APPENDIX 1 — BACKGROUND OF IS CURRICULA AND RELATED DISCIPLINES

Computer Science Curricula

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

Information Systems Curricula

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

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

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

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

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

Characteristics of IS'97 Development

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

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

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

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

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

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

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

5. The learning units provide small units for curriculum design. They support tailoring of

courses and are not as prescriptive as courses used in previous models. This allows flexibility by individual academic units, yet with the ability to remain focused on overall objectives of the curriculum. This approach will help ensure the quality of graduates (Denning, 1992; Bemowski, 1991a, 1991b; Cherkasky, 1992).

IS 2002 Extensions

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

APPENDIX 2 — DETAILS OF THE DEVELOPMENT OF IS 2009

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

Past curriculum projects have been largely based on the work of a small task force that has shared its work at a variety of conferences and incorporated the feedback from the sessions to the model curriculum. In addition, written drafts have been shared widely and comments solicited. Also, surveys have been used to gather industry input. Typical processes are driven by a few individuals with little input from the academy as a whole. In an effort to create an open and transparent process that is open to the IS community as broadly as possible, the IS 2009 model curriculum committee used web-based collaboration technologies in addition to several traditional approaches described above to include and hopefully engage the global IS community.

As with previous curriculum projects, the IS 2009 task force has presented the development process at several conferences. In addition, we have published reports at different stages of the project. Further we have created a wiki to support collaboration and to make it easier for the community to give feedback during the curriculum revision process. The AIS email listserv was utilized several times to solicit feedback and direct users to the wiki Web site. Table A3.1 details the timeline for this effort.

Table A3.1: Details of the IS 2009 Task Force interactions with the community

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

APPENDIX 3 – DEPTH OF KNOWLEDGE METRICS AND RELATED PEDAGOGY

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

Depth of Knowledge Metric

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

The characteristics of the metric include

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

The template shown in column 3 of Table A3.1 was consulted when writing behavioral objective and goal statements for the IS 2009 courses; these statements allow authors and faculty to be more precise in communicating expectations for both students and teachers.

Identifying Expectations

The statements of characteristics of graduates contain "keywords" that can be detected using the template of the metric. For example, if the expectation is to "apply problem solving techniques in configuring a local area network," this is the equivalent of a level 4 objective. To a large extent, the knowledge levels specified within IS 2009 are compatible with the definitions of Table A3.1. The exit objectives of the goals and objectives have been checked and verified to assure consistency with the expectations of industry and academics.

Content Analysis of Statements of Expectation

The knowledge levels of IS 2009 are designed to give guidance to educators in planning as well as in the analysis of outcomes. Column 3 of Table A3.1 describes a template for writing objectives. This template was originally defined in IS'90 and has been expanded in the present context. The language used in writing behavioral objectives was derived from the Bloom taxonomy. The template may be used prescriptively in writing presentation goals and student performance objectives to ensure that the implied level of difficulty is presented. Likewise, given the objective, the student's behavior can be observed and compared with the objective statement to ensure that the students achieve the desired results of the presentation goal statements.

Learning Techniques for Different Levels

Learning techniques often differ for different levels. Level 1 knowledge in IS 2009 (awareness) is knowledge that is immediately apparent. Given an appropriate stimulus, it is knowledge that is recalled. IS 2009 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 2009 level 3 (usage/comprehension) requires considerable practice and creative repetition. Level 4 (application) requires unsupervised practice. Team work, project work, and other participative learning facilitate achieving these levels. Proper sequencing is an important factor in achieving student success. Project laboratories are ideal for this level of student activity. In fact, these laboratories are beneficial at all levels of instruction (Doran, Longenecker, and Pardu, 1994; Dutt, 1994). Some institutions have been successful with total participatory project environments (Holland College 1993).

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

IS'90,'94,'95, 2002, 2009 Depth of Knowledge	Bloom Levels of Knowledge	Template for Writing Behavioral Objectives Students completing ... will be able to	Meaning of Depth of Knowledge Level and Activities Associated with Attaining that Level
0 No Knowledge			
1 Awareness	1 Knowledge Recognition	Define ... List characteristics of ... Name components of ... Diagram ... List advantages/disadvantages of ...	Introductory Recall and Recognition Class presentations, discussion groups, reading, watching videos, structured laboratories. Involves only recognition, but with little ability to differentiate. Does not involve use.
2 Literacy Strong Knowledge	1 Differentiation in context	Compare and contrast ... Explain ... Write/execute simple ... Define functional capabilities that are ... Describe interrelations of ... to related objects	Knowledge of Framework and Contents, Differential Knowledge Continued lecture and participative discussion, reading, team work and projects, structured labs. Requires recognition knowledge as a prerequisite. Requires practice. Does not involve use.
3 Concept/Use Skill	2 Comprehension Translation/ Extrapolation Use of Knowledge	Use ... Communicate the idea of ... Form and relate the abstraction of ... as ... Given a set of ..., interpolate/extrapolate to ... List concepts/major steps in ...	Comprehension and Ability to Use Knowledge *when Asked/Prompted* Requires continued lab and project participation, presentation involving giving explanations and demonstrations, accepting criticism; may require developing skills in directed labs.
4 Detailed Understanding, Application Ability	3 Application Knowledge	Search for correct solution to ... and apply it to ... Design and implement a ... for ... Write syntactically correct ... and/or debug ... Apply the principles of ... to ... Implement a ... and maintain it	Selection of the Right Thing and Using It *without Hints* Semi-structured team-oriented labs where students generate their own solutions, make their own decisions, commit to and complete assignments, and present and explain solutions.
5 Advanced	4 Analysis 5 Synthesis 6 Evaluation	Develop/originate/institute ... Construct/adapt ... Generate novel solutions to ... Come up with new knowledge regarding ... Evaluate/judge the relative value of ... with respect to ...	Identification, Use and Evaluation of New Knowledge An advanced level of knowledge for those very capable of applying existing knowledge in which *denovo* solutions are found and utilized in solving and evaluating the proposed new knowledge.

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

APPENDIX 4 — IS BODY OF KNOWLEDGE

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

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

1. It builds on and is closely associated with IS 2002/IS'97 and the body of knowledge presented in these documents. The current BoK is not, however, a direct extension of the prior versions.
2. The IS 2009 body of knowledge has significantly benefited from the work done in the context of the computing ontology project (see Cassel et al., 2008), which has brought together representatives from all computing disciplines to develop a comprehensive concept structure for the entire field.
3. In addition to the ontology project, IS 2009 also directly utilizes, as described above, \the work that has been done in other computing disciplines to specify their bodies of knowledge.
4. The body of knowledge was also strongly influenced by the new high-level undergraduate IS program learning objectives that were specified in this project and articulated in Section 10.

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

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

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

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

Information Systems Specific Knowledge Areas

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

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

Information Systems Specific Knowledge Areas -- continued

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

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

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