Information Systems '95:
A Summary of the Collaborative IS
Curriculum Specification of the Joint
DPMA, ACM, AIS Task Force

ABSTRACT: Information Systems '95 (IS '95), a model curriculum for a bachelor's degree in Information Systems (IS), is the resulting development of collaborative work of a Joint Task Force of the Data Processing Management Association (DPMA), the Association for Computing Machinery (ACM), and Academy for Information Systems (AIS). Representation on the task force includes both academic and industrial members. This paper summarizes the full report (Figure 1). A definition of the IS discipline and its relevance within the business and university community is discussed. Resources needed to support a viable program are identified, including faculty, and information technology. Courses are identified and the characteristics of graduates defined. A paradigm is provided which couples a definition of the IS discipline and its underlying principles to the characteristics of the IS graduate. An updated IS body of knowledge is presented. It is based on previous efforts of DPMA and ACM (Longenecker and Feinstein 1991a,b,c; Ashenhurst 1972; Couger 1972; ACM 1983 and ACM 1990; DPMA 1981, 1986). The current body of knowledge contains the Computer Science and Engineering body of knowledge (Turner and Tucker 1991). 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 study of specific aspects of the curriculum. A modular concept of learning units is defined and utilized in specifying proposed courses. Methods for mapping the learning units to alternate course plans are discussed. Elements from the body of knowledge are combined in a logical top-down manner to form Learning Units (LU). Each LU contains a goal statement, behavioral objectives and associated elements from the body of knowledge. Five curriculum areas with 20 sub-areas form clusters of these learning units. A complete set of 128 learning units form meta-presentation units which can be organized in different schemes to meet individual institutional missions. One possible organization of these units into ten courses is presented. This paper provides curriculum guidelines for implementing undergraduate programs in information systems. The full report, IS '95, provides the detail necessary for design and implementation of courses. Dissemination of the curriculum and plans for review and updating the curriculum are presented.

BACKGROUND

A curriculum for computer science (CS) was first outlined in 1965 (ACM 1968) and was revised a decade later (ACM 1978).

Curriculum development for information systems (IS) began in the early 1970s (ACM 1981; DPMA 1981, 1986; Nunamaker 1982). The chronology is shown in Figure 2. IS curricula have reflected many dynamic changes caused by the rapid development of information technology. IS curricula have recognized the need for both an organizational and technical emphasis (Nunamaker 1982).

The IS '90 model was developed and completed in 1991 (Longenecker and Feinstein 1991b,c). This model was based on a survey of information systems programs in approximately 1000 colleges and universities in North America (Longenecker and Feinstein 1991a). Participants came from both industry and academia.

IS '90 prompted considerable dialogue. A partial list of papers that discuss various aspects of IS education is found in the bibliography (Aggarwal 1994; Burn 1994; Cale 1994; Chow 1994; Daigle 1993,1994; Daniels 1992; Denison 1993; Doran 1994; Herbert E. Longenecker, Jr., a Co Chair of the Joint Task Force, DPMA b Co Chair of the Joint Task Force, AIS c Co Chair of the Joint Task Force, ACM 1 University of South Alabama 2 University of Colorado 3 University of Minnesota 4 Bentley College

"to improve the performance of people through the use of information technology... where the ultimate objective is performance improvement... where the focus is the people who make up the organization..." 

(Sprague 1993, p14)

The current model is a joint effort of the ACM, AIS and DPMI. It draws heavily from the previous work. To obtain updated information, a survey of approximately 2000 participants from both business and education was conducted early in 1994. Preliminary versions of the curriculum have been presented in 1994 and at ISECON (Information System Education Conference), DSI (Decision Sciences Institute), IAIM (International Academy of Information Management), ICIS (International Conference on Information Systems) and SIGCSE (Special Interest Group for Computer Science Education).

INFORMATION SYSTEMS IN ORGANIZATIONS

Information systems have always been significant in the management and operation of organizations. The use of computing has evolved from machines which could calculate and produce simple reports to distributed multiprocessors with powerful individual work-stations for the end user. Computer-based information systems are complex socio-technical entities that have taken on critical roles in local, national and global organizations. Information systems provide support for the goals of the organization and its management — strategic, tactical and operational — in a timely and cost-effective manner. The applied nature of the IS discipline suggests a critical link between education with the practicing professional community (Hoffman 1991; Trauth 1993; Mawhinney 1994; Longenecker, Feistman 1991a, c; Longenecker, Reaugh, Fournier and Feistman 1994).

The IS professional of the '90s must be increasingly aware of the role of IS in achieving strategic (Hammer 1990) and competitive (Porter 1986) advantage in the business process. This includes functional awareness of quality (Deming 1986) and total quality management and team-based (Zulmer 1993) processes for re-engineering (Hammer and Champy 1993; Kane 1992; Sprague 1993). Organizations of the 1990's will rely heavily on information systems.

Graduates should play a significant role in the implementation of these processes. IS '95 recognizes the need for its graduates to develop the necessary skills to be successful in future IS environments.

RECURRING THEMES AND PRINCIPLES

Important principles or themes should be stressed throughout the student's educational experience. The principles and recurring themes which are characteristic of the IS graduates (Figure 3A and 3B) have been extracted from much of the previous work (Nunamaker 1991; Longenecker and Feistman 1991; Longenecker, Reaugh, Fournier, Feistman 1994). The topic headers represent the principles in order of importance deemed desirable by industry (Hoffman 1991; Mackowiak 1991). These categories and recommendations are compatible and consistent with the findings of Trauth, Mawhinney and Chow (Trauth 1993; Mawhinney 1994; Chow 1994).

An important emphasis is placed on systems theory, user-centered requirement-based problem solving, software engineering, and hardware and software integration (Trauth 1993). IS '95 develops a stepwise, continuous development of applications starting with simple small systems progressing to more complex enterprise level systems. IS '95 also stresses problem identification and solving techniques beginning with the introductory classes and followed in a consistent manner through the advanced portion of the curriculum. The entire model is based on a spiral approach to presenting material (Argyris 1976, 1977) which has the student revisits items multiple times with increasing complexity.
COMMUNICATIONS
- IS graduates must communicate in a variety of settings using oral, written and multimedia techniques.

PROBLEM SOLVING
- A fundamental activity of the IS professional is problem solving. IS professionals must be able to choose from a variety of different problem solving methodologies to analytically formulate a solution.
- An IS graduate must think creatively in solving problems.
- An IS graduate must be able to work on project teams and use group methods to define and solve problems.

ORGANIZATION and SYSTEM THEORY
- IS professionals must be grounded in the principles of system theory.
- An Information System is intimately and inextricably linked with the organization in which it is embedded and which it serves. The information system must be congruent with, and supportive of, the strategy, principles, goals and objectives of the organization. Therefore, the IS professional must have sufficient background to understand the functioning of organizations.
- IS professionals must understand and be able to function in the multinational and global context of today's information dependent organizations.

INFORMATION TECHNOLOGY (DATABASE, MODELING, IS DEVELOPMENT)
- IS professionals must understand modeling, measurement, and simulation approaches and methods.
- Graduates must function competently at an entry level position. In that respect they must be able to describe and develop Information Systems both personally and in groups which are characterized by the following:
  - IS provides the info/infra structure - a system of data and information flow and responsibility within the organization.
  - IS provides direct support for the operational activities of the organization.
  - IS provides a means of meeting the internal and external reporting requirements of the organization.
  - IS provides measurements necessary for establishing quality and improvement.
  - IS provides a historical record of the activities of the organization.
  - IS provides a strategic weapon to be used to gain competitive advantage.
  - IS provides the link to external information.
  - IS provides for more timely development and marketing of products and services.

INFORMATION TECHNOLOGY (COMPUTER HARDWARE, COMMUNICATIONS, OPERATING SYSTEMS)
- As IS becomes more quantitative and develops additional analytic methods, the IS professional must develop sufficient understanding of relevant software and hardware engineering concepts, and the underlying principles on which the methods are based.
- An IS professional must have the ability to apply and work readily with (specify, acquire, configure, install, and operate) control, networked and telecommunicating distributed systems; the IS professional must integrate hardware, software and communicating systems into effective organizational solutions.
- An IS graduate must adjust rapidly to specific hardware, software and communications environments.

DEVELOPMENT AND DESIGN
OF IS '95
Over the past twenty years, a number of IS curricula of varying approach and content have been published. In part this was due to the rapid rate of change and the maturation of the field was experiencing. The direct predecessor to the present model, IS '90, was implemented in a top-down systematic and analytically determined manner (Gagne 1988). IS '90 was formulated using standard systems development techniques, resulting in a logical, complete and maintainable model.

The IS '90 curriculum was centered on the concept that graduates must be able to build and deploy information systems, based on their ability to apply knowledge of information technology, use organizational concepts and apply team oriented database systems development methodologies (Figure 3A and 3B). These broad goals gave rise to the knowledge clusters of IS '90 which are carried forth in IS '95 as curriculum areas.

The applied focus IS '95 draws upon the linkage between theory and practice. The primary requirement of IS '95 graduates is to be able to implement and deploy information systems within an organizational context. This requirement is consistent with a survey conducted in 1993 and with the work of Trauth and Mawhinney (Trauth 1993; Mawhinney 1994). These references stress the importance of oral and written communication, as well as problem identification and solution. They also note the need for an understanding of fundamental organizational principles and express concern that today's graduates be able to adjust to rapid change and to continue the learning process independently.

IS '95 defines an approach to IS course delivery that is based on instructional design methodology derived from Gagne (1988). With this methodology, learning units (knowledge units: Bruner 1966) are comprised of goals with corresponding objectives. The learning units (Figures 6 and 8) are assigned to curriculum areas and sub-area descriptions (Figures 7, 9A and 9B, and Figure 10).

Courses in IS '95 are implementations of the concepts of broad curriculum areas (Figures 9A and 9B). These five curriculum areas are clusters of knowledge which are sequential in nature (Figure 7). The courses corresponding to each curriculum area are labeled IS '95 P0 through IS '95 10. IS '95 P0 is considered to be a prerequisite to the program.

Courses are described with an overview or catalog description, course scope and topics, and outcome expectations, and are defined by a collection of learning units. The learning units (see Figure 8) contain goal and objective statements and the relevant elements from the body of knowledge. This approach allows the courses to be maintained by modification of individual learning units, without disruption of the entire curriculum. As new goals, objectives and/or topics evolve, they can be integrated into the existing learning units.

The set of courses represents a complete model that includes all of the learning units. As a model they are presented to provide guidance and are not meant to be prescriptive. Institutions may wish to develop their own courses based on these learning units and to accommodate their individual missions which may require additional learning units.

BODY OF KNOWLEDGE FOR INFORMATION SYSTEMS
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 of these subject areas represents specific domains of knowledge. The body of
knowledge consists of 457 elements in a four level hierarchy and is derived from the analysis of all of the previous IS curriculum models (ACM 1982, 1989; DPM 1981, 1986; Longenecker and Feinstein 1991; Longenecker, Reaugh et al 1994). IS '90 and IS '94 used a three level hierarchy. By adding a fourth level to the Information and Technology subject area in IS '95, it was possible to fully contain the CS body of knowledge (Turner and Tucker 1991).

DEPT OF KNOWLEDGE METRIC

A key ingredient in IS '95 is a depth of knowledge metric. This metric is based on the work of Bloom (Bloom 1956) This work describes a 6 level metric. The present metric is presented in Figure 5. Bachelor level programs usually achieve level 4 or the application level.

Characteristics of the metric describe:
- the definition of the levels of knowledge,
- the behavior to be demonstrated by those completing learning units of the curriculum,
- how goals and objectives are developed compatible at 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 a given level can be assessed.

The knowledge levels specified within IS '95 are compatible with those of Bloom's hierarchy. The present metric is presented in Figure 5. Goal and objective statements were written using the template structure of column 3 of Figure 5.

Finally, the exit objectives of the goals and objectives have been checked and verified against those of Figures 5 and 4 to assure consistency with the expectations of industry and academics.

Figure 4 shows a two level description of each of the subject areas of the body of knowledge in column 1. Columns 2-4 show data derived by surveying academicians on the importance of the various categories to different categories of students (IS majors, IS minors and end users). Column 5 represents data derived from a survey of industry expectations for new hires (Mawhinney 1994). By inspection of columns 4 and 5 it is evident that there is little difference between industry expectations and the depth standard set by IS academics.

It is apparent from Figure 4 that graduates of an IS program require comprehensive usage level of information technology. Graduates should be able to accept direction and complete tasks assigned (Denning 1992) and also be able to apply their knowledge without direction. This information has been used for setting depth expectations within IS '95.

QUALITY
- IS professionals must understand quality, planning, steps in the continuous improvement process as it relates to the enterprise, and tools to facilitate quality development.
- IS professionals must understand the role of management and leadership in the IS function. This includes the tools that are available to accomplish this role.
- IS professionals must possess a tolerance for change and skills for managing the process of change.
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sentation of curriculum area abstractions resulting from this activity. Figure 7 shows a subdivision of the curriculum areas of Curriculum '95. Letters A through E identify the curriculum areas. The first area "A" represents prerequisite material to the Information Systems program. Courses are identified with each curriculum area. The task force reached a compromise on 10 courses, but fully recognized that other arrangements are feasible.

Figure 8 is a graphical representation of a learning unit. One hundred and twenty eight (128) learning units were identified, each with a set of objectives and associated goal. A complete listing of these learning units is given in Figure 10. In this figure, the learning units are matched to the curriculum sub-areas. In Figure 11 the learning units are displayed to show the spiral nature of the curriculum. The knowledge levels expected in later years is greater than in early exposures.

RESOURCES NECESSARY TO IMPLEMENT A PROGRAM BASED ON IS '95

Faculty
The strength of the information systems program lies with its faculty. Both educational and practical experience are needed. There must be enough faculty to provide course offerings that allow the students to complete the program in a timely manner. Faculty members must remain current in the discipline. The professional development and scholarly activities are a joint obligation of the institution and individual faculty member. The professional competence of the faculty should span a range of interest in information systems including: computer systems concepts, information systems concepts, data management, telecommunications and networks, systems development and design, systems integration, information systems management, facilities management and policy development.

Computing Facilities
Adequate computing facilities are essential for effective delivery of the IS program for both faculty and students. These resources normally involve a blend of computer facilities of varying capabilities and complexity. Students at different levels in the curriculum have different needs. Hardware and software are changing rapidly improving. It is critical that faculty and students have access to facilities that represent the kind of environments that graduates should expect professionally. It should be recognized that a growing number of students have their own systems. Provision should be made for them to access their institution's resources through a variety of Internet tools.

Other Resources
Suitable classroom facilities, equipped with appropriate information technology teaching resources, should be provided. Library support should include access to appropriate journals, proceedings, monographs and reference books. Adequate clerical and technical support must also be provided.

RELATED ACADEMIC PROGRAMS
Information Systems programs reside in a variety of settings with different institutional requirements. Many programs are closely allied with computer science departments. It is important for them to review the
### Templates for Objective Writing, and Meaning of the Depth Levels with Associated Learning Activities

<table>
<thead>
<tr>
<th>Template for Writing Behavioral Objectives</th>
<th>Meaning of Depth of Knowledge Level, and Activities Associated with Attaining that Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students completing... will be able to:</td>
<td>Introductory Recall and Recognition</td>
</tr>
<tr>
<td>Define...</td>
<td>Class presentations, discussion groups, reading, watching videos, structured...</td>
</tr>
<tr>
<td>List Characteristics of...</td>
<td>Does not involve use.</td>
</tr>
<tr>
<td>Name Components of...</td>
<td>Knowledge of Framework and Contents, Differential Knowledge</td>
</tr>
<tr>
<td>Diagram...</td>
<td>Continued lecture and participative discussion, reading, team work and projects,...</td>
</tr>
<tr>
<td>List Advantages/Disadvantages of...</td>
<td>Does not involve use.</td>
</tr>
<tr>
<td>Compare and contrast...</td>
<td>Comprehension and Ability to Use Knowledge when Asked</td>
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<tr>
<td>Explain...</td>
<td>Requires continued lab and project participation, presentation involving giving...</td>
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<tr>
<td>Write/Execute simple...</td>
<td>Selection of the Right Thing and Using It without Hints</td>
</tr>
<tr>
<td>Functional capabilities are...</td>
<td>Semi-structured team oriented labs wherein students generate their own solutions,...</td>
</tr>
<tr>
<td>Describe interrelations of...to related objects</td>
<td>Implement solutions, commit to and complete assignments, present and explain...</td>
</tr>
<tr>
<td>USE...</td>
<td>Identification, Use and Evaluation of New Knowledge</td>
</tr>
<tr>
<td>Communicate the idea of...</td>
<td>An advanced level of knowledge for those very capable of applying existing knowledge</td>
</tr>
<tr>
<td>Form and relate the abstraction of... as</td>
<td>in which denovo solutions are found and utilized in solving and evaluating the...</td>
</tr>
<tr>
<td>Given a set of...Interpolate/extrapolate to ..</td>
<td>proposed new knowledge.</td>
</tr>
<tr>
<td>List concepts / major steps in...</td>
<td></td>
</tr>
<tr>
<td>Search for correct solution to...and apply it to... Design and implement a...for...</td>
<td></td>
</tr>
<tr>
<td>Be able to write syntactically correct...and/or debug...</td>
<td></td>
</tr>
<tr>
<td>Apply the principles of...to... Implement a... and maintain it</td>
<td></td>
</tr>
<tr>
<td>Develop/originate/institute... Construct/adapt... Generate novel solutions to...</td>
<td></td>
</tr>
<tr>
<td>Come up with new knowledge regarding...</td>
<td></td>
</tr>
<tr>
<td>Evaluate/judge the relative value of, with respect to...</td>
<td></td>
</tr>
</tbody>
</table>

**IS '95** uses the spiral model (Argyris, 1976, 1977) in which elements of the body of knowledge are revisited many times through the curriculum in different and accelerated manners. This spiral approach is a systemic approach and is similar to that recommended by Gagne (Brunner 1960, 1966; Briggs 1977; Soloway 1984; Gagne 1988). In column 4 the nature of expectations for a learner are explained, as are some of the methods which may be employed to achieve the levels of knowledge. In general, the highest level of expectation in the undergraduate curriculum is level 4, or application knowledge. For learners to graduate with this level of knowledge requires that the level be achieved not only once, but sustained for a considerable period of time. In addition, each earlier level is a prerequisite level of knowledge and must be achieved before the more advanced levels are attained. This can only be achieved by very creative repetition and coaching from the faculty in previous courses. This integrated view of the curriculum requires faculty to be knowledgeable of which elements are included, at what level, and what expectations there should be for learners.

**Figure 6. ARCHITECTURE OF IS '95 CURRICULUM**

This figure shows the objects of IS '95 and their relations. Curriculum Presentation Areas have courses, and also have curriculum area components, or curriculum sub-areas. The Body of Knowledge has Subject Areas, and the subject areas have elements. Courses are made up of Learning Units (see figure 6 for definition of a learning unit, as are curriculum sub-areas. Learning units have multiple areas from the body of knowledge. Curriculum presentation areas set out the broad areas for presentation of material. Curriculum area components are significant sub-presentation areas (see definition in Figure 7). Likewise, courses of IS '95 are administrative sequences within a curriculum area. Both Courses and Curriculum areas are defined by learning units (see definition in Figure 9) which through a goal statement identify elements of the body of knowledge to be presented as a unit. Learning unit objectives define the expected behavior of learners, and also set standards for evaluation of the students' ability.

**REVIEW AND UPDATING OF IS '95**

This paper is only a summary of IS '95. If you would like to be involved in the continuing review process for IS '95 please request a copy of the document from:

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REFERENCES

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C. Information Technology

The goal is to provide students who are aware of information technology and its potential organizational significance an opportunity to gain breadth and depth in the technical aspects of the discipline. The prerequisite exposure in developing simple knowledge work systems gives students a necessary base. A system's view is used to present computing system architectures and operating systems software. Interconnection of information resources through telecommunications is a major component of modern computer systems. Students will be expected to develop significant programming skills in development, configuration, and operation of the technologies involved in an introduction to developing information systems is initiated in a rigorous programming sequence involving objects, data structures and related processes. Also, the relationship of these structures in the development of simple applications is considered.

IS 95.4 Information Technology: Hardware and Software
IS 95.5 Programming, Data, and Object Structures
IS 95.6 Telecommunications

C. Information Applications and Systems Development

Students who are competent with the fundamental skills of information technology will work in teams to learn to analyze problems, design and implement information systems. The systems analysis course provides experience in systems requirements and developing a logical design. Course work involves team or individual projects. Students will examine several courses, access to indexed files within a database management system, data communications, and information technology. Projects and assignments throughout the curriculum will be used in the design of physical data systems that will meet the needs of the organization.

IS 95.7 Analysis and Logical Design
IS 95.8 Physical Design and Implementation with DBMS
IS 95.9 Physical Design and Implementation with a Programming Environment

E. IS Deployment and Management Processes

Students who have successfully designed and implemented departmental level information systems will extend their knowledge by performing in a significant project conducted with industrial or personal experiences. Projects are designed to solve real-world problems for a real client; however, a computer simulation may be employed.

Management of the information systems function, systems integration, and project management to ensure project quality are integral components of the course. The projects are handled in a semi-formal manner whereby students read and present relevant papers, or they may be addressed through use of the development of appropriate process standards focusing on the key issues and ensuring that they are tailored to the application. Complete system design solutions may be too aggressive; however, the project should focus on the development of several key processes in continuous improvement of their function. Development of mission statements; determination of physical flows based on re-engineering of the functions, database logical and physical design; function analysis, design and implementation; conversion design and implementation are important components of this team project.

IS 95.10 Project Management and Practice

37. DPMA 1985. "DPMA Associate Level Model Curriculum in CIS", Published by DPMA, Park Ridge, IL.
38. DPMA 1986. "DPMA Model Curriculum, 1986", Published by DPMA, Park Ridge, IL.
STATEMENT OF PEER REVIEW INTEGRITY

All papers published in the Journal of Information Systems Education have undergone rigorous peer review. This includes an initial editor screening and double-blind refereeing by three or more expert referees.