IS 2002

Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems

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Association for Information Systems (AIS)
Association of Information Technology Professionals (AITP)

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FOREWORD

The IS 2002 report is the latest output from model curriculum work for information systems that began in the early 1970s and has matured over a thirty year period. The IS 2002 model curriculum is the first update of the curriculum effort of the ACM, AIS and AITP societies since IS'97. IS'97 has been widely accepted and has become 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 part of the Computing Curricula 2001 project (CC2001; Engel and Roberts, 2001), which is a joint undertaking of the Computer Society of the Institute for Electrical and Electronic Engineers (IEEE-CS) and the Association for Computing Machinery (ACM) to develop curriculum guidelines for undergraduate programs in computing. In addition to IS 2002, CC2001 consists of several volumes that contain curriculum recommendations for other computing disciplines, including computer science (completed, see www.acm.org/ sigcse/cc2001/), computer engineering, and software engineering. All of these reports are under the control of separate committees and will be published as they are completed.

All aspects of the computing field are facing rapid, continuous 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 and national 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 2.

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.

The editors of IS 2002 thank those who have helped in this project. 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 2002 is a model curriculum for undergraduate degree programs in Information Systems. It draws heavily on past efforts, primarily IS'97, and is the second collaborative effort by ACM, AIS, and AITP. Information Systems, as an academic field, encompasses two broad areas: (1) acquisition, deployment, and management of information technology resources and services (the information systems function); and (2) development and evolution of technology infrastructures and systems for use in organizational processes (systems development). This report provides the background material that led to the new and revised set of courses. It includes a mapping from the course structure of IS'97 to the new set. It also includes a detailed set of course descriptions and advice to the intended users of the report who have a stake in the achievement of quality IS degree programs.

The model curriculum is based on common structures and degree programs in the United States and Canada. Assumptions about student backgrounds and degree programs may not be applicable in other countries. The model, however, is grounded in a fundamental body of computing and information systems knowledge. It can, therefore, be employed as a reference model for international use. The curriculum represents a reasonable consensus of the IS community. The motivations for this revision include the explosive growth of the Internet, the increased computing literacy of entering students and the information systems accreditation movement.

Several characteristics of the IS profession have been relatively constant over time and have been integrated into the curriculum. These are:

1. IS professionals must have a broad business and real world perspective.
2. IS professionals must have strong analytical and critical thinking skills.
3. IS professionals must have interpersonal communication and team skills and have strong ethical principles.
4. IS professionals must design and implement information technology solutions that enhance organizational performance.

The curriculum update is based on surveys of appropriate mastery levels of the IS'97 elements and of key skill areas. Using this information a new course was added, IS 2002.2 – *Electronic Business Strategy, Architecture and Design*. Based on the improved computer literacy of entering students, two courses, IS'97.P0 – *Knowledge Work Software Tool Kit* and IS'97.2 – *Personal Productivity with IS Technology* were merged into a single course, IS 2002.P0 – *Personal Productivity with IS Technology*. All the other course names remain the same with the exception of IS'97.9 – *Physical Design and Implementation with a Programming Environment* which was changed to IS 2002.9 – *Physical Design and Implementation in Emerging Environments.* This was done to reflect the evolution in rapid application development and other programming environments.

The curriculum assumes that students have prerequisite skills in software packages commonly used in organizational work or that remedial modules will provide these skills. The information systems coursework available to students can be organized programmatically in three levels:

1. General courses in information systems suitable for all students regardless of their majors or minors.

2. Specialized information technology and application design courses for both majors and minors in information systems.
3. Specialized application development, deployment, and project management courses for majors in information systems.

The IS curriculum is designed to produce graduates equipped to function in entry level information systems positions with a strong basis for continued career growth. The curriculum reflects input from both industry and universities. It responds to industry requests for both increased emphasis in technical orientation and improved skill in individual and group interactions. The curriculum requires an embedded problem solving and critical thinking framework in all courses. The exit characteristics of information systems graduates are defined in the report. The curriculum has formal information systems courses but also assumes use of prerequisite or corequisite courses in communications, mathematics, and statistics, and business functions. The communications prerequisite courses should provide students with listening skills and the knowledge to be effective in written and oral communication. The mathematics and statistics prerequisites should provide basic quantitative and qualitative techniques. The business courses should cover common business functions, economics, and international considerations.

The architecture of the information systems curriculum at the highest level consists of five curriculum presentation areas: information systems fundamentals; information systems theory and practice; information technology; information systems development; and information systems deployment and management processes. The five presentation areas consist of ten courses and one prerequisite course. The courses are based on an updated body of knowledge and a set of learning units, both of which are derived from IS'97.

The structure and sequence of the ten courses permit completion of the curriculum in two years to fit within the constraints of business schools; however it is understood that non-business programs may wish to expand the time to completion. The curriculum gives course descriptions and resource recommendations for the IS degree program. The course descriptions include the catalog description, scope, topics, and discussion of how the course fits into the curriculum plan.

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USE OF THE IS 2002 CURRICULUM REPORT

The model Information Systems undergraduate 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 the information systems program
- accrediting boards
- information systems faculty
- non-information systems faculty in the school or college where the information systems program resides
- information systems practitioners
- information systems students

In this section, the uses of the report by these intended stakeholders are described and its value explained.

For Academic Executives to Whom the Information Systems Program Reports

The IS discipline is an essential part of business and government organizations. Information systems are complex systems requiring both technical and organizational expertise for design, development, and management. They affect not only operations but also competitive 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. 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 regional conditions, develop up-to-date instructional materials, and manage student projects and internships.

2. Physical Space Requirements

   Physical space requirements for the Information Systems program are similar to those of

engineering, biological and physical sciences. The facilities should include:

a. Laboratories equipped with computer workstations, network ports, high-speed Internet access and/or wireless capabilities.

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 industry. 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 the program that adequate technical support is provided.

For Academic Heads Responsible for the Information Systems Program

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. Industry has expressed a need for both increased emphasis in technical orientation and improved skill in individual and group interactions. Graduates need to be able to interact effectively with clients and to work effectively in teams. Students must have good written and oral communication skills. 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 elsewhere in the document.

For Accreditation Boards that Accredit Information Systems Programs

Accreditation of IS programs requires a widely accepted definition of the discipline and curriculum. This report, developed by the major professional societies in information systems, provides the basis for the curriculum criteria employed in IS accreditation.

For Information Systems Faculty

The curriculum recommendations are described with different levels of detail. Courses are defined at a high level with course descriptions. These include course title, catalog description, scope, topic list, and discussion.

Each course is described in the appendix in terms of learning units for the course. Each learning unit is explained by its goals and objectives. A separate web resource (www.is2002.org) links the learning units to the elements from the IS body of knowledge that fit the objectives. The IS body of knowledge was derived from industry and university survey responses. Each IS body of knowledge element for a course has a competency or depth of knowledge level for achievement in the course. This defines the depth of coverage for the topic in the course.

The learning goal, objectives, and body of knowledge elements with competency levels provide faculty members with details of the rationale supporting each course. They provide a basis for curriculum tailoring and curriculum experimentation. Each course represents a prescriptive grouping of learning units. However, this grouping is only one of several that may be appropriate. Given local conditions, faculty members may wish to modify the courses. With a modified set of courses, the set of learning units assists in evaluating completeness of topic coverage.

For Non-Information Systems Faculty

The use of information technology is pervasive in society. The ability 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 are capable users may have a comparative advantage in their employment. 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 2002 identifies prerequisite skills needed by all students in basic personal productivity software. Students in all majors should have a working knowledge of how to utilize software for word processing, Internet access, and electronic mail, spreadsheet processing, 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 2002 curriculum specifies some general courses to provide understanding and skill in information technology suitable for all students. There is a Fundamentals of Information Systems course and a course on Personal Productivity with IS Technology. For students who desire more depth, a course on Information Systems Theory and Practice is also offered. These courses establish a foundation for specialized courses related to functional area information systems. Such courses may be taught by functional area faculty, by Information Systems faculty, or by cooperative arrangements.

Students in functional areas may wish to have a minor in Information Systems. The IS 2002 curriculum defines a set of courses suitable for a minor. The courses include fundamental technologies for information systems and a systems analysis and logical design course.

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 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.

INFORMATION SYSTEMS MODEL CURRICULA

IS 2002 Model Curriculum and 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 curricula task groups 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 groups 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 aided model curriculum development.

IS 2002 is the second collaborative effort by ACM, AIS, and AITP. All three 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 science, information systems, and software engineering. AITP is a professional organization primarily composed of information systems practitioners that focuses on education and professional development of its members. AIS, established in 1994, is composed of faculty members in information systems. The partnership of ACM, AIS, and AITP, therefore, combines the breadth of pedagogical and curriculum interests of these organizations.

Although ACM, AIS, and AITP are worldwide organizations, IS 2002 does not represent a universal curriculum. The model curriculum for undergraduate degree programs in information systems is based on the typical degree structure in U.S. and Canadian universities. It does not seek to specify requirements for different educational systems around the world. The model curriculum can, however, serve as a useful reference for designers of information systems degree programs outside the USA and Canada.

The most recent undergraduate curriculum model, IS '97 (Davis et al., 1997; Couger 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. Members of the Joint Task Force presented drafts of IS '97 at numerous conferences from 1994 to 1996 and received significant feedback that substantially strengthened the report. Since much of the work for the 1997 model was actually completed between 1994 and 1995, it has been approximately seven years since the 1997 model curriculum was developed. Since 1997, the task force members have been collecting survey data to better understand how the model curriculum was being used.

The next sections present the principles guiding the curriculum revision and outlining the motivation for updating IS '97. This is followed by a review of guiding assumptions about the IS profession that helped to shape the curriculum design and evolution. The scope of the curriculum update is presented, so that programs transitioning from IS'97 to IS 2002 will better understand the model's evolution. Next, the report provides a description of Information Systems as a field of academic study. The relationship of the IS courses and programs is explained. Exit characteristics for graduates are outlined. This is followed by a brief presentation of the course architecture and intended course sequence. Finally, the report concludes by providing high-level course descriptions of the IS 2002 model curriculum and appendices for reference.

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 IS community.

2. The model curriculum should be designed to help IS faculty produce competent and confident entry level graduates well suited to work-place responsibilities.

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

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

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

MOTIVATION FOR THE CURRICULUM UPDATE OF IS'97

Since the last revision of the undergraduate curriculum guidelines, three major factors have spurred the need to reexamine and update the existing standard. These were the advent of the Internet, the changes in student computing literacy, and the information accreditation movement. This section reviews each of these motivating factors.

Internet

As discussed previously, much of the work in developing IS '97 occurred prior to 1995. During the writing of IS'97 the utility of Web and Internet programming was not yet foreseen, with

limited references to thin-client programming concepts, Internet protocols and applications, and other relevant content. Although it was known that the impact of these then novel concepts could be large, it was at the time unrealized. In the intervening years, the Internet has grown to become a major aspect of all IS environments.

Changes in Student Computing Literacy

Over the past decade, there has been a significant change in the basic computer literacy of incoming university students. In the past, very few students entered a university having significant skills in using a desktop computer, with even fewer students owning or having easy access to a computer. Today, with the advent of the Internet and low cost PCs, most students entering a university have at least a modest level of computer literacy.

Information Systems Accreditation Movement

There has been interest in the accreditation of programs in Information Systems since the accreditation of programs in Computer Science was begun in the mid 1980s. The work on IS'97, with its support from the major IS professional societies provided a catalyst for IS accreditation. With the support of the National Science Foundation, the Criteria for the Accreditation of Programs in Information Systems have been developed with IS'97 serving as the basis of the IS curriculum criteria. ABET is the agency with responsibility for accrediting all programs in computing, engineering, and technology (Gorgone and Lidtke, 2002). The Computing Accreditation Commission (CAC) has responsibility for accrediting computer science and information systems programs. The first pilot visit was completed during Fall 2001.

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 must have a broad business and real world perspective. Students must therefore understand that:
   - IS are enablers of successful performance in organizations
   - IS span and integrate all organizational levels and business functions
   - IS are increasingly of strategic significance because of the scope of the organizational systems involved and the role systems play in enabling organizational strategy
2. IS professionals must have strong analytical and critical thinking skills. 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

3. IS professionals must exhibit strong ethical principles and have good interpersonal communication and team skills. Students must understand that:
   - IS require the application of professional codes of conduct
   - IS require collaboration as well as successful individual effort
   - IS design and management demand excellent communication skills (oral, written, and listening)
   - IS require 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
   - Be fluent in techniques for acquiring, converting, transmitting, and storing data and information
   - Focus on the application of information technology in helping individuals, groups, and organizations achieve their goals

SCOPE OF THE CURRICULUM UPDATE

A survey of computing faculty in the United States was conducted to obtain data on two areas related to the curriculum update. The first was to determine their current view of the appropriate depth of mastery for each of the elements in the IS'97 body of knowledge. The second was to gather similar information for key skill areas identified within IS'97. Some of the observations of this research have been published (Longenecker et al., 2000; Landry et al., 2000). The primary conclusions are summarized as:

1. IS analysts have specific skills at approximately IS'97 skill depth level 3 (the ability to *USE* knowledge) in areas of Interpersonal and Team Skills, Business Knowledge, Organizational Process Development (including IS Systems Analysis and Design), Project Management, Database, Software Development, Web Programming, and Systems Integration.
2. Skills identified in IS'97 as Exit Curriculum Areas match expectations of the computing industry as well as IS faculty.
3. Skill areas produced by programs of Information Technology match expectation of Information Systems faculty.
4. The model courses of IS'97 are acceptable to both IS and IT faculty. Interestingly, both CS and SE faculty also feel IS'97 courses are relevant.

When analyzing survey data and IS'97 curricula in summer of 2001, the missing element in the curriculum was found to be a course on Internet-based commerce. At most universities, this course has been a popular required or elective course for several years, and so, there was a clear discrepancy between the existing model curriculum and what was being operationalized. Thus, a new course was added to the model curriculum to address this limitation, IS 2002.2 – *Electronic Business Strategy, Architecture and Design*. Without restructuring other aspects of the model curriculum, the addition of a new Internet-based commerce course to the model curriculum would result in a curriculum of eleven required courses. There was a desire by the committee to limit the model curriculum to a target of ten courses, or 30 semester units, which therefore would result in the elimination of one of the existing IS'97 courses. This decision was driven by recently

approved accreditation standards and by the practical credit hour constraints of many IS programs.

IS'97 had a prerequisite course, IS'97.P0 – *Knowledge Work Software Tool Kit*, that assumed students had elementary exposure to a suite of software tools useful for knowledge workers (spreadsheets, databases, presentation graphics, database retrieval, statistics, word processing, and electronic mail). It was also assumed that students could gain this knowledge through a formal course or through self-study modules. Beyond this course, IS'97 had a required course, IS'97.2 – *Personal Productivity with IS Technology*, that focused on improving student skills in using packaged software, in both individual and group work, by designing and developing solutions. Given the need to limit the IS 2002 curriculum to ten courses and the rapid and significant improvement in the general computing literacy of entering students, IS'97.P0 and IS'97.2 were merged into a single prerequisite course, IS 2002.P0 – *Personal Productivity with IS Technology*.

Beyond the addition of the Internet-based commerce course, IS 2002.2, and the merging of IS97.P0 and IS'97.2 into a single prerequisite course (or self-study modules), the remaining courses were retained with appropriate updating of the course "Scope" and "Topic" descriptions. In most cases, this resulted in the addition of Internet-centric content and more contemporary terminology and concepts. Course names remained unchanged except for IS'97.9 – *Physical Design and Implementation with a Programming Environment* that was changed to IS 2002.9 – *Physical Design and Implementation in Emerging Environments*. This change was motivated by the continual evolution in rapid application development and programming environments. A mapping of courses and a summary of the changes is represented in Table 1.

Table 1. Mapping Of IS 2002 Courses To IS'97 Courses

IS 2002 Courses		IS'97 Courses
IS 2002.P0 – Personal Productivity with IS Technology	← MERGING ←	IS'97.P0 – Knowledge Work Software Tool Kit IS'97.2 – Personal Productivity with IS Technology
IS 2002.1 – Fundamentals of Information Systems	← UPDATE	IS'97.1 – Fundamentals of Information Systems
IS 2002.2 – Electronic Business Strategy, Architecture and Design		**NO EXISTING COURSE**
IS 2002.3 – Information Systems Theory and Practice	← UPDATE	IS'97.3 – Information Systems Theory and Practice
IS 2002.4 – Information Technology Hardware and Systems Software	← UPDATE	IS'97.4 – Information Technology Hardware and Systems Software
IS 2002.5 – Programming, Data, File and Object Structures	← UPDATE	IS'97.5 – Programming, Data, File and Object Structures
IS 2002.6 – Networks and Telecommunication	← UPDATE	IS'97.6 – Networks and Telecommunication
IS 2002.7 – Analysis and Logical Design	← UPDATE	IS'97.7 – Analysis and Logical Design
IS 2002.8 – Physical Design and Implementation with DBMS	← UPDATE	IS'97.8 – Physical Design and Implementation with DBMS
IS 2002.9 – Physical Design and Implementation in Emerging Environments	← UPDATE	IS'97.9 – Physical Design and Implementation with a Programming Environment
IS 2002.10 – Project Management and Practice	← UPDATE	IS'97.10 – Project Management and Practice

INFORMATION SYSTEMS AS A FIELD OF ACADEMIC STUDY

Computer-based information systems have become a critical part of the products, services, operations, and management of organizations. The effective and efficient use of information and communications technologies is an important element in 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 (Mawhinney, Morrell, and Morris, 1994; Trauth, Farwell, and Lee, 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 communications technology to operational processes, decision support, and competitive 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 30 year period 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 following terms represent a sampling of names associated with the academic discipline of Information Systems:

Information Systems
Management Information Systems
Computer Information Systems
Information Management
Business Information Systems
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, and management of information technology resources and services (the information systems function) and (2) development, operation, and evolution of infrastructure and systems for use in organizational processes (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 business 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 (accounting, finance, marketing, operations, human resources, and so forth). They must understand concepts and processes for achieving organizational goals with information technology. The academic content of an information systems degree program therefore includes information technology, information systems management, information systems development and implementation, organizational functions, and concepts and processes of organizational management.

RELATIONSHIP BETWEEN THE INFORMATION SYSTEMS CORE COURSES, THE MINOR, AND THE MAJOR

Prerequisite Computer Use 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, Internet 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. 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: A survey course provides all students an introduction to the purposes, uses, and value of information systems and information resources in organizations. It introduces concepts and methods by which systems are designed and implemented. The technologies and processes for providing information and communications resources are explained. The opportunities for users to employ these resources are illustrated. Students can build on their prerequisite knowledge to investigate useful concepts, functions, and capabilities usually 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. Knowledge at this level is necessary for further work in Information 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 approaches are utilized.

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

IS Majors: An IS major consists of the entire model curriculum. Students proficient at this level are prepared to enter a career in the IS field.

PRE- AND COREQUISITES TO AN INFORMATION SYSTEMS DEGREE PROGRAM

There are general academic requirements that should be met prior to formal Information Systems courses (prerequisites) or concurrent with IS courses (corequisites). Students are expected, as a prerequisite, to have a basic proficiency in the fundamental tools of personal computing such as e-mail, Web browsing, spreadsheets, word processing, desktop database management systems, presentation graphics, and external database retrieval tools.

All Information Systems students should be able to communicate effectively both orally and in writing. They should be able to apply both quantitative and qualitative data analysis techniques. IS graduates should have acquired strong interpersonal skills. They should have a basic understanding of the main functional areas of an organization and should have been exposed to concepts of international business. Some of the topics should be prerequisites but others may be interleaved with Information Systems courses.

Prerequisite or interleaved topics directly applicable to the IS curriculum therefore include:

- Communication. This should cover general and technical writing, oral communications, presentations, and listening skills.

- Quantitative and qualitative analysis. This includes such topics as discrete mathematics, introduction to calculus, introductory statistics, and archival document analysis.

- Functional areas of an organization. Students should be exposed to the principles of economics and functional areas of the organization such as accounting, finance, human resources, marketing, logistics, and operations. They should also be introduced to special issues in international business.

Finally, as a basis for lifetime learning, students should also have a solid foundation in behavioral, social, and natural sciences.

EXIT CHARACTERISTICS OF INFORMATION SYSTEMS GRADUATES

The graduate of an IS program should be equipped to function in an entry level position and should have a basis for continued career growth (Lee, Trauth, and Farwell, 1995; Landry et al., 2000). Figure 1 presents a high-level categorization of the exit characteristics that emphasizes the central role of Technology-Enabled Business Development at the intersection of the four major areas that were identified in the initial assumptions about the IS profession. Table 2 divides the main categories further into subcategories and presents concrete, practical representative examples of the exit characteristics in each subcategory. The overarching objective for IS professionals is to enable organizations to utilize computer and communications and related information technology to achieve their strategic objectives with a customer service orientation.

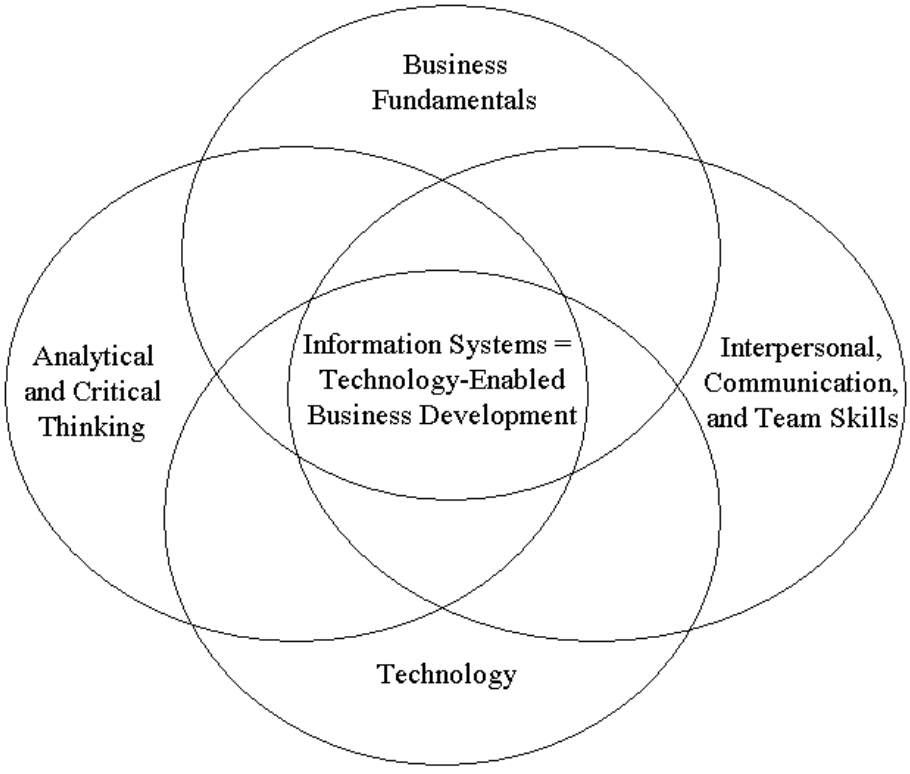


Figure 1. High-Level Categorization of IS Graduate Exit Characteristics

Table 2. Representative Capabilities and Knowledge Expected for IS Program Graduates

ANALYTICAL AND CRITICAL THINKING		
Organizational Problem Solving	**Ethics and Professionalism**	**Creativity**
Problem solving models, techniques, and approaches Personal decision making Critical thinking Methods to collect, summarize, and interpret data Statistical and mathematical methods	Codes of conduct Ethical theory Leadership Legal and regulatory standards Professionalism - self directed, leadership, time management Professionalism - commitment to and completion of work	Creativity concepts Creativity techniques The systems approach
BUSINESS FUNDAMENTALS		
Business Models	**Functional Business Areas**	**Evaluation of Business Performance**
Contemporary and emerging business models Organizational theory, structure, and functions System concepts and theories	Accounting Finance Marketing Human Resources Logistics and Manufacturing	Benchmarking Value chain and value network analysis Quality, effectiveness, and efficiency Valuation of organizations Evaluation of investment performance
INTERPERSONAL, COMMUNICATION, AND TEAM SKILLS		
Interpersonal	**Team Work and Leadership**	**Communication**
Listening Encouraging Motivating Operating in a global, culturally diverse environment	Building a team Trusting and empowering Encouraging Developing and communicating a vision/mission Setting and tracking team goals Negotiating and facilitating Team decision making Operating in a virtual team environment Being an effective leader	Listening, observing, interviewing, and documenting Abstraction and precise writing Developing multimedia content Writing memos, reports, and documentation Giving effective presentations

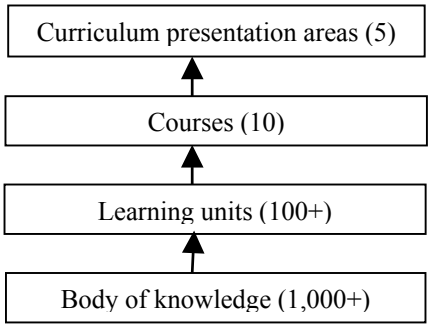
TECHNOLOGY			
Application Development	**Internet Systems Architecture and Development**	**Database Design and Administration**	**Systems Infrastructure and Integration**
Programming-principles, objects, algorithms, modules, testing Application development – requirements, spec's, development Algorithmic design, data, object, and file structures Client-server software development	Web page development Web architecture design and development Design and development of multi-tiered architectures	Modeling and design, construction, schema tools, and DB Systems Triggers, stored procedures, design and development of audit controls Administration: security, safety, backup, repairs, and replicating	Computer systems hardware Networking (LAN/WAN) and telecommunications LAN/WAN design and management Systems software Operating systems management Systems configuration, operation, and administration

INFORMATION SYSTEMS = TECHNOLOGY-ENABLED BUSINESS DEVELOPMENT		
Systems Analysis and Design, Business Process Design, Systems Implementation, IS Project Management		
Strategic utilization of information technology and systems IS planning IT and organizational systems	Systems analysis Logical and physical design Design execution Testing	Deployment Maintenance Use of IT Customer service

ARCHITECTURE OF THE INFORMATION SYSTEMS CURRICULUM

The IS 2002 curriculum is organized at the highest level as a set of curriculum presentation areas. Each of these areas has one or more courses. Each course should be built from learning units. The learning units, described in detail in IS'97 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems and updated continuously on the web site www.is2002.org, should focus on presentation goals that blend elements of the IS body of knowledge. Learning unit objectives provide a mechanism to assess student performance.

Each of the elements will be explained in this section starting with the curriculum presentation areas.



Curriculum Presentation Areas

A view of the curriculum depicting the IS curriculum presentation areas is given in Figure 2. The dotted box on the top shows the prerequisite knowledge to the presentation areas whereas the dotted box on the upper right highlights the part of the program taught by faculty in other functional areas or other academic units. The other five boxes show the part of the program generally taught by the IS faculty. The figure also depicts the general sequence in which the material is acquired by students in the IS program. A description of the content for the five areas is presented in Table 3.

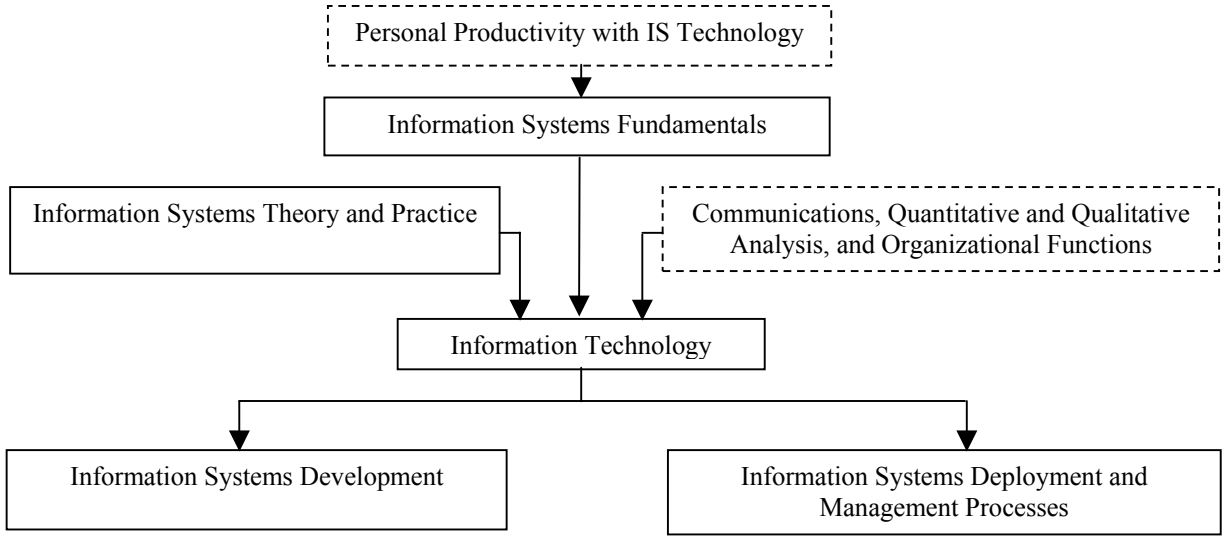


Figure 2. Curriculum Presentation Areas for IS Curriculum

Curriculum Presentation Area	Description
Information Systems Fundamentals	Information systems fundamentals include a broad introduction to the field of Information Systems and information technology plus instruction designed to improve personal productivity in an organization through effective and efficient use of information technology.
Information Systems Theory and Practice	Students will be introduced to concepts and theories that explain or motivate methods and practices in the development and use of information systems in organizations. The concepts and theories will include systems, management, and organization, information, quality, and decision making. The relationship of information systems to corporate planning and strategy and concepts relating information technology to comparative advantage and productivity are explained. The concepts and practices underlying the use of information technology and systems in improving organizational performance are presented.
Information Technology	Students will gain breadth and depth in the technical aspects of the discipline. Computing system architectures, operating systems software, and interconnection of information resources through networking are major components of presentation and discussion. Students will be expected to develop significant skills by participating in installation, configuration, and operation of the technologies.
Information Systems Development	Students will work in teams to analyze problems and design and implement information systems. Systems analysis provides experience determining system requirements and developing a logical design. Instruction in physical design of information systems will ensure that the students can use a logical design to implement information systems in both a DBMS and in emerging development environments. Students should be exposed to a variety of development approaches.
Information Systems Deployment and Management	Students engage in numerous projects. Management of the information systems function, systems integration, and project management to ensure project quality are integral components of this curriculum area.

Table 3. Content for Five IS Curriculum Presentation Areas

Courses

Courses in IS 2002 are the building blocks that implement the broad curriculum presentation areas diagramed in Figure 2. The courses are labeled IS 2002.P0 through IS 2002.10. Figure 3 shows the course architecture and sequence of courses within IS 2002, including the prerequisite course IS 2002.P0. The structure is a suggested architecture and sequence with the appreciation that each university's situation is somewhat unique. In any event, this architecture allows the entire program to be completed within a scope of two years. This model will therefore fit within the broader curricula constraints of most business schools. For IS programs housed outside business, great flexibility in the sequence can be employed.

IS 2002.P0 is considered to be a prerequisite to the program. The IS 2002 curriculum assumes that students have a prerequisite knowledge of desktop computing with an elementary exposure to a suite of software applications useful for knowledge workers such as word processing, spreadsheets, e-mail, and Internet browsing. In addition, students are assumed to also have knowledge and skill of IS technology to be a successful knowledge worker as described in the prerequisite course IS 2002.PO – *Personal Productivity with IS Technology*. Courses are described later in the report with course title, scope, and topics. Courses are based on a three-credit semester calendar. The set of courses represents a complete model that includes all of the learning units. As a model, they are presented to provide guidance. Institutions may develop their own courses based on learning units to accommodate unique individual missions. Figure 4 presents the courses categorized based on the target groups, and Figure 5 maps them to the curriculum presentation areas.

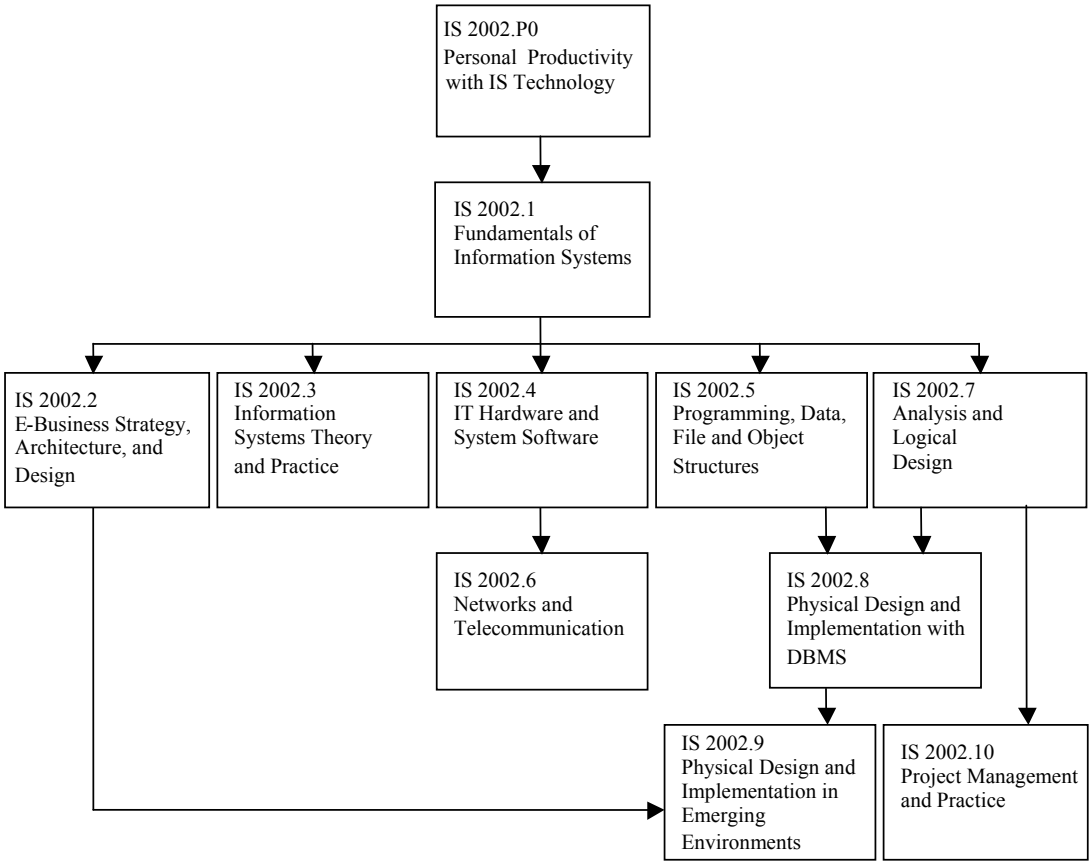


Figure 3. IS 2002 Representative Course Sequence

Student Groups	Curriculum Model
All Students	IS 2002.P0Personal Productivity with IS Technology IS 2002.1 Fundamentals of Information Systems
IS Majors and Minors	IS 2002.2 Electronic Business Strategy, Architecture and Design IS 2002.4 Information Technology Hardware and Software IS 2002.5 Programming, Data, File and Object Structures IS 2002.7 Analysis and Logical Design
IS Majors	IS 2002.3 Information Systems Theory and Practice IS 2002.6 Networks and Telecommunication IS 2002.8 Physical Design and Implementation with a DBMS IS 2002.9 Physical Design and Implementation in Emerging Environments IS 2002.10 Project Management and Practice

Figure 4. Representative IS 2002 Curriculum Design for All Students, IS Minors, and IS Majors

P. Prerequisite
IS 2002.P0 Personal Productivity with IS Technology

A. Information Systems Fundamentals
IS 2002.1 Fundamentals of Information Systems
IS 2002.2 Electronic Business Strategy, Architecture and Design

B. Information Systems Theory and Practice
IS 2002.3 Information Systems Theory and Practice

C. Information Technology
IS 2002.4 Information Technology Hardware and Software
IS 2002.5 Programming, Data, File and Object Structures
IS 2002.6 Networks and Telecommunications

D. Information Systems Development
IS 2002.7 Analysis and Logical Design
IS 2002.8 Physical Design and Implementation with DBMS
IS 2002.9 Physical Design and Implementation in Emerging Environments

E. Information Systems Deployment and Management Processes
IS 2002.10 Project Management and Practice

Figure 5. IS Curriculum Presentation Areas and Courses

Learning Units

A learning unit describes a set of material to be learned by students. A course is a group of learning units. Each learning unit is stated in terms of a goal, a set of objectives, and elements of the IS body of knowledge along with competency or depth of knowledge levels.

The material to be covered by a learning unit is expressed in a presentation goal. The learning

unit is designed to combine elements from the IS body of knowledge. Competency levels are specified for each included element from the body of knowledge. A sequence of behavioral objectives is provided within each learning unit. These objectives are written to describe a specific competency level. The objectives form the basis for assessment of student accomplishment.

Each learning unit is specified by a goal statement that explains the purpose of the learning unit. For example, a learning unit goal might be "to present top-down implementation strategies." The learning unit goal statement is elaborated by one or more learning unit objectives. These are stated as behavioral objectives defining what a student should be able to do after learning the material in the unit. The student should be able to explain, discuss, use, apply, and demonstrate central concepts. For example, a behavioral objective for a learning unit might be "apply system software functions to analyze resource use and performance characteristics for an application." The learning objectives can be used by faculty to assess student achievement relative to the learning unit or by students in evaluating their knowledge.

Each learning unit has a set of topics that define the coverage for the unit. These topics consist of elements from the IS body of knowledge. The depth of coverage for each topic in a learning unit is specified by a depth of knowledge level ranging from 1 to 5 (with 4 being the highest competency level specified for an undergraduate program). A topic may be covered at a low depth of knowledge level as part of an introductory course and in more depth (higher competency) in a subsequent course. The sequencing of learning units is based on instructional design methodology derived from Gagne, Briggs, and Wager (1988).

The learning units provide the basis for detailed course design. The objective is to present elements of the IS body of knowledge to willing learners through pedagogical techniques associated with desired levels of learning. The pedagogy differs for desired depth of knowledge levels. A low level of competency may be achieved with lectures and exercises; the highest level of knowledge is achieved by active learning techniques such as projects.

Body of Knowledge

The IS body of knowledge consists of the topics to be taught at some level of competency in an IS curriculum. The IS 2002 body of knowledge is a reorganization and extension of the IS'97 body of knowledge. The body of knowledge was derived from surveys of practitioners and academics and mapping of relevant topics from curricula for Computer Science and other computer related disciplines.

The elements or topics in the IS body of knowledge form the lowest level building blocks for the curriculum. The elements, with desired competency levels, are grouped under learning units and learning units are grouped into courses. The body of knowledge units are described at a detailed level at www.is2002.org.

RESOURCES FOR IS DEGREE PROGRAMS

A capable faculty is the first required resource. In addition, computing, laboratory, classroom, and library resources are essential elements for a successful academic program in Information Systems (Gorgone and McGregor, 1989). 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. 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 member. 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. These resources normally involve a blend of computer facilities of varying capabilities and complexity. This should include the most current networking and computing technologies.

Faculty and student majors will have their own systems, many with notebook computers. 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 are 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.

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.

In addition to software and hardware, it is paramount to the success of the program that adequate technical support must 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

Programs in Information 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.

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.

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 is 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.

IS 2002 COURSE SPECIFICATIONS

In this section, we provide high-level course descriptions for IS 2002 including the ten courses within the Model Curriculum and one prerequisite. 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.

IS 2002.P0 – Personal Productivity with IS Technology (Prerequisite: elementary knowledge of word processing, spreadsheets, e-mail, and Web browsing)

CATALOG: Students with minimal skills will learn to enhance their personal productivity and problem solving skills by applying information technologies to problem situations and by designing and using small information systems for individuals and groups.

SCOPE: This prerequisite course enables students to improve their skills as knowledge workers. The emphasis is on personal productivity concepts using functions and features in computer software such as spreadsheets, databases, presentation graphics, and Web authoring. Although identified as a course, this material can be delivered as self-study modules, as modules associated with other courses using the software, or as a full course.

TOPICS: Knowledge work productivity concepts; advanced software functionality to support personal and group productivity such as templates and macros; reuse rather than build from scratch; organization and management of data (sorting, filtering) via spreadsheets and database tools; accessing organizational and external data; information search strategies; tool use optimization and personalization; professional document design; Web page design and publishing; effective presentation design and delivery.

DISCUSSION: Students who have prerequisite end-user knowledge work skills will have an opportunity to extend their basic problem solving skills by undertaking, completing, and using a sequence of more extensive "personal systems." The course has both a theoretical problem solving component and an equivalent component of structured supervised laboratory experience. The knowledge work tool set as well as local and wide area network telecommunications are the context for the problem domain.

IS 2002.1 – Fundamentals of Information Systems (Prerequisite: IS 2002.P0)

CATALOG: Systems theory, quality, decision making, and the organizational role of information systems are introduced. Information technology including computing and telecommunications systems are stressed. Concepts of organizations, information systems growth, and process improvement are introduced.

SCOPE: This course provides an introduction to systems and development concepts, information technology, and application software. It explains how information is used in organizations and how IT enables improvement in quality, timeliness, and competitive advantage.

TOPICS: Systems concepts; system components and relationships; cost/value and quality of information; competitive advantage of information; specification, design, and re-engineering of information systems; application versus system software; package software solutions; procedural versus non-procedural programming languages; object oriented design; database features, functions, and architecture; networks and telecommunication systems and applications; characteristics of IS professionals and IS career paths; information security, crime, and ethics. Practical exercises may include developing macros, designing and implementing user interfaces and reports; developing a solution using database software.

DISCUSSION: 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 and telecommunications systems will be examined. Standard systems purpose and organization will be introduced.

The concept that information is of significance in stating and attaining organizational goals will be used as the basis for exploring the development of databases to store information. Information systems will be introduced to process and communicate the information. 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.

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.

IS 2002.2 – Electronic Business Strategy, Architecture and Design (Prerequisite: IS 2002.1)

CATALOG: The course focuses on the linkage between organizational strategy and networked information technologies to implement a rich variety of business models in the national and global contexts connecting individuals, businesses, governments, and other organizations to each other. The course provides an introduction to e-business strategy and the development and architecture of e-business solutions and their components.

SCOPE: This course examines the linkage of organizational strategy and electronic methods of delivering products, services and exchanges in inter-organizational, national, and global environments. Information technology strategy and technological solutions for enabling effective business processes within and between organizations in a global environment are considered.

TOPICS: Electronic commerce economics, business models, value chain analysis, technology architectures for electronic business, supply chain management, consumer behavior within electronic environments, legal and ethical issues, information privacy and security, transborder data flows, information accuracy and error handling, disaster planning and recovery, solution planning, implementation and rollout, site design, Internet standards and methods, design of solutions for the Internet, intranets, and extranets, EDI, payment systems, support for inbound and outbound logistics.

DISCUSSION: A course in electronic business has during the recent years become an integral part of the Information Systems curriculum. The proliferation of Internet technologies has had a profound impact on the way business is conducted both in for-profit and not-for-profit organizations. It is essential that an IS curriculum prepares graduates to function in environments where the integration of computing and communication technologies is reshaping organizations and their fundamental processes, regardless of their industry.

This course integrates various perspectives. First, it is essential to provide a good understanding of the changes in the business environment enabled by modern information and communication technologies. Thus, the course should discuss topics such as new business models, the economics of e-business, and value chains and value networks. In addition, it is essential that the students have a strong understanding of the operational issues that are critical to every successful e-business solution, such as marketing, logistics, and payment methods using the electronic tools.

Second, the students need to understand how e-business systems are linked to the organizational environment and how they affect and are affected by the context in which they are built. Therefore, the course needs to cover the legal and ethical aspects of the design and development of e-business solutions, special challenges related to global e-business systems (e.g., transborder data flows, differences in privacy legislations, operating in a multicurrency environment), and the societal effects of the widespread usage of e-business technologies.

Third, the course should provide the students with an introduction to the technical architecture and the detailed technology solutions that are required to implement reliable and efficient e-business solutions. This includes infrastructure (computing hardware and software, networking hardware and software, support, disaster recovery), development methods and technologies specific to the e-business environments, web interface development, and e-business solution deployment.

IS 2002.3 – Information Systems Theory and Practice (Prerequisite: IS 2002.1)

CATALOG: Students who have constructed personal information systems will be exposed to the theory of the Information Systems discipline. Application of these theories to the success of organizations and to the roles of management, users, and IS professionals are presented.

SCOPE: This course provides an understanding of organizational systems, planning, and decision process, and how information is used for decision support in organizations. It covers quality and decision theory, information theory, and practice essential for providing viable information to the organization. It outlines the concepts of IS for competitive advantage, data as a resource, IS and IT planning and implementation, change, and project management.

TOPICS: Systems theory and concepts; information systems and organizational system; decision support; quality; level of systems: strategic, tactical, and operational; system components and relationships; information systems strategies; roles of information and information technology; roles of people using, developing, and managing systems; IS planning and change management; human-computer interface; IS development process; evaluation of system performance; societal and ethical issues related to information systems design and use.

DISCUSSION: Students having end-user skills who have implemented personal productivity systems using personal productivity work tools will be prepared to use the information systems theory presented in this course.

The course presents the basic concepts for use in subsequent courses: the systems point of view, the organization and development of a system, information flows, the nature of information systems, and basic techniques for representing systems structure.

Learning, goal setting and achieving, decision making, and other characteristics of individuals, groups, and teams are explored. Organizational models and planning are presented. Quality concepts are explained. IS planning and development activities are explored in the organizational context of management and users. Cross-functional management and user teams are discussed.

IS 2002.4 – Information Technology Hardware and System Software (Prerequisite: IS 2002.1)

CATALOG: Principles and application of computer hardware and software will be presented through lecture of the theoretical underpinnings, installation, configuration, and operational laboratory experiences.

SCOPE: This course provides the hardware/software technology background to enable systems development personnel to understand tradeoffs in computer architecture for effective use in a business environment. System architecture for networked computing systems and operating systems will be covered.

TOPICS: Hardware: CPU architecture, memory, registers, addressing modes, busses, instruction sets, multi processors versus single processors; peripheral devices: hard disks and other storage devices, video display monitors, device controllers, input/output; operating systems functions and types; operating system modules: processes, process management, memory and file system management; examples and contrasts of hardware architectures and operating systems.

DISCUSSION: Students who are knowledgeable of and have developed personal information systems will gain an in-depth exposure to information technology hardware and software components and their interaction.

A systems view of computer systems will be utilized in identification of computer system components. Peripheral devices will be identified and principles of operation will be studied and learned. The operating system software, including I/O drivers and extensions to the operating system will be examined, learned and utilized in the laboratory.

Organization of the operating system will be studied to understand how concurrent processes, scheduling, memory management, and I/O are accomplished. The flow of information in the operating system in relation to the computer and to application software will be considered.

Standards, standard organizations and resulting hardware and software consequences will be identified and studied. General principles will be expressed.

IS 2002.5 – Programming, Data, File and Object Structures (Prerequisite: IS 2002.1)

CATALOG: This course presents object oriented and procedural software engineering methodologies in data definition and measurement, abstract data type construction and use in developing screen editors, reports and other IS applications using data structures including indexed files.

SCOPE: This course provides an exposure to algorithm development, programming, computer concepts, and the design and application of data and file structures. It includes the use of logical and physical structures for both programs and data.

TOPICS: Data structures and representation: characters, records, and files; precision of data; information representation, organization, and storage; algorithm development; programming control structures; program correctness, verification, and validation; file structures and representation. Programming in traditional and visual development environments that incorporate event-driven, object-oriented design.

DISCUSSION: Students will gain in-depth understanding of defining and measuring events that produce data, both simple and complex, and principles, concepts, and practices of successful software development.

Formal problem solving strategies will be presented. Program design methods and strategies including top down implementation will be discussed and implemented. Graphic programming environments will be explored. Capabilities

of a number of programming languages will be presented. Skills will be developed in at least one language supporting an indexed file system.

Software engineering principles will be practiced with a systems view. Students will learn to recognize objects and abstract data types, concepts of event driven and data flow models, module identification, modularity including parameters, module naming, cohesion, coupling desired and erroneous practices, and testing. Verification and validation methods will be presented and practiced by generating small modules and larger programs.

Specific data structures including arrays, records, stacks, queues, and trees will be created and used. The course will provide an introduction to the use of predefined user interface components.

IS 2002.6 – Networks and Telecommunication (Prerequisite: IS 2002.4)

CATALOG: Students will gain in-depth experience of networking and telecommunications fundamentals including LANs, MANs, WANs, intranets, the Internet, and the WWW. Data communication and telecommunication concepts, models, standards, and protocols will be studied. Installation, configuration, systems integration and management of infrastructure technologies will be practiced in the laboratory.

SCOPE: This course provides an in-depth knowledge of data communications and networking requirements including networking and telecommunications technologies, hardware, and software. Emphasis is upon the analysis and design of networking applications in organizations. Management of telecommunications networks, cost-benefit analysis, and evaluation of connectivity options are covered. Students learn to evaluate, select, and implement different communication options within an organization.

TOPICS: Telecommunication configurations; network and Web applications; distributed systems; wired and wireless architectures, topologies, and protocols; installation, configuration, and operation of bridges, routers, switches, and gateways; network performance tuning; privacy, security, firewalls, reliability; installation and configuration of networks; monitoring and management of networks; and communications standards.

DISCUSSION: Students who have used networking technologies to complete assignments in previous courses and who are knowledgeable of the significance of information technology in facilitating information systems will be given an opportunity in this course to gain considerable depth in networking, both theoretically and through practical laboratory experience.

Students will learn about some of the significant networking standards and the organizations that have developed the standards. The ISO seven-layer OSI model and the TCP/IP model will be used as organizing frameworks. The ITU and IEEE standards will be reviewed and global telecommunication policies and competing standards will be examined.

The technology supporting communications providers, satellite communications, as well as local and metropolitan systems will be explored. Devices including media, modems, multiplexers, computer interfaces, switches, and routers will be studied.

Acquisition, installation, configuration, and other details of management of the various technologies will be studied.

IS 2002.7 – Analysis and Logical Design (Prerequisite: IS 2002.1)

CATALOG: Students with information technology skills will learn to analyze and design information systems. Students will practice project management during team oriented analysis and design of a departmental level system.

SCOPE: This course examines the system development and modification process. It emphasizes the factors for effective communication and integration with users and user systems. It encourages interpersonal skill development with clients, users, team members, and others associated with development, operation, and maintenance of the system. Structured and object oriented analysis and design, use of modeling tools, adherence to methodological life cycle and project management standards.

TOPICS: Life cycle phases: requirements determination, logical design, physical design, and implementation planning; interpersonal skills, interviewing, presentation skills; group dynamics; risk and feasibility analysis; group-based approaches: project management, joint application development (JAD), and structured walkthroughs; structured versus object oriented methodologies; RAD, prototyping; database design; software package evaluation, acquisition, and integration; global and inter-organizational issues and system integration; professional code of ethics.

DISCUSSION: Students with the basic skills of information technology will learn to gather information in order to identify problems to be solved. They will determine system requirements and a logical design for an information system. A project of limited scope will be designed during this course.

Students will investigate alternative solutions, and will determine feasibility of solutions. They will identify value added by the completion of the system.

Students will be exposed to methods to support each stage of the development process. While automated tools are not a substitute for understanding of the processes involved, they may be used to ensure that a particular methodology is used rigorously. If manual methods are used, it is important to define the methodology thoroughly.

Project management will be taught and used to control the team project. Team concepts including personal and interpersonal skills will be discussed and monitored. Empowerment concepts will be used and measured. Scheduling and completing individual and group actions will be used to ensure project milestone completion.

IS 2002.8 – Physical Design and Implementation with DBMS (Prerequisite: IS 2002.5 and IS 2002.7)

CATALOG: Students successfully completing the analysis and logical design course will continue in this course to learn to develop the detailed physical design and implementation of a logical design.

SCOPE: This course covers information systems design and implementation within a database management system environment. Students will demonstrate their mastery of the design process acquired in earlier courses by designing and constructing a physical system using database software to implement the logical design.

TOPICS: Conceptual, logical, and physical data models, and modeling tools; structured and object design approaches; models for databases: relational and object oriented; design tools; data dictionaries, repositories, warehousing, and data mining; database implementation including user interface and reports; multi-tier planning and implementation; data conversion and post implementation review.

DISCUSSION: Students who have completed the information analysis and logical design course will engage in the physical design and implementation process for an information system of a limited scope.

Automated tools or manual methods will be used within a team oriented project environment to design and implement a departmental information system requiring an enterprise level database.

A data model will be developed to guide the detailed design process for database construction.

A corresponding functional analysis of the problem will be completed. Program specifications will be developed and utilized in construction of the physical system. Unit testing, integration, and integration testing of the final system will be accomplished. Tools will be used to measure the complexity of solutions; quality assurance measures implemented as project standards will be used to control project quality and risk.

Code generators or libraries will be used to facilitate rapid development of the desired system. Existing project management software will be used to manage user expectations and completed work.

IS 2002.9 – Physical Design and Implementation in Emerging Environments (Prerequisites: IS 2002.2 and IS 2002.8)

CATALOG: Students who have completed the analysis and logical design course will extend their knowledge by implementing an information system in an emerging systems environment. Teams will use project management principles to implement an information system.

SCOPE: This course covers physical design and implementation of information systems applications. Implementation in emerging distributed computing environments using traditional and contemporary development methodologies.

TOPICS: Topics may include selection of development environments and standards; structured, event driven, and object oriented application design; testing; software quality assurance; system implementation; user training; system delivery; post implementation review; configuration management; maintenance; multi-tiered architectures and client independent design.

DISCUSSION: Students will utilize a contemporary development environment to implement a project that spans the scope of the previous courses. If object-oriented programming has not been taught to the students earlier in the curriculum, then it should be used here. If only object-oriented methods have been used, some procedural methods should be employed.

System or object representation, modular design, use of control structures with proof of correctness, verification, testing and validation should be integral components of software quality assurance. Implementation standards should be developed by the students and used rigorously as project teams complete a significant system. A conversion and training plan should be developed and implemented involving hardware, data, people, and software systems.

Project management tools should be used to ensure timely completion of the project. Interdependence skills should be practiced and evaluated. A contemporary methodology should guide the project sequence.

IS 2002.10 – Project Management and Practice (Prerequisite: IS 2002.7)

CATALOG: Advanced IS majors operating as a high-performance team will engage in and complete the design and implementation of a significant information system. Project management, management of the IS function, and systems integration will be components of the project experience.

SCOPE: This course covers the factors necessary for successful management of information systems development or enhancement projects. Both technical and behavioral aspects of project management are applied within the context of an information systems development project.

TOPICS: Managing the system life cycle: requirements determination, design, implementation; system and database integration issues; network management; project tracking, metrics, and system performance evaluation; managing expectations of managers, clients, team members, and others; determining skill requirements and staffing; cost-effectiveness analysis; reporting and presentation techniques; management of behavioral and technical aspects of the project; change management. Software tools for project tracking and monitoring. Team collaboration techniques and tools.

DISCUSSION: This is the capstone course for IS majors who have completed the systems analysis and design sequences. It focuses on engaging in and completing a major system development project.

Within the project context management of IS, systems integration is an explicit requirement for students to address.

The project is a team effort and allows a final opportunity to practice personal and interdependence skills to ensure team member empowerment and success. Project management tools will be employed by the team to ensure tracking of the project and communication of project goals and accomplishments to the client.

Automated development tools may or may not be used depending on available resources. However, standards will be developed for all project deliverables. Software quality assurance methodologies will be employed to ensure a successful outcome for the project.

On-going presentation of project planning, analysis, design, conversion plan, and other documentation will be done by the team. Each team member should play a significant role in some aspect of presentation.

REFERENCES

Couger, J. Daniel, Gordon B. Davis, Dorothy G. Dologite, David L. Feinstein, John T. Gorgone, A. Milton Jenkins, George M. Kasper, Joyce C. Little, Herbert E. Longenecker, Jr., and Joseph S. Valacich. 1995. "IS'95: Guideline for Undergraduate IS Curriculum", *MIS Quarterly,* Vol. 19 No. 3, pp. 341-359.

Couger, J. Daniel, Gordon B. Davis, David L. Feinstein, John T. Gorgone, and Herbert E. Longenecker, Jr. 1997. "IS'.97: Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems, *Data Base,* Vol. 26 No. 1, pp. I-94.

Davis, G. B., J. T. Gorgone, J. D. Couger, D.L. Feinstein, and H.E. Longenecker, Jr. 1997. "IS '97 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems," ACM, New York, NY and AITP (formerly DPMA), Park Ridge, IL.

Engel, Gerald and Eric Roberts (Eds). 2001. *Computing Curricula 2001 – Computer Science*. IEEE Computer Society and Association for Computing Machinery. http://www.computer.org/education/cc2001/final/cc2001.pdf (accessed Oct 24, 2002).

Gagne, Robert M., Leslie J. Briggs and Walter W. Wager. 1988. *Principles of Instructional Design*, Third Edition. New York: Holt, Rinehart, and Winston.

Gorgone, John T., J. Daniel Couger, Gordon B. Davis, David L. Feinstein, George Kasper, and Herbert E. Longenecker. 1994. "Information Systems '95," *Data Base,* Vol. 25, No. 4, pp. 5-8.

Gorgone, John T. and D. Lidtke. 2002. The IS criteria can be found at www.abet.org.

Gorgone, John T. and John D. McGregor. 1989. "Computing Sciences Accreditation: A Cooperative Effort in CIS." *Computer Science Education*, Vol. 1, No. 2, pp. 99-110.

Landry, Jeffrey P., Herbert E. Longenecker, Jr., Brandon Haigood, and David L. Feinstein. 2000. "Comparing Entry-Level Skill Depths Across Information Systems Job Types: Perceptions of IS Faculty," *Proceedings of Sixth Americas Conference on Information Systems*, Long Beach, CA.

Lee, Denis M. S., Eileen M. Trauth, and Douglas Farwell. 1995. "Critical Skills and Knowledge Requirements of Professionals: A Joint Academic/Industry Investigation." *MIS Quarterly*, September 1995, Vol. 19, No. 3, pp. 313-340.

Longenecker, Herbert E., Jr., Jon D. Clark, J. Daniel Couger, David L. Feinstein, John T. Clark. 1994. "Development of IS'95: A Joint Activity of DPMA, ACM, ICIS, AIS," *ISECON'94*, p. 1.

Longenecker, Herbert E. Jr., David L. Feinstein, Brandon Haigood, and Jeffrey P. Landry. 2000. "IS'2000: On Updating the IS'97 Model Curriculum for Undergraduate Programs of Information Systems," *Journal of Information Systems Education*, Vol. 10, No. 2.

Mawhinney, Charles H., Joseph S. Morrell, and Gerard J. Morris. 1994. "The IS Curriculum: Closing the Gap," *ISECON'94 Proceedings*, pp. 249-256.

Trauth, Eileen M., D. W. Farwell, and D. Lee. 1993. "The IS Expectation Gap: Industry Expectations versus Academic Preparation." *MIS Quarterly* Vol. 17, No. 3, pp. 293-307.

APPENDIX 1 — INTRODUCTION TO APPENDIX MATERIAL

Information Systems 2002 (IS 2002) is a model curriculum for a bachelor's degree in Information Systems (IS). It is based on an update of the IS'97 model curriculum. The grounds for the update are based on nationally presented results of survey research performed by the co-chairs. The materials are designed for faculty who need a significant level of details to organize and design courses and write course materials.

IS'97 was the result of the collaborative work of a Joint Task Force of the Association for Computing Machinery (ACM), the Association for Information Systems (AIS), and the Association of Information Technology Professionals (AITP). The Appendix presents detailed materials from the work of the IS'97 task force and IS 2002 updates.

Appendix	Title	Overview
2	Background of IS Curricula and Related Disciplines	Computing curricula were first developed in the late 1960s in Computer Science (CS). The need for Information Systems (IS) curricula was identified in 1970s (Ashenhurst, 1972; Couger, 1973), and the curricula were developed over the next decade. Since the late 1970s, both the ACM and DPMA have supported the development of model curricula for Information Systems. This Appendix provides a chronology of significant events in these developments and the relationship between IS and other disciplines.
3	Details of the Development of IS 2002	This section provides a brief overview of the IS 2002 development process.
4	Depth of Knowledge Metric and Related Pedagogy	A cognitive behavioral metric is presented for specifying and evaluating depth of knowledge. The specification includes a numeric depth indicator and appropriate language to describe presentation goals and resultant behavior expected of students completing specific parts of the curriculum.
5	IS Body of Knowledge	An overview of the IS body of knowledge is presented. The full Body of Knowledge is in the form of a four level outline hierarchy. This appendix discusses the first two levels. It is based on previous efforts of DPMA and ACM (Longenecker and Feinstein, 1991a, 1991b, 1991c; Ashenhurst, 1972; Couger, 1973; Nunamaker, Couger, and Davis, 1982; ACM, 1983; DPMA, 1981, 1986). The IS 2002 body of knowledge contains the Computer Science and Engineering body of knowledge (Turner and Tucker, 1991), results from a study of SEI documents, elements obtained from a review of the ISCC'99 curriculum, and from a study of the EC Institute body of knowledge.
6	IS 2002 Learning Unit Goals	This appendix includes the learning unit goals for the learning units linked to each of the courses. A complete set of learning unit objectives and associated elements of the IS body of knowledge are available at http://www.is2002.org.

APPENDIX 2 — 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). A recent version includes a very significant re-development and is called Computing Curricula 2001, Computer Science Volume (Engel and Roberts, 2001).

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. Key events are listed in Figure A2.1.

Figure A2.1 – Key Chronology of IS Curriculum Events

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
April, 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; Daigle and Kemp, 1993, 1994; Daniels et al., 1992; Denison, 1993; Doran, Longenecker and Pardu, 1994; Cohen, 1993, 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 has experienced a wide degree of success. It has become the 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 is five years old at the time of the development of IS 2002. Survey research conducted by the co-chairs indicates that there is still a wide agreement of practitioners and academicians as to 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 has been expanded based on available materials from the ISCC'99 curriculum and from the EC Institute body of knowledge documents. The co-chairs have added a new course in E-Commerce, and have 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 3 — DETAILS OF THE DEVELOPMENT OF IS 2002

IS 2002 is a minor revision of IS'97. As such it is largely based on the IS'97 materials. It includes the results of several years of research presented at national meetings. It contains a rewrite performed by the co-chairs with content assistance from meeting participants and others cited within the document. There have been no major structural revisions. The research effort supporting changes made to the courses, body of knowledge, and learning units was presented at ISECON, IAIM, and AIS. In addition, the body of knowledge was updated based on the ISCC'99 curriculum, and from the EC Institute body of knowledge. The details of the IS'97 development process are described in Davis et al. (1997) and will not be repeated here.

APPENDIX 4 – DEPTH OF KNOWLEDGE METRICS AND RELATED PEDAGOGY

A key ingredient in IS 2002 is 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 A4.1 is a summary of the depth of knowledge metric. Note that there are conceptually five levels for depth of knowledge in IS'97 but only the first four are used for an undergraduate program. The IS 2002 levels differ from Bloom levels in that Bloom's level 1 is divided into IS 2002 levels 1 and 2 and Bloom levels 4, 5, and 6 are mapped to IS 2002 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 Joint IS'97 Curriculum Task Force and the IS 2002 co-chairs used the taxonomy of knowledge description adopted by IS'90 (Longenecker and Feinstein, 1991c; Longenecker et al., 1994) summarized above. The IS 2002 co-chairs used the template shown in column 3 for use in writing behavioral objective and goal statements; 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. The knowledge levels specified within IS 2002 are compatible with the definitions of Table A4.1. 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 2002 are designed to give guidance to educators in planning as well as in the analysis of outcomes. Column 3 of Table A4.1 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 2002 (awareness) is knowledge that is immediately apparent. Given an appropriate stimulus, it is knowledge that is recalled. IS 2002 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 2002 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,'97 2002 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 A4.1. Knowledge Levels, Templates for Objective Writing, and Meaning of the Depth Levels with Associated Learning Activities

APPENDIX 5 — IS BODY OF KNOWLEDGE

A specific discipline may be defined by its associated body of knowledge. The Information Systems body of knowledge consists of three major subject areas:

1.0 Information Technology
2.0 Organizational and Management Concepts
3.0 Theory and Development of Systems

Each subject area contains major topics and each major topic contains subtopics, which are the lowest level curriculum elements of the body of knowledge. A fourth level with more detail for third level elements is useful in describing curriculum content.

Sources Used in Defining the Body of Knowledge

Each of these subject areas represents specific domains of knowledge. The entire body of knowledge consists of more than a thousand elements in a four level hierarchy (Nunamaker, Couger, and Davis, 1982; DPMA, 1981,1986; Longenecker and Feinstein, 1991c; Longenecker, Feinstein et al., 1994). Adding the fourth level made it possible to include the more than 100 elements from the CS knowledge body by Turner and Tucker (1991) and the 120 elements from the software engineering body of knowledge. Elements of the software engineering body of knowledge were explicitly derived from analysis of curriculum content contained in reports on software engineering education developed by the Software Engineering Institute (Ford, 1990, 1991), and were based on the observations of Glass (1992), other reports from the SEI (Berry, 1992; Ford, Gibbs, and Tomayko, 1987; Ford and Ardis, 1989; Ford, 1994; Gibbs and Ford, 1986; Shaw, 1986, 1990; SEI, 1991; Tomayko and Shaw, 1991), and other efforts (BCS, 1989; Ford and Gibbs, 1989; Freeman, 1987; Gibbs, 1989; Leventhal and Mynatt, 1987; NSF, 1993; Parnas, 1990; Wasserman, 1976).

Two Level View of the Body of Knowledge

Table A5.1 shows a two level hierarchy of the body of knowledge. The three major subject areas are broken into subareas. While Table A5.1 shows only two levels, the complete body of knowledge available at the URL http://www.is2002.org contains the expansion to four levels. As reported in IS'97 (Davis et al., 1997), earlier surveys suggest that there is a substantial agreement between industry expectations and the depth standard set by IS academics.

Body of Information Systems Knowledge

1.0 Information Technology
- 1.1 Computer Architectures
- 1.2 Algorithms and Data Structures
- 1.3 Programming Languages
- 1.4 Operating Systems
- 1.5 Telecommunications
- 1.6 Database
- 1.7 Artificial Intelligence

2.0 Organizational and Management Concepts
- 2.1 General Organization Theory
- 2.2 Information Systems Management
- 2.3 Decision Theory
- 2.4 Organizational Behavior
- 2.7 Managing the Process of Change
- 2.8 Legal and Ethical Aspects of IS
- 2.9 Professionalism
- 2.10 Interpersonal Skills

3.0 Theory and Development of Systems
- 3.1 Systems and Information Concepts
- 3.2 Approaches to Systems Development
- 3.3 Systems Development Concepts and Methodologies
- 3.4 Systems Development Tools and Techniques
- 3.5 Application Planning
- 3.6 Risk Management
- 3.7 Project Management
- 3.8 Information and Business Analysis
- 3.9 Information Systems Design
- 3.10 Systems Implementation and Testing Strategies
- 3.11 Systems Operation and Maintenance
- 3.12 Systems Development for Specific Types of Information Systems

Table A5.1. IS 2002 Body of Knowledge Presented as a Two Level Hierarchy
(See www.is2002.org for the complete structure. Categories 2.5 and 2.6 are intentionally missing to maintain numbering consistency between curriculum versions.)

APPENDIX 6 — IS 2002 COURSE LEARNING UNIT GOALS

Appendix 6 contains detailed descriptions of the IS 2002 course learning unit goals.

IS 2002.P0 – Personal Productivity with IS Technology (Prerequisite: elementary knowledge of word processing, spreadsheets, e-mail, and Web browsing)

Learning Unit Number	Learning Unit Goal
1	to introduce systems and information technology definitions and concepts to novice users
2	to develop skill to effectively use standard knowledge work software packages (operating system and user interface, word processing, spreadsheet, database, statistics, and data management, presentation graphics, and communications)
3	to introduce the concepts of problem solving within the context of information systems of limited complexity using standard knowledge work software packages
4	to introduce the relevance and application of information technology in society
13.1	to describe the concept of knowledge work and the need for personal information technology to support it
13.2	to relate individual vs. organizational information system requirements
13.3	to introduce concepts of individual vs. collaborative knowledge work and relate them to information needs analysis and technology
13.4	to describe and explain the goals and process of analysis, and documentation of knowledge work, information technology, and information requirements for individuals and work groups
13.5	to define concepts, principles, and practical approaches to management of individual software and data
13.6	to explain organizational database concepts, components, structures, access, security, and management considerations
13.7	to define the content, availability, and strategies to access information external to the organization
13.8	to present and explain the life cycle of development of an information system including the concepts of software acquisition vs. development
13.9	to introduce and explore the use of general purpose and application software
13.10	to introduce and explore software development approaches, then explain the goals and strategies of procedural, event driven, and object oriented programming paradigms
13.11	to introduce and develop the process of algorithm and structured code development
13.12	to introduce the purpose and develop ability to use a relational database software package
13.13	to introduce and develop ability to design and implement a graphical user interface facility
13.14	to present the prototype process, and to introduce and apply the concepts of evaluation and evolutionary refinement to personal application prototypes
13.15	to present foundation technologies and define importance in future information technology capabilities
13.16	to identify, investigate, analyze, design, and develop with packages (and/or high level languages) a single personal level information system applications to enhance individual productivity
15.17	to define concepts of an individual information management infrastructure, and to apply strategies and tools for implementing, accessing, and using information resources

IS 2002.1 – Fundamentals of Information Systems (Prerequisite: IS 2002.P0)

Learning Unit Number	Learning Unit Goal
5	to introduce systems and quality concepts
6	to provide an introduction to the organizational uses of information to improve overall quality
7	to present hardware, software, and related information technology concepts
8	to provide concepts and skills for the specification and design or the re-engineering of organizationally related systems of limited scope using information technology
9	to show how information technology can be used to design, facilitate, and communicate organizational goals and objectives

10	to explain the concepts of individual decision making, goal setting, trustworthiness, and empowerment
11	to show career paths in Information Systems
12	to present and discuss the professional and ethical responsibilities of the IS practitioner

IS 2002.2 – Electronic Business Strategy, Architecture and Design (Prerequisite: IS 2002.1)

Learning Unit Number	Learning Unit Goal
200	to present organizational value and supply chain concepts, and distinguishing characteristics of traditional versus evolving organizations utilizing internet technologies
201	to present and distinguish between types of e-commerce business relationship types including B2B, B2C, B2G, C2C, C2G, G2G
202	to present and explain value and supply chain concepts and examples with respect to evolving e-commerce business relationships
203	to present consumer issues that are frequently solved in e-commerce systems including shopping carts, human computer interface designs, interactions with payment processing mechanisms, and relationships to information technology development and support
204	to present concepts and specific examples of e-commerce functionality found in common business relationships
205	to present and explain ethical, contractual, and regulatory issues involving domestic and trans-border interactions involving interorganizational business relationships
206	to present, discuss, and explain hardware and software system components commonly utilized in implementation of inter-organizational systems
207	to present, develop, explore, and illustrate the nature and use of IS development methodologies in an interorganizational setting, and to discuss responsibilities at all life cycle stages
208	to explain and consider the obligations for protection of individual privacy as well as organizational security in interorganizational systems

IS 2002.3 – Information Systems Theory and Practice (Prerequisite: IS 2002.1)

Learning Unit Number	Learning Unit Goal
16	to introduce, discuss, and describe fundamental concepts of IS theory and their importance to practitioners
17	to show how an information system is a strategic and integral component of an organization
18	to discuss how an information system is developed and managed within an organization
19	to present and discuss the relevance of the cognitive process and human interactions in information system design and implementation
20	to discuss how individuals make decisions and set and achieve goals
21	to discuss the Simon Model of organizational decision making and its support by IS
22	to introduce systems theory, quality, and organizational modeling and demonstrate their relevance to information systems
23	to discuss a systems based role for management, users, and designers
24	to explain physical systems and work flow and how information systems relate to organizational systems
25	to present other organizational models and their relevance to IS
26	to discuss the relationship of IS planning to organizational planning
27	to demonstrate specific classes of application systems including TPS and DSS
28	to discuss and examine the process, standards, and policies for development of information systems: development methodologies, life cycle, workflow, OOA, prototyping, spiral, end-user, and other approaches

29	to discuss outsourcing and alternate implementations of the IS function
30	to discuss performance evaluation consistent with quality management and continuous improvement
31	to introduce the societal implications of IS and related ethical issues to introduce and explore ethical concepts and issues relating to personal and professional behavior to introduce, compare, and contrast ethical models and approaches to explore ethical and social analysis skills to consider the nature and existence of power
119	to discuss and explain ethical and legal principles and issues; to discuss and explain ethical considerations of information systems development, planning, implementation, usage, sales, distribution, operation, and maintenance
123	to investigate issues relative to managing the information systems function

IS 2002.4 – Information Technology Hardware and System Software (Prerequisite: IS 2002.1)

Learning Unit Number	Learning Unit Goal
62	to explain in systems terms the fundamental characteristics and components of computer and telecommunications hardware, and system software, and demonstrate how these components interact
63	to provide an overview of peripheral devices and their function
64	to introduce the concepts of computer hardware architectures
65	to introduce the concepts of system software components and interactions
67	to introduce the major concepts in operating systems, including process definition, concurrent processing, memory management, scheduling, interrupt processing, security, and file systems
68	to introduce a variety of operating environments (traditional, GUI, multimedia) and resource requirements
69	to discuss, explain, and install multimedia facilities
70	to introduce the requirements for interoperability and systems integration
71	to install, configure, and operate a multi-user operating system

IS 2002.5 – Programming, Data, File and Object Structures (Prerequisite: IS 2002.1)

Learning Unit Number	Learning Unit Goal
2	to present the concept that data is a representation and measurement of real-world events
43	to show and explain the logical and physical structure of data to represent characters, records, files, and multimedia objects
44	to explain the concepts of classes, abstract data types (ADT), and objects
45	to explain and illustrate with IS examples of formal synthetic and analytic problem solving
46	to present a systems view of object representations and compare with data flow models
47	to develop skills in developing an algorithmic solution to a problem and be able to represent it with appropriate program and data objects
48	to present top-down implementation strategies
49	to present object implementation concepts
50	to present modular design, cohesion, and coupling concepts
51	to present a systems view of verification and validation
52	to present and expose students to a variety of programming environments, development tools, and graphics development environments

53	to introduce the concepts and techniques used to represent and operate on data and file structures, with simple examples
54	to explain how to develop structures using abstract data types representing arrays, lists, trees, records, and files, and demonstrate how they are applied as components of programs and applications
55	to present and use index file structures, including key organizations
56	to explain a variety of fundamental structures that are building blocks for the development of programs and IS applications
57	to provide the foundations for applications of data structures and file processing techniques
58	to present and ensure problem solving involving files and database representations
59	to present and develop useful structured file (database) editors, posting mechanisms, and reports (simple, control break)
60	to continue the development of programming techniques, particularly in the design, testing, and debugging of IS related programs of some complexity
61	to develop an awareness of the relative capabilities and limitations of most common programming languages

IS 2002.6 – Networks and Telecommunication (Prerequisite: IS 2002.4)

Learning Unit Number	Learning Unit Goal
32	to develop awareness and associated terminology of the different objects, media, and devices necessary for telecommunications, including local (LAN) and wide area (WAN) networks
33	to develop an awareness of how telecommunication systems are used to support organizational communication infrastructure including information systems, teleconferencing, and telecommuting.
34	to explore the issues related to the economics, design, and management of computer networks
35	to familiarize the student with the telecommunication standards and with regulatory organizations and their standards
36	to discuss and explain underlying principles and issues of distributed versus centralized computer systems
37	to present architectures, topologies, and protocols of telecommunications
38	to present the hardware and software components of telecommunications systems and how they are organized to provide required services
39	to provide awareness of the responsibilities inherent in providing telecommunication services, including security, privacy, reliability, and performance
40	to explain how to install equipment necessary to implement a telecommunication system, e.g. cable, modems, Ethernet connections, gateways, and routers
41	to explain how to design, install, configure, and manage a LAN
124	to discuss issues pertinent to the management and transfer of emerging technologies

IS 2002.7 – Analysis and Logical Design (Prerequisite: IS 2002.1)

Learning Unit Number	Learning Unit Goal
72	to present necessary concepts to provide the skills necessary to do the analysis, modeling, and definition of information systems problems
73	to give students exposure to using commercial program products to implement information

	systems
74	to show how to collect and structure information in the development of requirements and specifications
75	to show how to develop a logical design, and develop and analyze alternatives involving implementation using packages, tailoring of packages, constructing software, or CASE tools
76	to develop a functional understanding of rapid prototyping and other similar alternative mechanisms for rapid development of information systems
77	to show how to assess risks and feasibility
78	to show students how to analyze organizational systems to determine how the systems might be improved
79	to develop skills for effective interpersonal communication to develop consensus using classical techniques as well as computer facilitated groupware
80	to demonstrate and analyze small group dynamics as related to working with users
81	to develop application skills for implementing databases and applications by operating and testing these databases
82	to present and use complexity metrics to assess developed solutions
83	to develop quality metrics for assessment of software development and project control of software development
84	to develop quality metrics for assessment of customer satisfaction at all phases of the life cycle
85	to explain the use of a professional code of ethics to evaluate specific IS actions

IS 2002.8 – Physical Design and Implementation with DBMS (Prerequisite: IS 2002.5 and IS 2002.7)

Learning Unit Number	Learning Unit Goal
86	to discuss the importance of finding synergistic solutions with team and clients
87	to show how to develop agreements describing work to be done, and to commit, rigorously complete and self-evaluate agreed work
88	to develop skills in data modeling of databases
89	to develop awareness of the syntactical and theoretical differences between database models
90	to develop skills in application of database systems development and retrieval facilities needed to facilitate creation of information system applications
91	to develop skills in application and structuring of database management systems
92	to develop skills in application and physical implementation of database systems, using a programming environment
93	to develop skills in the use of a combination of code generators and language facilities to implement multi-user departmental or simple enterprise level systems
94	to provide an opportunity to develop and use project management, project standards, and a system implementation plan, and to implement a documentation plan
95	to show how to design a conceptual data model and logical database model, convert the logical database designs to physical designs, develop the physical database, and generate test data
96	to provide opportunity to develop functional specifications for an information system, develop a detailed information system design, and develop information system application controls
97	to show how to develop a conversion and installation plan, develop a hardware systems and environmental plan
98	to show how to develop detailed program specifications, develop programs, set up system test parameters, install, and test the new system, implement the conversion plan, employ configuration management
99	to show how to develop a physical work-flow plan with a client
117	to show how to present a system design, test plan, implementation plan, and evaluation, in written and oral form
127	to discuss performance evaluation consistent with quality management and continuous

	improvement

IS 2002.9 – Physical Design and Implementation in Emerging Environments (Prerequisites: IS 2002.2 and IS 2002.8)

Learning Unit Number	Learning Unit Goal
100	to develop skills in analysis, design, and development of application software using a programming environment
101	to identify differences between a structured, event-driven, and object-oriented application design and explain the implications of these approaches to the design and development process
103	to be able to develop program tests and system tests
104	to understand the different programming environments available for business application development
112	to develop a functional understanding of proactive principled behavior and time management
113	to ensure attitudes necessary for successful team behavior including empathetic listening, consensus negotiation, conflict resolution, and synergistic solution finding, and to apply the concept of commitment and rigorous completion
114	to ensure goal setting and alignment of team activities with project obligations
115	to describe interactions with higher levels of management in selling project objectives and performing project management tasks
116	to describe and explain life cycle concepts, and apply them to the course project
118	to discuss and apply the concept of life-long learning
120	to present and explain the evolving leadership role of information management in organizations

IS 2002.10 – Project Management and Practice (Prerequisite: IS 2002.7)

Learning Unit Number	Learning Unit Goal
105	to ensure skills needed to design a project development and implementation plan
106	to further develop and practice essential project management skills
107	to develop skill in use of project management tools and methods within the context of an information systems project
108	to select the proper project management tools and demonstrate their use
109	to initiate, design, implement, and discuss project close down
110	to determine and analyze a significant problem using the systems approach to problem solving
111	to develop requirements and specifications for multi-user information system based on a database
121	to present and explain the evolving leadership role of information management in organizations
122	to examine the process for development of information systems policies, procedures, and standards in the organization
125	to discuss outsourcing and alternate implementations of the IS function
126	to discuss management of time and interpersonal relations

APPENDIX 7 — REFERENCES FOR THE APPENDICES

ACM Curriculum Committee on Computer Science. 1968. "Curriculum 68: Recommendations for the Undergraduate Program in Computer Science." *Communications of the ACM*, 11:3, March 1968, pp. 151-197.

ACM Curriculum Committee on Computer Science. 1979. "Curriculum 78: Recommendations for the Undergraduate Program in Computer Science." *Communications of the ACM*, 22:3, March 1979, pp. 147-166.

ACM. 1983. "ACM Recommendations for Information Systems, Volume II," New York: ACM Committee on Computer Curricula of ACM Education Board.

Aggarwal, A. K. and Bruce Rollier. 1994. "Globalization and the Information Systems Curriculum," *ISECON'94 Proceedings*, pp. 70-74.

Argyris, Chris. 1976. "Single Loop and Double Loop Models in Research Design on Decision Making," *Administrative Science Quarterly*, Volume 21, Number 3, September 1976, pp. 363-375.

Argyris, Chris. 1977. "Double Loop Learning in Organizations," *Harvard Business Review*, Volume 55, Number 5, September/October 1977, pp. 115-125.

Ashenhurst, R. L. (Ed.) 1972. "A Report of the ACM Curriculum Committee on Computer Education for Management." Association for Computing Machinery, Inc., 1972.

Bemowski, Karen. 1991a. "America 2000," *Quality Progress*, Volume 24, Number 10, October 1991, pp. 45-48.

Bemowski, Karen. 1991b. "Restoring the Pillars of Higher Education," *Quality Progress*, Volume 24, Number 10, October 1991, p. 37.

Berry, Daniel M. 1992. "Academic Legitimacy of the Software Engineering Discipline," Technical Report SEI-92-TR-034, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, November 1992.

Bloom, Benjamin S. (Ed.) 1956. *The Taxonomy of Educational Objectives: Classification of Educational Goals. Handbook 1: The Cognitive Domain*. New York: McKay Press, 1956.

BCS. 1989. "A Report on Undergraduate Curricula for Software Engineering," The British Computer Society and The Institution of Electrical Engineers, June 1989.

Burn, Janice M., Eugenia M. W. Ng Tyre, Louis C. K Ma, and Ray S. K. Poon. 1994. "Are IS Graduates Prepared for the Real World?" *Proceedings of the 1994 International Academy for Information Management Conference*, pp. 95-110.

Cale, Edward G., Jr. 1994. "Teaching Information Systems in a Functionally Integrated MBA Program," *Proceedings of the 1994 International Academy for Information Management Conference*, pp. 87-94.

Cherkasky, Stanley M. 1992. "Total Quality for a Sustainable Advantage," *Quality*, Volume 31, August 1992, pp. 4-8.

Chow, Jacqueline, Geoffrey Dick and Bob Edmundson. 1994. "Industry Satisfaction with IS Graduates in the 1990 s: An Empirical Study," *Proceedings of the 1994 International Academy for Information Management Conference*, pp. 153-174.

Cohen, Eli B. 1993. “Can Interactive-Audio Televised Introduction Be Effective? A Review of the Literature.” *ISECON’93 Proceedings*, pp. 205-218.

Cohen, Eli B. 1994. “Tips for Teaching.” *ISECON’94 Proceedings*, p. 129.

Couger, J. (Ed.) 1973. “Curriculum Recommendations for Undergraduate Programs in Information Systems,” *Communications of the ACM*, Volume 16, Number 12, December 1973, pp. 727-749.

Couger, J. Daniel. 1996. *Creativity and Innovation in Information Systems Organizations*. Danvers, Massachusetts: Boyd and Fraser Publishing Company.

Daigle, Roy J. and Janet J. Kemp. 1993. “Managing Applications Development: Introducing Project Management Into the Applications Development Cluster,” *ISECON’93 Proceedings*, pp. 5-12.

Daigle, Roy J. and Janet J. Kemp. 1994. “The Applications Development Cluster of IS’90: Introducing Database Concepts,” *ISECON’94 Proceedings*, pp. 207-214.

Daniels, Robert, Glenda Hayes, Herbert E. Longenecker, Jr. and Roy J. Daigle. 1992. “Implementation of the DPMA IS’90 Curriculum for Information Systems,” *Proceedings of the 1992 International Academy for Information Management Conference.*

Davis, G. B., J. T. Gorgone, J. D. Couger, D.L. Feinstein, and H. E. Longenecker, Jr. 1997. “IS ‘97 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems,” ACM, New York, NY and AITP (formerly DPMA), Park Ridge, IL.

Denison, Barbara. 1993. “Integrating Quality Management into the MIS Curriculum.” *ISECON’93 Proceedings,* pp. 128-133.

Denning, Peter. 1992. “Educating a New Engineer,” *Communications of the ACM*, Volume 35, Number 12, December 1992, pp. 82-97.

Doran, Michael V., Herbert E. Longenecker, Jr. and J. Harold Pardu. 1994. “A Systems Approach to a Data Structures Course for IS Students Consistent with DPMA IS’90,” *ISECON’94 Proceedings*, pp. 236-243.

DPMA. 1981. *DPMA Model Curriculum, 1981*. Park Ridge, Illinois: Data Processing Management Association.

DPMA. 1986. *DPMA Model Curriculum, 1986.* Park Ridge, Illinois: Data Processing Management Association, 1986.

Dutt, James S. 1994. “A Cooperative Learning Approach to Teaching an Introductory Programming Course.” *Proceedings of the International Academy for Information Management*, 1994, p. 225.

Engel, Gerald and Eric Roberts (Eds). 2001. *Computing Curricula 2001 – Computer Science*. IEEE Computer Society and Association for Computing Machinery. http://www.computer.org/education/cc2001/final/cc2001.pdf (accessed Oct 24, 2002).

Ford, Gary. 1990. “1990 SEI Report on Undergraduate Software Engineering Education,” Technical Report SEI-90-TR-3, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, March 1990.

Ford, Gary. 1991. “1991 SEI Report on Graduate Software Engineering Education,” Technical Report SEI-91-TR-2, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, April 1991.

Ford, Gary. 1994. “A Progress Report on Undergraduate Software Engineering Education,” Technical Report SEI-94-TR-011, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, May 1994.

Ford, Gary and Mark A. Ardis. 1989. “1989 SEI Report on Graduate Software Engineering Education,” Technical Report SEI-89-TR-21, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, June, 1989.

Ford, Gary and Norman E. Gibbs. 1989. “A Master of Software Engineering Curriculum: Recommendations from the Software Engineering Institute,” *IEEE Computer*, September 1989, pp. 59-71.

Ford, Gary, Norman Gibbs and James Tomayko. 1987. “Software Engineering Education: An Interim Report from the Software Engineering Institute,” Technical Report SEI-87-TR-8, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, May 1987.

Freeman, Peter. 1987. “Essential Elements of Software Engineering Education Revisited,” *Software Engineering Education: The Educational Needs of the Software Community*, Norman E. Gibbs and Richard E. Fairley, Editors. New York: Springer-Verlag, pp. 61-74.

Gagne, Robert M., Leslie J. Briggs and Walter W. Wager. 1988. *Principles of Instructional Design*, Third Edition. New York: Holt, Rinehart, and Winston.

Gibbs, Norman E. 1989. “The SEI Education Program: The Challenge of Teaching Future Software Engineers,” *Communications of the ACM*, Volume 32, Number 5, May 1989, pp. 594-605.

Gibbs, Norman E. and Gary A. Ford. 1986. “The Challenges of Educating the Next Generation of Software Engineers,” Software Engineering Institute, Technical Report SEI-86-TM-7, Carnegie Mellon University, Pittsburgh, Pennsylvania, June 1986.

Glass, Robert L. 1992. “A Comparative Analysis of the Topic Areas of Computer Science, Software Engineering and Information Systems,” *Journal of Systems Software*, Volume 19, Number 4, pp. 277-289.

Gorgone, John T., J. Daniel Couger, Gordon B. Davis, David L. Feinstein, George Kasper, and Herbert E. Longenecker. 1994. “Information Systems ‘95,” *DataBase,* Volume 25, Number 4, November 1994, pp. 5-8.

Granger, Mary J. and David L. Schroeder. 1994. “Enhancing Existing Undergraduate Information Systems Courses with an International Emphasis,” *Proceedings of the 1994 International Academy for Information Management Conference*, pp. 75-86.

Haney, John D. 1994. “Affiliations with Industry.” *ISECON’94 Proceedings*, p. 215.

Holland College. 1993. “Learning Guides for Business Information Processing” Holland College, Prince Edward Island, Canada.

Johnson, David W., Roger T. Johnson, and Edythe Johnson Houlubec. 1993. “The New Circles of Learning: Cooperation in the Classroom and School.”

Klein, Ronald D., Charlotte S. Stephens and John L. Bohannon. 1994. “A Comparative Analysis of Information Systems Curricula in Collegiate Business Programs,” *Proceedings of the 1994 International Academy for Information Management Conference*, pp. 3-12.

Koffman, Elliot P., David Stemple, and Caroline E. Wardle. 1984. “Recommended Curriculum for CS1: A Report of the ACM Curriculum Task Force for CS1,” *Communications of the ACM,* Volume 27, Number 10, October 1984, pp. 998-1001.

Koffman, Elliot P., David Stemple, and Caroline E. Wardle. 1985. “Recommended Curriculum for CS2: A Report of the ACM Curriculum Task Force for CS2,” *Communications of the ACM*, Volume 28, Number 8, August 1985, pp. 815-818.

Leventhal, Laura M. and Barbee T. Mynatt. 1987. “Components of Typical Undergraduate Software Engineering Courses: Results from a Survey,” *IEEE Transactions on Software Engineering*, Volume SE-13, Number 11, November 1987, pp. 1193-1198.

Lidtke, D. and Mulder, M. 1999. “ISCC’99, An Information Systems-Centric Curriculum ‘99”, January 1999. NSF DUE/CES-9352944, DUE-9455450, and DUE-9796243.

Lim, B. L. 1993. “A Project-Intensive Introductory Object-Oriented Programming Course.” *ISECON’93 Proceedings*, pp. 157-161.

Litchfield, Brenda. 1996. “Cooperative Learning Seminar,” University of South Alabama, Mobile, January 19, 1996.

Longenecker, Herbert E., Jr., Jon D. Clark, J. Daniel Couger, David L. Feinstein, and John T. Clark. 1994. “Development of IS’95: A Joint Activity of DPMA, ACM, ICIS, AIS,” *ISECON’94 Proceedings*, p. 1.

Longenecker, Herbert E., Gordon B. Davis, John T. Gorgone, J. Daniel Couger, and David L. Feinstein. 1997. “IS’97: A Co-Chairs Report and Panel Discussion of the Joint ACM/AIS/DPMA Information Systems Curriculum for Four Year Undergraduate Programs.” *Proceedings of the SIGCSE Conference*, 1997.

Longenecker, Herbert E., Jr., and David L. Feinstein. 1991a. “A Comprehensive Survey of USA and Canadian Undergraduate Programs in Information Systems,” *Journal of Information Systems Education*, Volume 3, Number 1, Spring 1991, pp. 8-13.

Longenecker, Herbert E., Jr., and David L. Feinstein. 1991b. “On Establishing Excellence in Information Systems,” *Journal of Information Systems Education*, Volume 3, Number 1, Spring 1991, pp. 26-31.

Longenecker, Herbert E., Jr., and David L. Feinstein (Eds.) 1991c. *IS’90: The DPMA Model Curriculum for Information Systems for 4 Year Undergraduates.* Park Ridge, Illinois: Data Processing Management Association.

Longenecker, Herbert E., Jr., David L. Feinstein, J. Daniel Couger, Gordon B. Davis, and John T. Gorgone. 1995. “Information Systems ’95: A Summary of the Collaborative IS Curriculum Specification of the Joint DPMA, ACM, AIS Task Force,” *Journal of Information Systems Education,* Volume 6, Number 4, pp. 174-187.

Longenecker, Herbert E., David L. Feinstein, and John T. Gorgone 1994. “Development and Review of IS’95 — A Joint Curriculum of DPMA, ICIS/AIS, and ACM for Four Year Information Systems Programs.” *Proceedings of the International Academy for Information Management*, 1994, p. 1.

Longenecker, Herbert E., David L. Feinstein, John T. Gorgone, Gordon B. Davis, J. Daniel Couger, and Ron L. Williams. 1996. “A Shared ‘CORE’ Curriculum for Information Systems (IS), Software Engineering (SE), and Computer Science (CS) Based on a 1995 National Survey.” *ISECON’96 Proceedings*.

Longenecker, Herbert E., Jr., David L. Feinstein, John T. Gorgone and Milton S. Jenkins. 1994. “Development and Review of IS’95: A Joint Curriculum of DPMA, ICIS/AIS, and ACM for Four Year Information Systems Programs,” *Proceedings of the 1994 International Academy for Information Management Conference*, pp. 1, 2.

Lorents, Alden C. and Greg Neal. 1993. “Information Engineering, IEF, and the CIS Curriculum.” *ISECON’93 Proceedings*, pp. 109-115.

Mawhinney, Charles H., Joseph S. Morrell and Gerard J. Morris. 1994. “The IS Curriculum: Closing the Gap,” *ISECON’94 Proceedings*, pp. 249-256.

McKinney, Alfred L., K. K. Agarwal, and Reza Sanati. 1994. “Integrating Graphics into Data Structures and Algorithms in the DPMA Model Curriculum,” *ISECON’94 Proceedings*, pp. 96-101.

NSF. 1993. “A Framework for Academic Program in Informatics: Task Force Report,” NSF Informatics Task Force, Center for Advanced Computer Studies, University of Southwestern Louisiana, Lafayette, November 1993.

Nunamaker, Jay F., J. Daniel Couger, and Gordon B. Davis. 1982. “Information Systems Curriculum Recommendations for the 80s: Undergraduate and Graduate Programs,” *Communications of the ACM*, Volume 25, Number 11, November 1982, pp. 781-805.

Parnas, David L. 1990. “Education for Computing Professionals,” *IEEE Computer*, Volume 23, Number 1, January 1990, pp. 17-22.

Pick, James B., Roger Baty, and Michael Phoenix. 1994. “Teaching Geographical Information Systems,” *ISECON’94 Proceedings*, pp. 35-42.

Pick, James B. and K. D. Schenk. 1993. “Development of and Information Systems Curriculum for Non-traditional Students,” *ISECON’93 Proceedings,* pp. 148-155.

Sanati, Reza, Alfred L. McKinney and Krishna K. Agarwal. 1994. “Teaching Computer Graphics Applications in the DPMA Model Curriculum,” *ISECON’94 Proceedings*, pp. 143-148.

Shaw, Mary. 1986. “Education for the Future of Software Engineering,” Technical Report SEI-86-TM-5, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, May 1986.

Shaw, Mary. 1990. “Prospects for an Engineering Discipline of Software,” Technical Report SEI-90-TR-20, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, September 1990.

Smith, Derek C. 1994. “Information Systems Curricula in South Africa,” *Proceedings if the 1994 International Academy for Information Management Conference*, pp. 175-178.

SEI. 1991. “Software Engineering Education Directory,” Technical Report SEI-91-TR-9, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, May 1991.

Tomayko, James E. and Mary Shaw. 1991. “Models for Undergraduate Project Courses in Software Engineering,” Technical Report SEI-91-TR-10, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, Pennsylvania, August 1991.

Turner, A. Joe and Allen Tucker (Eds.) 1991. “Computing Curricula 1991: Report of the ACM/IEEE-CS Joint Curriculum Task Force,” *Communications of the ACM*, Volume 34, Number 6, pp. 68-84, July 1991.

Wasserman, Anthony I. 1976. “Toward Improved Software Engineering Education,” *Software Engineering Education: Proceedings of an Interface Workshop,* Anthony I. Wasserman and Peter Freeman, eds. New York: Springer-Verlag, pp. 108-115.

Waguespack, Les. 1994. “Domain Analysis is an Essential Skill of the OO Analyst,” *ISECON’94 Proceedings*, pp. 186-193.