of plans and policies to achieve efficient and effective information systems. The course addresses issues relating to defining the high-level IS infrastructure and the systems that support the operational, administrative and strategic needs of the organization. The remainder of the course is focused on developing an intellectual framework that will allow leaders of organizations to critically assess existing IS infrastructures and emerging technologies as well as how these enabling technologies might affect organizational strategy. The ideas developed and cultivated in this course are intended to provide an enduring perspective that can help leaders make sense of an increasingly globalized and technology intensive business environment.

Learning objectives

Students will learn to

1. Understand the various functions and activities within the information systems area, including the role of IT management and the CIO, structuring of IS management within an organization, and managing IS professionals within the firm.
2. View an organization through the lens of the information systems used to enable core and supportive business processes as well as those that interface with suppliers and customers.
3. Understand the concepts of information economics at the enterprise level.
4. Appreciate into how IS represents a key source of competitive advantage for firms.
5. Structure IS-related activities to maximize the business value of IS within and outside the company.
6. Understand existing and emerging information technologies, the functions of IS and its impact on the organizational operations.
7. Evaluate the issues and challenges associated with successfully and unsuccessfully incorporating IS into a firm.
8. Understand how strategic decisions are made concerning acquiring IS resources and capabilities including the ability to evaluate the different sourcing options.
9. Apply information to the needs of different industries and areas.
10. Understand the role of IT control and service management frameworks from the perspective of managing the IS function in an organization.

Topics

- The IS function
- IS strategic alignment
- Strategic use of information
- Impact of IS on organizational structure and processes
- IS economics
- IS planning

- Role of IS in defining and shaping competition
- Managing the Information Systems function
    - IS leadership: The role of the CIO and IS management
    - Structuring the IS organization
    - Hiring, retaining, and managing IS professionals
    - Managing a mixed set of internal and external resources
- Financing and evaluating the performance of Information Technology investments and operations
- Acquiring Information Technology resources and capabilities
    - Acquiring infrastructure capabilities
    - Sourcing Information Systems services
    - Sourcing Information Systems applications
- Using IS/IT governance frameworks
- IS risk management
    - Managing business continuity
    - Managing security and privacy

Discussion

- The core course in IS Strategy, Management and Acquisition will take a high-level approach to the management and acquisition of IS-resources within the firm.
- The course will deliver the student specific strategies used in firms today to help form the basis of IS strategic management. Based on this knowledge student will then be asked to apply said strategies to management issues within an IS context.
- Specifics on what frames of strategic thinking are used in this course are left unanswered. Institutions may have certain capabilities or constraints that can be optimized to offer the best thinking for the companies that are hiring their graduates. Also, there are different regional issues that need to be addressed in order to match the current thinking with specific IS strategies.
- Using a case study methodology is highly recommended for this course as it will help the students strategically identify issues in a real-world setting. In general, it is essential that the pedagogical approaches chosen for this course will carefully consider the fact that the issues covered are at a higher level of abstraction than what the students are used to based on their practical experience in organizations.

Title: Application Development
Elective Course

Catalog description

The purpose of this course is to introduce the students to the fundamental concepts and models of application development so that they can understand the key processes related to building functioning applications and appreciate the complexity of application development. Students will learn the basic concepts of program design, data structures, programming, problem solving, programming logic, and fundamental design techniques for event-driven programs. Program development will incorporate the program development life cycle: gathering requirements, designing a solution, implementing a solution in a programming language, and testing the completed application.

Learning objectives

Students will learn to:

1. Use primitive data types and data structures offered by the development environment
2. Choose an appropriate data structure for modeling a simple problem
3. Understand basic programming concepts
4. Write simple applications that relate to a specific domain
5. Design, implement, test, and debug a program that uses each of the following fundamental programming constructs: basic computation, simple I/O, standard conditional and iterative structures, and the definition of functions.
6. Test applications with sample data
7. Apply core program control structures

Topics

- Program design
- Program development lifecycle
- Requirements determinants and analysis
- Modular design
- Techniques for modeling program structures
- Programming concepts
  - Variables
  - Literals
  - Types
  - Expressions
  - Procedures
  - Functions
  - Parameters
  - Operators and operations
  - Decision logic
  - Looping
  - Subprocedures
  - Passing parameters
- Coding
- Unit testing

- Control structures
    - Sequential
    - Conditional
    - Iterative
- Input/Output (I/O) design
    - Text-based
    - Graphical user interface (GUI)
- Data structures
    - Primitive data types, composite data types, arrays
    - Memory management
    - Sequential and random file processing
- Database access
- Development approaches
    - Object-oriented
    - Procedural
    - Declarative
    - Rapid application
    - Structured
- Application integration
- Prototyping
- Overview and history of programming languages

Discussion

- The course benefits from computer lab resources either in class or available for licensing on individual students' computers. The choice of language should reflect commonly used languages and tools with the expectation that learning any language will generalize to other languages. For this reason it may be best to concentrate on one language to develop depth rather than breadth across several languages.

Title: Business Process Management
Elective Course

Catalog description

In this course students will be introduced to key concepts and approaches to business process management and improvement. The main focus of this course is both understanding and designing business processes. Students will learn how to identify, document, model, assess, and improve core business processes. Students will be introduced to process design principles. The way in which information technology can be used to manage, transform, and improve business processes is discussed. Students will be exposed to challenges and approaches to organizational change, outsourcing, and inter-organizational processes.

Learning objectives

Students will learn to:

1. Model business processes
2. Benchmark business processes performance
3. Assess business processes performance
4. Design business process improvements
5. Understand the role and potential of IT to support business process management
6. Understand the challenges of business process change
7. Understand how to support business process change
8. Understand different approaches to business process modeling and improvement
9. Understand the challenges and risks concerning business process outsourcing
10. Use basic business process modeling tools
11. Simulate simple business processes and use simulation results in business process analysis

Topics

- Overview
    - Challenges in managing business processes
    - Approaches to business process management & improvement

- Understanding organizational processes
    - Business process definition and classification
    - Identifying core processes
    - Modeling processes
    - Documenting processes

- Process Assessment
    - Measuring performance
    - Benchmarking
    - Statistical techniques for process measurement

- Process Improvement
    - Process design guidelines and principles
    - Continuous process improvement

  - Change management

- Using IT for process management and improvement
  - Business process improvement and modeling software
  - Tools of business process simulation
  - ERP Systems

- Organizational issues in business process management
  - Understanding the customer
  - Business process outsourcing
  - Managing processes that cross organizational borders

Discussion

- The course description does not identify specific approaches and methods for business process management and improvements, such as BPR, TQM, or Six Sigma. This will allow instructors and institutions to decide which specific approaches to cover.
- The demonstration of leading ERP systems such as SAP is highly recommended.
- The use of case studies for discussion and reflection in this course is highly recommended.
- The use of group project in this course is highly recommended.
- The organization of an SAP Practicum can be considered.

Title: Enterprise Systems
Elective Course

Catalog description

This course is designed to provide students with an understanding of the theoretic and practical issues related to the application of Enterprise Systems within organizations. The main focus of this course is to demonstrate how Enterprise Systems integrate information and organizational processes across functional areas with a unified system comprised of a single database and shared reporting tools. Enterprise systems, by their multi-dimensional integrative nature, offer the depth of functionality and breadth of integration to demonstrate how global operations of organizations are managed. Thus, students will gain an appreciation of the scope of Enterprise Systems and the motivation for implementing them. [Optional: Example software will be used to illustrate how Enterprise Systems work. An integrated project, which requires the application of conceptual as well as technical (software) skills of students, will be required.]

Learning objectives

Students will learn to:

1. Understand the fundamentals of Enterprise Systems and issues associated with their implementation.
2. Evaluate the costs and benefits of implementing an Enterprise System.
3. Understand how enterprise systems integrate functional areas into one enterprise-wide information system.
4. Explain how "best practices" are incorporated in Enterprise Systems.
5. Recognize how an organizational process often spans different functional areas.
6. Describe the role of Enterprise Systems in carrying out processes in an organization.
7. Learn to integrate key concepts from functional-oriented courses, such as accounting, marketing, and organizational behavior, to promote the development of integrative skills.
8. Explain how integrated information sharing increases organizational efficiencies.
9. Identify, describe, and evaluate the major Enterprise System software providers and their packaged systems.
10. Understand current trends related to Enterprise Systems.

Topics

- Business processes and business process integration
- Making the case for acquiring and implementing Enterprise Systems
- Analyzing business requirements for selecting and implementing an Enterprise System
- Selection of Enterprise Systems software
- Challenges associated with the implementation of global Enterprise Systems applications
- Organizational change
- Strategic alignment
- User commitment
- Communications
- Training

- Job redesign
- Governance of processes and data
- Post-implementation issues
- Enterprise System processes
- Order processing
- Purchasing
- Production logistics
- Accounting
- Planning & Control
- Human resource functions
- How Enterprise Systems support e-business

Discussion

- The course specification intentionally leaves Enterprise System software unspecified. Institutions have to make the decision of whether and how to provide students with experience with actual Enterprise System software. It is, however, preferable that the course include exposure to and hands-on use of one of the two large Enterprise System vendors in the market place, SAP or Oracle, or one of the several smaller vendors such as SSA Global, Microsoft (Axapta, Great Plains and Solomon), Intuit, or Minicom, to name a few. The importance of actual use is clear. Enterprise System software is in place in a majority of large organizations and increasing in use in small and medium sized organizations.
- A group project is highly recommended to assess both practical/applied aspects and the conceptual/theoretical content of the course. For example, a group project could require students to study a real-world organization and evaluate the suitability of SAP R/3 or another software solution. This evaluation would then be compared with other Enterprise System software products in terms of product functionality, support and flexibility for configuration and customization, architecture and technology compatibility, web-based functionality, ease of interfacing with other legacy systems, and implementation costs. If software resources permit, the group could then design and configure a simple workable integrated Enterprise System, using SAP R/3 for example, that demonstrates the integration of information from several modules, such as accounts receivable, sales, manufacturing/production, procurement, accounts payable, or general ledger. Student groups would analyze the functional areas in a real-world organization and map them into SAP R/3. Students would create an enterprise structure, relevant master data in the software, transactions that demonstrate integration of core processes, and provide documentation. Students thereby apply specialist skills and knowledge drawn from other traditional disciplines to an actual organization and demonstrate the development of skills such as analytical skills, communication, critical thinking, problem solving, and teamwork.
- The course provides a pedagogical basis for a change in the delivery of education from a functional orientation to a process orientation, leading to the integration of curriculum across functions.

Title: Introduction to Human-Computer Interaction
Elective Course

Catalog description

This course provides an introduction to the field of human-computer interaction (HCI). HCI is an interdisciplinary field that integrates cognitive psychology, design, computer science and others. Examining the human factors associated with information systems provide the students with knowledge to understand the factors that influence usability and acceptance of IS. This course will examine human performance, components of technology, methods and techniques used in design and evaluation of IS. Societal impacts of HCI such as accessibility will also be discussed. User-centered design methods will be introduced and evaluated. This course will also introduce students to the contemporary technologies used in the empirical evaluation methods.

Learning objectives

Students will learn to:

1. Design, implement and evaluate effective computer interfaces.
2. Understand the concepts of user differences, user experience and collaboration as well as how to design contextually.
3. Understand the basic cognitive psychology issues involved in HCI.
4. Understand the different devices used for input and output and the issues / opportunities associated with these devices.
5. Interact with the software design process in order to create computer interfaces.
6. Understand the role of theory and frameworks in HCI.
7. Apply a number of design techniques.
8. Apply contemporary techniques to evaluate computer interfaces.

Topics

- Relevance of HCI
- Principles in HCI design
    - Ergonomic engineering
    - Cognitive engineering
    - Affective engineering
- User-Centered Design
    - Users
        - Capabilities
            - Conceptual models
            - Metaphors
            - Mental models
        - Individual differences
        - Learning
        - Errors
        - Training
- Special HCI Issues Related to
    - Users
        - Children
        - Elderly
        - Accessibility

        - Gender
    - Organizations
    - Society
    - Task Analysis
- Devices
    - PCs
    - Industrial devices
    - Consumer devices
    - Mobile devices
- Development
    - Introduction to projects
    - Prototyping
    - Contextual inquiry
    - Usability engineering
- Evaluation Methods
    - Heuristics
    - Cognitive evaluation
    - Usability testing
    - Questionnaires
    - Research design

Discussion

- This course is not about developing basic interactive technologies (such as input/output devices), but rather, it briefly introduces these technologies, and then focuses on developing human-centered organizational information systems that support users' organizational tasks. Human physical, cognitive, and affective characteristics are discussed, as are organizational tasks and context. Such discussions are oriented toward achieving a good fit between human, technology, and tasks within the organizational and business context.

- This course in HCI will take the student through the HCI life-cycle (analysis, design, testing and implementation) in order to be competent in all aspects of HCI practice. This includes understanding the theory perspective of HCI research, the current methods in design and testing and the final implementation of the project. For this reason fundamental SA&D skills will have to be injected into the course or prerequisites will have to be met.

- A project based approach is highly recommended for this course. This includes implementing several hands-on skills either in a laboratory or through self-paced learning at home. This will help students develop the full range of skills that is needed for HCI work.

- It is important that students understand that various concepts and techniques outlined in this class draw upon a multitude of disciplines (e.g., cognitive psychology, consumer behavior, etc.). By gaining a solid understanding of various core theories that inform HCI design, the student can then translate this knowledge into building working prototypes in a broad range of contexts.

Title: IT Audit and Controls
Elective Course

Catalog description

This course introduces the fundamental concepts of the information technology audit and control function. The main focus of this course is on understanding information controls, the types of controls and their impact on the organization, and how to manage and audit them. The concepts and techniques used in information technology audits will be presented. Students will learn the process of creating a control structure with goals and objectives, audit an information technology infrastructure against it, and establish a systematic remediation procedure for any inadequacies. The challenge of dealing with best practices, standards, and regulatory requirements governing information and controls is addressed.

Learning objectives

Students will learn to:

1. Understand the role and objectives of the information technology audit.
2. Develop an appropriate information technology audit process.
3. Identify risks to the confidentially, integrity, and availability of information and processes.
4. Describe the risks inherent in various types of information systems ranging from manual, basic accounting, to advanced operational information and knowledge for decision making.
5. Understand how to design and implement assurance procedures and control measures to effectively manage risks.
6. Understand best practices, standards, and regulatory requirements governing information and controls. Gain the ability to measure the degree of compliance with them.
7. Understand the role of auditing in systems development, including the review of the development process and participation in systems under development.
8. Understand data forensics
9. Secure and preserve evidence.
10. Develop disaster recovery and business continuity plans.

Topics

- The need for information technology audit & controls
- Information technology risks – Business Process and Business Continuity
    - Protection of information assets
    - Business process evaluation and risk management
    - Systems development and maintenance activities
    - Disaster recovery and business continuity
- Auditing ethics, guidelines, and standards of the profession
    - Control Objectives for Information and related Technology (COBIT)
    - ISACA
    - Val IT
- Undertaking an information system audit
    - Internal audit and external audit

- Controls over information and processes
    - Physical and environmental controls
    - Network controls
    - System software controls
    - Database controls
    - Application controls
    - Internet and e-commerce controls
    - Installation and operational controls
    - Change controls
    - Access controls
    - Encryption, authentication and non-repudiation
    - End-user controls
    - Software licensing controls
    - Governance
- Controls Assessment
    - Separation of duties
    - Delegation of authority & responsibility
    - System of authorizations
    - Documentation & records
    - Physical control over assets & records
    - Management supervision
    - Independent checks
    - Recruitment & training

Discussion

- The use of case studies, professional standards, and sample audit software programs are encouraged to exemplify concepts covered.

Title: IS Innovation and New Technologies
Elective Course

Catalog description

New IS technologies are being used to change how organizations communicate both internally and as well as with external partners. These technologies have been integrated into an exciting academic discipline that is integral to all business activities. This course is designed to introduce students to new and innovative technologies and examine how these powerful systems have fundamentally reshaped modern organizations along with our society. Using online collaborative technologies that were developed in the context of social networking and online communities, corporations are reengineering both internal business processes and those related to customers, suppliers, and business partners. Developing innovative ways to communicate and collaborate can lead to new business opportunities, and new efficiencies. This course investigates the technologies, methods and practices of developing new innovations such as online communities, and how this knowledge and these skills are applied to re-engineer business processes. For example, how products, services and information systems are developed, and how geographically disperse virtual teams collaborate.

Learning objectives

Students will learn to:

1. Understand how technologies are increasing the ability of organizations to globalize business processes and to extend their reach to global customers.
2. Apply the techniques used to innovate IS technologies.
3. Understand how businesses have used IS technologies to innovate and reengineer business processes.
4. Understand the concepts associated with network effects.
5. Understand how the web as a platform enhances creativity, information sharing and functionality.
6. Understand the role of web technologies such as online communities in the business world, and how they deliver value.
7. Apply the popular community-oriented tools, such as online social networking tools, to business problems.
8. Apply basic tools of economics to digital goods and services.
9. Deal with the challenges associated with new technologies and innovation.

Topics

- Globalization
- Conversation about the commoditization of IT
- Technologies that have shaped the electronic world
- Process of IS innovation
    - Diffusion
    - Innovation cycles
- Strategic importance of the web as a platform
    - Web services
    - Collective intelligence
    - Peer-to-peer networking
    - Social networking

- Web 2.0 tools
  - RSS
  - Podcasts
  - Wikis
  - Blogs
  - Mash-ups
- Information organization
  - Categorization
  - Taxonomies
  - Tagging
- Virtual Teams
- Economics of digital goods and services
  - Ecommerce distribution
    - The Long Tail
    - Wikinomics
    - The Free Economy
- Search space
  - How search works
  - How search is monetized
  - Strategic importance of search
- Knowledge Management
- Future trends

Discussion

- It is essential for the health of the IS discipline to actively recruit IS students. This course will focus on topics designed to excite students about the IS discipline. Specifically, this course will look at how IS is used in the world around the student and how IS can be utilized to create powerful applications. This is done by delivering topics that will gain traction with the target audience. In turn, by exposing students to a variety of business views of IS the students would better understand the possibilities within the field.
- This course is different from the introduction to IS as it does not provide a comprehensive overview of IS, rather topics are selected that may peak students' interest in IS. The topics are a means to delivering an understanding of the IS field.
- It is critically important that we expose students to how IS is impacting the world around them and more specifically how IS functions in the business world.
- This course should include hands on demonstrations and projects that allow students to manage these online tools; understand the importance of information flows and provide the strategic importance of such systems.

Title: IT Security and Risk Management
Elective Course

Catalog description

This course provides an introduction to the fundamental principles and topics of Information Technology Security and Risk Management at the organizational level. Students will learn critical security principles that enable them to plan, develop, and perform security tasks. The course will address hardware, software, processes, communications, applications, and policies and procedures with respect to organizational IT Security and Risk Management.

Learning objectives

Students will learn to:

1. Understand the fundamental principles of Information Technology security.
2. Understand the concepts of threat, evaluation of assets, information assets, physical, operational, and information security and how they are related.
3. Understand the need for the careful design of a secure organizational information infrastructure.
4. Perform risk analysis and risk management.
5. Understand both technical and administrative mitigation approaches.
6. Understand the need for a comprehensive security model and its implications for the security manager.
7. Create and maintain a comprehensive security model.
8. Understand and apply security technologies.
9. Understand basic cryptography, its implementation considerations, and key management.
10. Design and guide the development of an organization's security policy.
11. Determine appropriate strategies to assure confidentiality, integrity, and availability of information.
12. Apply risk management techniques to manage risk, reduce vulnerabilities, threats, and apply appropriate safeguards/controls.

Topics

- Introduction to Information Security
- Inspection
  - Resource Inventory
  - Threat Assessment
  - Identifying Vulnerabilities
  - Assigning Safeguards
- Protection
  - Awareness
  - Access
  - Identification
  - Authentication
  - Authorization
  - Availability
  - Accuracy

  - Confidentiality
  - Accountability
  - Administration
- Detection
  - Intruder Types
  - Intrusion Methods
  - Intrusion Process
  - Detection Methods
  - Monitoring Systems
- Reaction
  - Incident Determination
  - Incident Notification
  - Incident Containment
  - Assessing Damage
  - Incident Recovery
  - Automated Response
- Reflection
  - Incident Documentation
  - Incident Evaluation
  - Legal Prosecution
- Risk Assessment Frameworks
  - COSO Integrated Control Framework
  - CoBiT – ISACA
  - Australia/New Zealand Standard – Risk Management
  - ISO Risk Management – Draft Standard
- Security Engineering
  - Protocols
  - Passwords
  - Access Controls
  - Cryptography
- Physical Aspects
  - Biometrics
  - Physical Tamper Resistance
  - Security Printing and Seals
- Security in Connected Systems and Networks
  - Distributed Systems
  - Telecom System Security
  - Network Attack and Defense
  - Protecting E-Commerce Systems
- Policy and Management Issues
  - Copyright and Privacy Protection
  - E-Policy

Discussion

- This course is intended as a first course in Information Assurance at the undergraduate level. This course will be a pre-requisite for additional information and network security courses for an Information Security track in the undergraduate program.
- The course description does not prescribe the specific approaches and methods for inspection, protection, detection, reaction, reflection, risk assessment and mitigation.

This will allow instructors and institutions to decide which specific approaches to cover.

- The use of case examples for discussion and reflection in this course is highly recommended.
- It is recommended to include an applied project for a potential client in which students conduct a risk assessment of a part of the client's IT infrastructure.

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APPENDIX 1 — BACKGROUND OF IS CURRICULA AND RELATED DISCIPLINES

Computer Science Curricula

A curriculum for Computer Science (CS) was first outlined in 1968 (see list in Figure A2.1; ACM, 1968) and revised a decade later (ACM, 1979). These curricula helped define the field of Computer Science. A joint task force of the IEEE-CS and ACM revised the curriculum in 1991 (Turner and Tucker, 1991). The next comprehensive revision was called Computing Curricula 2001, Computer Science Volume (Engel and Roberts, 2001), which was updated in with an interim revision in 2008 (CS2008 Review Task Force, 2008).

Information Systems Curricula

Curriculum development for Information Systems (IS) began in the early 1970s (Ashenhurst, 1972; Couger, 1973); both the ACM and DPMA published versions of IS model curricula in the 1980s (DPMA, 1981, 1986; Nunamaker, Couger, and Davis, 1982). The IS'97 model curriculum (Davis et al., 1997) represented the first formal and combined effort of ACM, AIS, and AITP, and it was followed with IS 2002 (Gorgone et al, 2003). Key events leading to that recommendation are listed in Figure A1.1.

Figure A1.1 – Key Chronology of IS Curriculum Events leading to

May, 1972	ACM Graduate Professional Programs in Information Systems (Ashenhurst, 1972)
December, 1973	ACM Undergraduate Programs in Information Systems (Couger, 1973)
March, 1981	ACM Educational Programs and Information Systems (Nunamaker, Couger and Davis, 1982)
1981	DPMA Curriculum for Undergraduate Information Systems Education (DPMA, 1981)
1983	ACM Information Systems Curriculum Recommendations for the 80s, Undergraduate and Graduate Programs (ACM, 1983; Nunamaker, Couger and Davis, 1982)
October, 1984	DPMA Secondary Curriculum on Information Technology and Computer Information Systems
October, 1985	DPMA Associate-Level Model Curriculum in Computer Information Systems
October, 1985	DPMA Model Curriculum for Undergraduate Computer Information Systems
May, 1990	ACM/IEEE Computing Curriculum for Computer Science for Undergraduates
October, 1990	DPMA IS'90 draft document (Longenecker and Feinstein, 1991c)
June, 1991	DPMA IS'90 Curriculum for Undergraduate Programs in Information Systems
July, 1991	ACM CS Curriculum (Turner and Tucker, 1991)
January, 1994	DPMA IS'94 Curriculum for Two Year Programs in Information Systems (Longenecker, Feinstein et al., 1994)
January, 1994	ACM Curriculum for Two Year Programs in Computer Information Systems
December, 1994	First Draft of IS'95 from the Joint ACM, AIS, DPMA Task Force (Gorgone et al., 1994; Longenecker et al., 1995; Couger, 1996)
February, 1996	First Draft of IS'97 from the Joint ACM, AIS, DPMA Task Force
December, 1997	ACM, AIS, AITP IS'97 Model Curriculum and Guidelines for Undergraduate Programs of Information Systems
December, 1999	ISCC An Industry Based Curriculum
December, 2002	IS 2002 Model Curriculum and Guidelines for Undergraduate Programs of Information Systems

The DPMA IS'90 model was begun in November 1988 and completed by July of 1991 (Longenecker and Feinstein, 1991b, 1991c). This model was based on a survey of Information Systems programs in approximately 1,000 colleges and universities in North America (Longenecker and Feinstein, 1991a). Participants in the effort, the Curriculum Task Force (CTF 90), were drawn from an international community of industry, business, and academia including both two and four year institutions. The work was supported by the DPMA but participants were also active in other organizations. Material from the unpublished work of the ACM-IS curriculum committee that met in the late 1980s was incorporated into the model.

The draft version “Information Systems – The DPMA Model Curriculum for a Four Year Undergraduate Degree (IS’90),” was released in October 1990. This draft was presented at ISECON (Information Systems Educational Conference) in Chicago, at the DSI (Decision Sciences Institute) meeting in San Diego, and at ICIS (International Conference for Information Systems) in Copenhagen. A final document was released in June 1991. IS’90 prompted considerable dialogue. A partial list of papers that discuss various aspects of IS education is found in the bibliography (Aggarwal and Rollier, 1994; Burn et al., 1994; Cale, 1994; Chow, Dick and Edmundson, 1994; Cohen, 1993, 1994; Daigle and Kemp, 1993, 1994; Daniels et al., 1992; Denison, 1993; Doran, Longenecker and Pardu, 1994; Granger and Schroeder, 1994; Haney, 1994; Klein, Stephens, and Bohannon, 1994; Lim, 1993; Longenecker, Feinstein, and Gorgone, 1994; Longenecker et al., 1996; Longenecker et al., 1997; Lorents and Neal, 1993; Mawhinney, Morrell, and Morris, 1994; McKinney, Agarwal, and Sanati, 1994; Pick and Schenk, 1993; Pick, Baty, and Phoenix, 1994; Sanati, McKinney, and Agarwal, 1994; Smith, 1994; Waguespack, 1994).

Characteristics of IS’97 Development

In February 1994, the initial meeting of a Joint Task Force for ACM, AIS, and DPMA collaboration on a model IS curriculum was held. At the meeting, the IS’90 body of IS knowledge was reviewed and updated. During subsequent meetings, curriculum presentation areas were described. Courses were also developed based on specific goals and objectives. Statements specifying the characteristics of graduates were reviewed and extended. Preliminary versions of the curriculum were presented in 1994 and 1995 at ISECON (Information Systems Educational Conference, Louisville), DSI (Decision Science Institute, Honolulu), IAIM (International Academy for Information Management, Las Vegas), ICIS (International Conference on Information Systems, Vancouver), and SIGCSE (Special Interest Group for Computer Science Education, Nashville).

The IS’97 materials were presented for review to 900 faculty, chairs, and distinguished IS professionals during the summer of 1995. The critique from the review process was used by the co-chairs in developing the edited version now called IS’97. The ACM Education Board members and DPMA management submitted significant suggestions for revision of IS’95. The upgraded materials were presented in 1995 at IACIS (International Association for Computer Information Systems), ISECON, DSI, and IAIM, and in 1996 at SIGCSE in Philadelphia.

IS’97 and its predecessor IS’90 differed from other approaches in several fundamental ways.

1. Development was based on a methodology that can be replicated as the knowledge base evolves.

2. Course content is determined in a functional manner rather than topically. For example, an integrated course in systems development replaces the necessity for separate courses in database, analysis, and design. These topics have always been strongly coupled and, therefore, can be taught together.

3. The depth of coverage of elements of the body of knowledge within the objectives is progressive. This allows all related topics to be covered in an integrated fashion with repetition and increasing depth until the required exit competence is achieved.

4. Measurable educational outcome objectives are identified and used uniformly throughout the methodology. Depth of knowledge is defined in a manner consistent with Bloom (1956). This allows for learning of the body of knowledge to a specified competence as well as continuous assessment and feedback (Argyris, 1976, 1977). Topics are revisited several times within the context of given goals of instruction (Gagne, Briggs, and Wager, 1988).

5. The learning units provide small units for curriculum design. They support tailoring of courses and are not as prescriptive as courses used in previous models. This allows

flexibility by individual academic units, yet with the ability to remain focused on overall objectives of the curriculum. This approach will help ensure the quality of graduates (Denning, 1992; Bemowski, 1991a, 1991b; Cherkasky, 1992).

IS 2002 Extensions

IS'97 experienced a wide degree of success. It became the initial basis for IS accreditation. Yet, the document was prepared largely in 1995, and was modified to keep it up-to-date until its publication in 1997. It was five years old at the time of the development of IS 2002. Survey research conducted by the co-chairs indicated that there was still a wide agreement of practitioners and academicians regarding the relevance of the spiral approach, the exit objectives, and most of the detailed learning objectives, but there was a clear need to update the model curriculum because of rapid contextual and technological change. The body of knowledge was expanded based on available materials from the ISCC'99 curriculum and from the EC Institute body of knowledge documents. The co-chairs added a new course in e-commerce, and made edits in the balance of the course descriptions to reflect current attitudes, surveyed skill elements, and feedback from six national presentations at AIS, ISECON, and IAIM to Information Systems faculty.

APPENDIX 2 — DETAILS OF THE DEVELOPMENT OF IS 2010

The joint AIS/ACM task force was launched in January of 2007, and it is submitting the final version of the curriculum recommendation for approval in November 2009. The co-chairs are Heikki Topi (Bentley University) and Joe Valacich (Washington State University). Other members of the committee include Kate Kaiser (Marquette University), Jay Nunamaker (University of Arizona), Janice Sipior (Villanova University), Gert-Jan de Vreede (University of Nebraska-Omaha), and Ryan Wright (University of San Francisco). This curriculum version is the first major revision since the IS '97 report (Davis et al. 1997), for which most of the work was done in the mid-1990s.

Past curriculum projects have been largely based on the work of a small task force that has shared its work at a variety of conferences and incorporated the feedback from the sessions to the model curriculum. In addition, written drafts have been shared widely and comments solicited. Also, surveys have been used to gather industry input. Typical processes are driven by a few individuals with little input from the academy as a whole. In an effort to create an open and transparent process that is open to the IS community as broadly as possible, the IS 2010 model curriculum committee used web-based collaboration technologies in addition to several traditional approaches described above to include and hopefully engage the global IS community.

As with previous curriculum projects, the IS 2010 task force has presented the development process at several conferences. In addition, we have published reports at different stages of the project. Further we have created a wiki to support collaboration and to make it easier for the community to give feedback during the curriculum revision process. The AIS email listserv was utilized several times to solicit feedback and direct users to the wiki Web site. Table A3.1 details the timeline for this effort.

Table A3.1: Details of the IS 2010 Task Force interactions with the community

Date	**Committee Interactions**	**Means**
August 2007	Initial proposal for IS 2010 process	AMCIS Panel
August 2007	Introduction of the IS Curriculum Wiki	ISWorld list
November 2007	Summary of the AMCIS 2007 panel and further developments	Communications of the AIS Volume 20
November 2007	Invitation to review the committee's progress on the IS Curriculum Wiki	ISWorld list
December 2007	IS 2010 status review	Panel at AIS SIG-ED IAIM 2007
June 2008	The role of IS 2010 as a global curriculum	Panel at ECIS 2008
August 2008	IS 2010 status review	Panel at AMCIS 2008
November 2008	Invitation to review the course descriptions	IS World list
December 2008	Summary of the AMCIS 2008 panel and further developments	Communications of the AIS Volume 23
December 2008	Current state of the IS 2010 project	Panel at IAIM SIG-ED (Special Interest Group on Education)
May 2009	Publication of the first comprehensive draft of IS 2010 and an invitation to review and comment	ISWorld list
September 2009	Publication of a revised draft and comprehensive responses to the community	IS curriculum wiki; ACM Ed Council, AIS Council
November 2009	Submission of the final version for approval to ACM and AIS	

APPENDIX 3 – DEPTH OF KNOWLEDGE METRICS AND RELATED PEDAGOGY

A key ingredient and accomplishment of IS'97 and IS 2002 was a competency or depth of knowledge metric with five levels (with four levels specified in the curriculum). This metric is based on but not identical to the work of Bloom (1956), which describes a six level metric. The metric makes it possible to communicate specifications and expectations.

Depth of Knowledge Metric

Table A3.1 is a summary of the depth of knowledge metric. Note that there are conceptually five levels for depth of knowledge but only the first four are used for an undergraduate program. The IS model curriculum levels differ from Bloom levels in that Bloom's level 1 is divided into IS curriculum levels 1 and 2, and Bloom levels 4, 5, and 6 are mapped to IS curriculum level 5.

The characteristics of the metric include

- the definition of the levels of knowledge,
- the behavior to be demonstrated by those who have completed the learning units of the curriculum,
- how goals and objectives are developed compatible with each knowledge level,
- how to determine the level of knowledge from previously defined goal and objective statements (reverse engineer knowledge levels from existing documentation),
- how material at a given level can be delivered to students, and
- how learning at given level can be assessed.

The template shown in column 3 of Table A3.1 was consulted when writing behavioral objective and goal statements for the IS 2010 courses; these statements allow authors and faculty to be more precise in communicating expectations for both students and teachers.

Identifying Expectations

The statements of characteristics of graduates contain "keywords" that can be detected using the template of the metric. For example, if the expectation is to "apply problem solving techniques in configuring a local area network," this is the equivalent of a level 4 objective. To a large extent, the knowledge levels specified within IS 2010 are compatible with the definitions of Table A3.1. The exit objectives of the goals and objectives have been checked and verified to assure consistency with the expectations of industry and academics.

Content Analysis of Statements of Expectation

The knowledge levels of IS 2010 are designed to give guidance to educators in planning as well as in the analysis of outcomes. Column 3 of Table A3.1 describes a template for writing objectives. This template was originally defined in IS'90 and has been expanded in the present context. The language used in writing behavioral objectives was derived from the Bloom taxonomy. The template may be used prescriptively in writing presentation goals and student performance objectives to ensure that the implied level of difficulty is presented. Likewise, given the objective, the student's behavior can be observed and compared with the objective statement to ensure that the students achieve the desired results of the presentation goal statements.

Learning Techniques for Different Levels

Learning techniques often differ for different levels. Level 1 knowledge in IS 2010 (awareness) is knowledge that is immediately apparent. Given an appropriate stimulus, it is knowledge that is recalled. IS 2010 level 2 knowledge (literacy) requires not only recognition, but recognition of the context of the knowledge; that is, the knowledge element and its parents and descendants should be familiar to the learner. Classroom activity or participative learning strategies are sufficient in transferring this level of knowledge, although level 2 activity can be enhanced in the lab. Although knowledge at levels 1 and 2 is relatively low, these levels should be mastered before higher levels can be achieved. It is the "revisiting" of previously presented and learned knowledge that is implied in the organization of learning units.

The more complex IS 2010 level 3 (usage/comprehension) requires considerable practice and creative repetition. Level 4 (application) requires unsupervised practice. Team work, project work, and other participative learning facilitate achieving these levels. Proper sequencing is an important factor in achieving student success. Project laboratories are ideal for this level of student activity. In fact, these laboratories are beneficial at all levels of instruction (Doran, Longenecker, and Pardu, 1994; Dutt, 1994). Some institutions have been successful with total participatory project environments (Holland College 1993).

The cooperative paradigm (Litchfield, 1996; Johnson, Johnson, and Houlubec, 1993) offers many advantages to learners, although it requires considerable change on the part of faculty. The cooperative paradigm greatly increases student motivation and better simulates the work environment in which graduates are expected to perform. The cooperative paradigm supports well the development of application level competencies.

IS'90,'94,'95, 2002, 2010 Depth of Knowledge	Bloom Levels of Knowledge	Template for Writing Behavioral Objectives Students completing ... will be able to	Meaning of Depth of Knowledge Level and Activities Associated with Attaining that Level
0 No Knowledge			
1 Awareness	1 Knowledge Recognition	Define ... List characteristics of ... Name components of ... Diagram ... List advantages/disadvantages of ...	Introductory Recall and Recognition Class presentations, discussion groups, reading, watching videos, structured laboratories. Involves only recognition, but with little ability to differentiate. Does not involve use.
2 Literacy Strong Knowledge	1 Differentiation in context	Compare and contrast ... Explain ... Write/execute simple ... Define functional capabilities that are ... Describe interrelations of ... to related objects	Knowledge of Framework and Contents, Differential Knowledge Continued lecture and participative discussion, reading, team work and projects, structured labs. Requires recognition knowledge as a prerequisite. Requires practice. Does not involve use.
3 Concept/Use Skill	2 Comprehension Translation/ Extrapolation Use of Knowledge	Use ... Communicate the idea of ... Form and relate the abstraction of ... as ... Given a set of ..., interpolate/extrapolate to ... List concepts/major steps in ...	Comprehension and Ability to Use Knowledge *when Asked/Prompted* Requires continued lab and project participation, presentation involving giving explanations and demonstrations, accepting criticism; may require developing skills in directed labs.
4 Detailed Understanding, Application Ability	3 Application Knowledge	Search for correct solution to ... and apply it to ... Design and implement a ... for ... Write syntactically correct ... and/or debug ... Apply the principles of ... to ... Implement a ... and maintain it	Selection of the Right Thing and Using It *without Hints* Semi-structured team-oriented labs where students generate their own solutions, make their own decisions, commit to and complete assignments, and present and explain solutions.
5 Advanced	4 Analysis 5 Synthesis 6 Evaluation	Develop/originate/institute ... Construct/adapt ... Generate novel solutions to ... Come up with new knowledge regarding ... Evaluate/judge the relative value of ... with respect to ...	Identification, Use and Evaluation of New Knowledge An advanced level of knowledge for those very capable of applying existing knowledge in which *denovo* solutions are found and utilized in solving and evaluating the proposed new knowledge.

Table A3.1. Knowledge Levels, Templates for Objective Writing, and Meaning of the Depth Levels with Associated Learning Activities

APPENDIX 4 — IS BODY OF KNOWLEDGE

Many significant aspects of an academic discipline are defined by its associated body of knowledge. In this version of the model curriculum, the Information Systems body of knowledge has been thoroughly re-architected to highlight the unique contributions that the discipline of Information Systems makes to computing, to benefit from the work that has been done in other computing disciplines, and to recognize the major role that various domain knowledge areas play in Information Systems.

This version of the Information Systems Body of Knowledge is based on a number of streams of work in computing.

1. It builds on and is closely associated with IS 2002/IS'97 and the body of knowledge presented in these documents. The current BoK is not, however, a direct extension of the prior versions.
2. The IS 2010 body of knowledge has significantly benefited from the work done in the context of the computing ontology project (see Cassel et al., 2008), which has brought together representatives from all computing disciplines to develop a comprehensive concept structure for the entire field.
3. In addition to the ontology project, IS 2010 also directly utilizes, as described above, \the work that has been done in other computing disciplines to specify their bodies of knowledge.
4. The body of knowledge was also strongly influenced by the new high-level undergraduate IS program learning objectives that were specified in this project and articulated in Section 10.

This version of the Information Systems Body of Knowledge is divided into four categories (See Figure A4.1):

1. General Computing Knowledge Areas, which are defined at a detailed level in the curriculum documents for the other computing disciplines (primarily CS 2008).
2. Information Systems Specific Knowledge Areas, which include the content to which IS contributes in a unique way that distinguishes it from other computing disciplines. Currently, it has been developed only for the core of the curriculum, as specified in Figure A4.2.
3. Foundational Knowledge Areas, primarily focusing on Leadership and Communication, and Individual and Organizational Knowledge Work capabilities. These are very important areas that form an essential part of the curriculum, but as discussed in Section 10, the foundational knowledge and skills are included in a number of different degree programs in different academic fields and therefore, not included as Information Systems Specific Knowledge Areas.
4. Domain-specific Knowledge Areas, describing the domain content required for a specific type of a Information Systems degree. As discussed earlier in this document, all Information Systems degree programs are associated with an application domain, but the domains and the relevant portions of their bodies of knowledge vary depending on the program.

General Computing Knowledge Areas (details from CS 2008)	
	Programming Fundamentals Algorithms and Complexity Architecture and Organization Operating Systems Net Centric Computing Programming Languages Graphics and Visual Computing Intelligent Systems
Information Systems Specific Knowledge Areas	
	IS Management and Leadership Data and Information Management Systems Analysis & Design IS Project Management Enterprise Architecture User Experience Professional Issues in Information Systems
Foundational Knowledge Areas	
	Leadership and Communication Individual and Organizational Knowledge Work Capabilities
Domain-related Knowledge Areas	
	General models of the domain Key specializations within the domain Evaluation of performance within the domain

Figure A4.1: Overview of the Information Systems Body of Knowledge

Information Systems Specific Knowledge Areas

- IS Management and Leadership
  - Information Systems Strategy
  - Information Systems Management
  - Information Systems Sourcing and Acquisition
  - Strategic Alignment
  - Impact of Information Systems on Organizational Structure and Processes
  - Information Systems Planning
  - Role of IT in Defining and Shaping Competition
  - Managing the Information Systems Function
  - Financing and Evaluating the Performance of Information Technology Investments and Operations
  - Acquiring Information Technology Resources and Capabilities
  - Using IT Governance Frameworks
  - IT Risk Management
  - Information Systems Economics
- Data and Information Management
  - Basic File Processing Concepts
  - Data Structures
  - Data Management Approaches
  - Database Management Systems
  - Data and Information Modeling at Conceptual and Logical Levels
  - Physical Database Implementation
  - Data Retrieval and Manipulation with Database Languages
  - Data Management and Transaction Processing
  - Distributed Databases
  - Business Intelligence and Decision Support
  - Security and Privacy
  - Policies and Compliance
  - Data Integrity and Quality
  - Data and Database Administration
- Systems Analysis & Design
  - Systems Analysis & Design Philosophies and Approaches
  - Business Process Design and Management
  - Analysis of Business Requirements
  - Analysis and Specification of System Requirements
  - Configuration and Change Management
  - Different Approaches to Implementing Information Systems
  - High-level System Design Issues
  - Identification of Opportunities for IT-enabled Organizational Change
  - Realization of IT-based Opportunities with Systems Development Projects
  - System Deployment and Implementation
  - System Verification and Validation
- IS Project Management
  - Project Management Fundamentals
  - Managing Project Teams
  - Managing Project Communication
  - Project Initiation and Planning
  - Project Execution & Control
  - Project Closure
  - Project Quality
  - Project Risk
  - Project Management Standards

Figure A4.2a: Information Systems Specific Knowledge Areas, Part I

Information Systems Specific Knowledge Areas -- continued

- Enterprise Architecture
  - Enterprise Architecture Frameworks
  - Component Architectures
  - Enterprise Application Service Delivery
  - Systems Integration
  - Content Management
  - Interorganizational Architectures
  - Processes for Developing Enterprise Architecture
  - Architecture Change Management
  - Implementing Enterprise Architecture
  - Enterprise Architecture and Management Controls
- User Experience
  - Usability Goals and Assessment
  - Design Processes
  - Design Theories and Tradeoffs
  - Interaction Styles
  - Interaction Devices
  - Information Search
  - Information Visualization
  - User Documentation and Online Help
  - Error Reporting and Recovery
- Professional Issues in Information Systems
  - Societal Context of Computing
  - Legal Issues
  - Ethical Issues
  - Intellectual Property
  - Privacy
  - IS as a Profession

Figure A4.2b: Information Systems Specific Knowledge Areas, Part II

APPENDIX 5 — REFERENCES FOR THE APPENDICES

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