EDITOR'S NOTE: Members of the Joint curriculum committee will be participating in and leading sessions at the Worldwide Conference on Information Systems education, June 11-14, 1995 in suburban Denver

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

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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 of 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;

> *"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)*

Cohen 1993, 1994; Granger 1994; Haney 1994; Hensel 1994; Klein 1994; Lim 1993; Longenecker 1992, 1993, 1994; Lorents 1993, 1994; Mawhinney 1994; McKinney 1994; Novitizki 1994; Pick 1993, 1994; Sanati 1994; Smith 1994; Waugespack 1993, 1994).

The current model is a joint effort of the ACM, AIS and DPMA. 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).

Figure 1. GUIDELINES PROVIDED BY IS '95 CURRICULUM MATERIALS

IS '95 Assists Information Systems Educators by
- Identifying recurrent themes, principles and outcome characteristics of IS graduates
- Utilizing an outcome oriented, systems based methodology for ensuring the quality of graduates
- Specifying depth of coverage and behavioral testing methodology suitable for lecture, lab, project, and other participative learning environments
- Identifying, sequencing, and defining of IS course content and relationships to other subject areas to form a complete curriculum recommendation fully aligned with IS industry expectations
- Providing a modular Learning Units structure and cross reference scheme that rigorously define course detail, and suggest a unit structure that can be integrated into other programs with retention of an appropriate IS focus and spirit needed for IS education while enabling other program objectives
- Defining the set of Learning Units in terms of goals and objectives with an associated set of elements of the Body of IS Knowledge
- Anticipating and accommodating continual curricula change

Figure 2. CHRONOLOGY OF I.S. 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 (ACM 1981);
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);
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;
October 1989, ACM unofficial, unpublished revision of ACM 1983;
May, 1990, ACM/IEEE Computing Curriculum for Computer Science for Undergraduates (Tucker 1990);
October 1990, DPMA IS '90 draft document (Longenecker and Feinstein 1990);
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, Reaugh 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/ICIS, DPMA Task Force.

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, Feinstein 1991a,c; Longenecker, Reaugh, Fournier and Feinstein 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 (Zultner 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 1992; Longenecker and Feinstein 1991c; Longenecker, Reaugh, Fournier, Feinstein 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 revisit items multiple times with increasing complexity.

Figure 3a. CHARACTERISTICS OF IS '95 GRADUATES

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) central, 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 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; DPMA 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).

DEPTH 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 given level can be assessed.

The knowledge levels specified within IS '95 are compatible with the definitions of 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 3 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 items 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.

Figure 3b . CHARACTERISTICS OF IS '95 GRADUATES

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.
- As the IS field matures, increasing attention is being directed to problem avoidance and to process simplification through re-engineering. Error control, risk management, process measurement and auditing are areas that IS professionals must understand and apply.
- IS professionals must possess a tolerance for change and skills for managing the process of change.
- Given the advancing technology in the IS field, education must be continuous.
- It is important that IS professionals understand principles of setting and rigorously and completely achieving goals.
- IS professionals should understand the concepts and application of principle centered leadership.
- IS professionals must set a high ethical standard.
- An IS graduate must be able to use planning, implementation and diverse management and project management tools in a project environment, and in a world which represents a changing environment of global scope.
- An IS graduate must possess an awareness of management application techniques, professional and ethical concepts, legal issues, and strategic planning.
- An IS graduate must be able to provide essential support for the decision making process in the organization.
- An IS graduate must understand mission directed, principle centered mechanisms to facilitate aligning group as well as individual missions with organizational missions.

GROUPS
- IS professionals must interact with diverse user groups in team and project activities.
- IS professionals must possess communication and facilitatory skills within team meetings and other related activities.
- IS professionals must understand the concept of empathetic listening, and utilize it proactively to solicit synergistic solutions in which all parties to an agreement benefit.
- IS professionals must be able to communicate effectively with a changing work-force.

INDIVIDUAL CHARACTERISTICS
- IS graduates must communicate effectively, continue to learn and update their skills, renew their principles, and be confident in their abilities as professionals. They must be sensitive to the expanding role IS plays in society and understand the evolving implications of their professional, ethical, legal and social responsibilities.
- IS professionals should cultivate creativity and develop a tolerance and respect for this characteristic in others.
- An IS graduate should be able to enter and continue successfully through a four year program, and perhaps continue into a graduate course of study.
- An IS graduate must understand the value and necessity of personal goal setting.
- An IS graduate must understand and demonstrate the concept of making a personal decision.
- An IS professional must be able to committ to perform work, and rigorously complete such agreements.
- An IS graduate must be committed to the process of life-long learning, and must have the skill and desire of knowing how to learn.

IS '95 MODEL OF CURRICULUM AREAS, LEARNING UNITS AND COURSES

A primary design goal of IS '95 was to incorporate the body of knowledge, a rational presentation structure, and a set of courses that would satisfy the different constituencies. The concept of a learning unit was developed to provide a system of fundamental presentation units (Gagne 1988).

Five curriculum areas of instruction which span the pedagogical requirements of the IS degree program were developed (Figure 7). The relation of these areas to the courses is presented in Figures 6, 9A and 9B. These curriculum areas were defined to represent the logical relationships of groupings from the body of knowledge within the curriculum (Figure 6). The curriculum areas were subdivided into sub-areas. A sequencing of knowledge was not implied by this subdivision. Curriculum sub-areas were identified as the primary knowledge areas contained within each curriculum area (Figure 7).

Figures 9A and 9B contain a detailed pre-

Figure 4. ACADEMIC VERSUS INDUSTRY EXPECTED COMPETENCIES

BODY OF IS KNOWLEDGE ELEMENTS	Expected Knowledge Levels			
	Survey of IS Academics			Survey of IS Industry
	End User	IS Minor	IS Major	Entry Level
1.1 Computer Architectures	1.4	2.2	3.1	3.4
1.2 Algorithms and Data Structures	1.3	2.3	3.4	3.2
1.3 Programming Languages	1.5	2.6	3.7	3.2
1.4 Operating Systems	1.4	2.4	3.2	3.1
1.5 Telecommunications	1.5	2.5	3.2	3.0
1.6 Database	1.8	2.8	3.7	3.5
1.7 Artificial Intelligence	1.4	2.0	2.6	1.9
2.1 General Organizational Theory	1.8	2.3	2.8	2.6
2.2 Information Systems Management	1.6	2.6	3.2	2.5
2.3 Decision Theory	1.7	2.2	2.7	2.4
2.4 Organizational Behavior	2.7	2.7	2.8	2.4
2.7 Managing the Process of Change	1.9	2.3	2.8	2.8
2.8 Legal and Ethical Aspects of IS	1.5	2.6	3.0	3.5
2.9 Professionalism	1.9	2.6	3.0	3.5
2.10 Interpersonal Skills / Communications	2.5	2.8	3.9	4.0*
3.1 Systems and Information Concepts	2.5	2.8	3.1	3.3
3.2 Approaches to Systems Development	1.5	2.3	3.2	3.4
3.3 Systems Development Concepts and Methodologies	1.5	2.3	3.2	3.3
3.4 Systems Development Tools and Techniques	1.4	2.6	3.5	2.5
3.5 Applications Planning	1.7	2.8	3.6	3.0
3.7 Project Management	1.6	2.6	3.3	3.0
3.8 Information and Business Analysis	1.7	2.7	3.4	3.4
3.9 Information System Design	1.6	2.7	3.6	3.1
3.10 Systems Implementation and Testing Strategies	1.5	2.7	3.5	3.6
3.11 Systems Operation and Maintenance	1.5	2.7	3.5	—
3.12 Systems Development for Specific Types of Information Systems	1.7	2.7	3.2	—

The data from academics was obtained in a DPMA sponsored national survey of IS program heads conducted by the Joint ACM, AIS/ICIS, DPMA Task Force in December 1993. The Industry survey information was taken from Table 1 of Mawhinney 1994. (* Estimated from Figure 3; Mawhinney 1994).

Column 1 are sub-subject areas from the body of IS knowledge. Sub-areas 1.1 through 1.7 are second level elements from 1.0 Information Technology, whereas 2.1 through 2.10 Organization and Management Concepts, and 3.1 through 3.12 are from 3.0 Theory and Development of Systems.

The numbers in columns 2 through 5 are means from the survey respondents and represent the average depth of learning expected by the sample group wherein each respondent had selected an integer knowledge level (see figure 5 where 1=Awareness, 2-Literacy, 3=Use and 4=Apply).

Figure 5. KNOWLEDGE LEVELS,

IS '90, '94, '95 Depth of Knowledge	BLOOM Levels of Knowledge
1 Awareness	1 Knowledge Recognition
2 Literacy	1 Differentiation
3 Concept/Use	2 Comprehension Translation/Extrapolation Use of Knowledge
4 Detailed Understanding Application	3 Application Knowledge
5 Skilled Use	4 Analysis 5 Synthesis 6 Evaluation

The Joint DPMA, ACM, AIS IS '95 Task Force affirms a commitment to the taxonomy of knowledge description adopted by the IS '90 (Longenecker and Feinstein 1991; Longenecker, Reaugh, Fournier and Feinstein 1994) which is summarized above. Knowledge levels explained in the first column are in alignment with those of Bloom (Bloom 1956). IS '95 task force has used the template shown in column 3 to 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.

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 "P" 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 with 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, monograms and reference books. Adequate clerical and technical support must be also 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

Template for Writing Behavioral Objectives Students completing .. will be able to:	Meaning of Depth of Knowledge Level, and Activities Associated with Attaining that Level
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.
Compare and contrast .. Explain .. Write/Execute simple .. Functional capabilities 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.
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 Requires continued lab and project participation, presentation involving giving explanations and demonstrations, accepting criticism; may require developing skills in directed labs.
Search for correct solution to..and apply it to .. Design and implement a .. for .. Be able to 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 wherein students generate their own solutions, make their own decisions, commit to and complete assignments, present and explain solutions continuously.
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.

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 excelerated manners. This spiral approach is a systems approach and is similar to that recommended by Gagne (Brunner 1960, 1966; Briggs 1977; Soloway 1986; 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 be 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.

recurring themes expected of computer science graduates to see how they may be integrated into common courses. The introductory courses can be designed so that they may be used by business and other students who may require an introduction to information systems concepts and technologies as end-users of the information technology. In some institutions IS subject matter may be integrated with other programs. The learning units then may be used to preserve the integrity of the IS program.

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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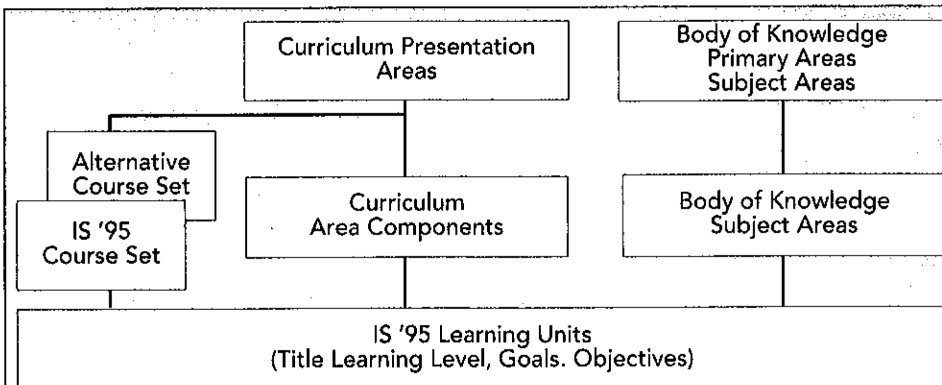
Figure 6. ARCHITECTURE OF IS '95 CURRICULUM



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 8 for defininition of a learning unit), as are curriculum sub-areas. Learning units have multiple areas from the body of knowledge.

Curriculum presentation areas setout 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.

Figure 7. IS '95 CURRICULUM AREA AND SUB-AREA DESIGNATIONS

Curriculum Areas and Sub-Areas for Curriculum '95

A. Fundamentals of Computer Information Systems
- A.1 IS Literacy
- A.2 End-User Computing

B. IS Theory and Practice
- B.1 Systems and Quality
- B.2 Decision Making
- B.3 IS Planning
- B.4 IT and Organizational Systems

C. Information Technology
- C.1 Computer Hardware
- C.2 System Software
- C.3 Telecommunications
- C.4 Programming
- C.5 Algorithmic Design

D. Systems Development
- D.1 Software Development
- D.2 Database
- D.3 Systems Analysis and Information System Design
- D.4 Teams and Interpersonal Relations
- D.5 Project Management

E. IS Deployment and Management
- E.1 Support Services
- E.2 Systems Integration
- E.3 Management of the IS Function
- E.4 Information Resource Management

Figure 8. CONCEPT OF A LEARNING UNIT

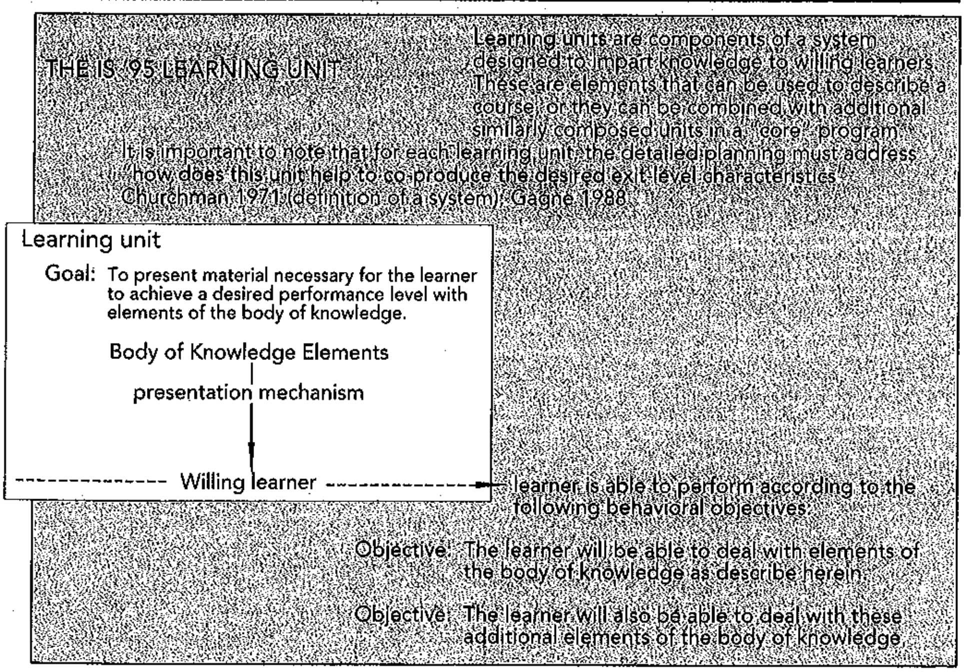


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Figure 9a. CURRICULUM AREAS IN IS '95. CURRICULUM AREA PREPRESENTS PROGRAM PREREQUISITES

Curriculum Areas Are Designated With The Alphabetic Label P, A, B, C, D And E, Whereas Sample Courses Of IS '95 Are Designated IS '95.0 Through IS '95.10.

P. Prerequisites

Prerequisite courses represent knowledge that is generally available to most university students in their first year, or may have been accomplished in a high school environment. Formal testing procedures should be used to ensure that waiving of this prerequisite is warranted.

IS '95.0 is shown in detail because it is likely to become the teaching responsibility of IS faculty. A list of other prerequisites is also shown and must be completed before entering IS '95.1, the first course in the degree program.

Expected prerequisites:

High school diploma (or equivalent)

Algebra (equivalent of college algebra, or 2 years high school algebra)

English composition

IS '95.0 - Knowledge Work Software Tool Kit

A. Fundamentals Of Computer Information Systems

Students who have developed basic end-user skills will have opportunity to gain breadth in the fundamentals of the information systems discipline and will gain hands-on experience in the use of information technology. These courses will provide an exciting glimpse into how information technology and information systems theory have ushered in the information age. They will demonstrate to the student why careers in computing information systems are stimulating and satisfying.

Systems theory provides a basis for understanding the major components of the discipline: 1) information technology and, 2) development of information systems. Systems theory also provides the basic mechanism for understanding quality concepts which are of growing interest and significance.

Graduates entering the work place need more skills that the traditional pc-tools course offers. A recommendation is the course in "personal productivity with IS technology." The end-user is being expected to take a more active role in the empowered organizations. Part of this new level of expected personal responsibility means being equipped with the knowledge work tools and an increasing degree of sophistication in problem solving. In addition, because of the increase in global telecommunications, end-users are expected to know how to access information anywhere in the world.

IS '95.1 - Fundamentals of Information Systems

IS '95.2 - Personal Productivity with IS Technology

B. IS Theory

Students who are familiar with information systems and information technology will be exposed to systems, quality, and decision theory. They will have opportunity to study organizational models and discover the relevance of different types of information systems that enable success at all levels of an organization.

The relationship of IS to corporate planning is stressed, as is the organizational consequences of implementing information systems. The concept of the strategic significance of information systems, as well as their development within continuously improving organizations is presented. Earlier curriculum models of the ACM and DPMA have included this course. However, in this implementation, the ground work has been developed using the previous courses of this model; consequently, there will be no need for discussion of computing systems and hardware. This will allow more time to consider IS theory and the concepts of re-engineering. Also, there will be time to introduce some IS management concepts that in the past have been introduced in a capstone sequence.

IS '95.3 - Information Systems Theory And Practice

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Figure 9b. CURRICULUM AREAS OF IS '95

C. Information Technology

This curriculum area provides 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 systems view is used to present computing system architectures and operating systems software. Interconnection of information resources through telecommunications is a major component of presentation and discussion. Students will be expected to develop significant skills through participating in installation, configuration, and operation of the technologies. Finally, 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

D. 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, and then design and implement information systems. The systems analysis course provides experience determining system requirements, and developing a logical design. The course shows skills particularly suitable for organizations involved in process re-engineering. Skills in project management will be learned and used throughout the course to facilitate team accomplishments.

Two sequences in physical design of information systems will ensure that the students can use a logical design to implement information systems. One sequence is involved with the design and implementation using CASE or ICASE. The other sequence involves development of the information system using a conventional programming language capable of making calls to a DBMS.

While some institutions will insist on teaching a separate database course, the recommendation here is that the database skills be spread over several courses. Access to indexed files within a database occurs in the information technology sequence. However, in two prior courses students will have had demands for implementation of several database solutions, and should be familiar with the data manipulation language, or equivalent, in the database to be used. In this curriculum area, design of the database occurs in the analysis sequence, while physical design and access occurs in both of the other sequences as an adjunct to the implementation process. This approach is compatible with the spiraling design of the curriculum. The repetition will develop confidence in the students through repeated, yet escalating expectations.

- 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 engaging in a significant project conducted with minimal supervision. It is desirable to solve a real problem for a real client; however, a simulated client may be employed.

Management of the information systems function, systems integration, and project management to ensure project quality are integral components of this course. They may be handled in a seminar fashion where students read and present relevant papers, or they may be addressed indirectly through use of the development of appropriate project standards focusing on the key issues and ensuring their coverage and application.

Complete enterprise solutions may be too aggressive; however, the project should focus on horizontal involvement of several departments involved 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

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