EDUCATING THE NEXT GENERATION OF INFORMATION SPECIALISTS,
IN COLLABORATION WITH INDUSTRY

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Abstract
This is a bold, new effort to have industry and academia work together to define the curriculum to prepare the information specialists for tomorrow. The task force which is working to develop this curriculum is made up of an equal number of members of industry and academia. In addition to a curriculum this work includes a plan for delivery. Not surprisingly, industry members are concerned that the graduates be able to adapt quickly to the environment of business and industry. Today all too many graduates lack skills in teamwork and communication. In most cases the employers are satisfied with the technical skills of graduates. This paper will discuss the background that lead to this project, the early developments of the "Profile of the Graduate," the work on delivery of the curriculum, a brief description of the status of the curriculum and how this addresses the concerns of industry.

Background

Based on a previous NSF/DUE project, 9352944, the needs of industry are the driver for the curriculum that is being developed. Though the representatives from a very wide range of businesses and industry, they are almost unanimous in what they want the graduate of a program in computer information science to prepare the graduate to do. Basically they are satisfied with the technological knowledge of the current graduates. However, they are uniformly concerned about the lack of skills to work in a team environment and to communicate orally and in written form.

Project approach

The first major task of the group was to develop a profile of the graduate. This profile is the specification which is needed in order to determine what should be in the curriculum. Once the profile is complete, the next task is to identify the knowledge-base needed in the curriculum in order that the student will be able to meet the requirements as specified in the profile.

In addition to covering the technical content, it is necessary to consider the additional skills that are necessary for an information scientist to function effectively. Emphasis will be placed on preparing the graduate to work as a member of a team, to have experiences from the beginning of the course of study in working collaboratively. Hands-on experiences will also be emphasized so that graduates have had multiple experiences in working with small and large groups, in taking leadership and followership roles in teams, in evaluating their own work and the work of members of their team. During the final year of the undergraduate program students will have an opportunity to work on a real project as a part of a business or industry team. Already we have had a pilot study of such an experience. This extremely successful pilot study will be discussed later in the paper. It pairs a project in industry with a class in which the instructor provides "Just-in-time-learning" so that the students are prepared for what they will be doing in the next step of the project.

Currently, the curriculum is being designed and refined. The first year will emphasize a breadth in the field of computing with some emphasis on enterprise computing. Students need to acquire a good understanding of computer applications and how they relate to the total business or industry in which they are involved. It is not sufficient for graduates to be able to write code and to speak "computerese." Though they must understand data structures, this is not sufficient. They must understand what data structures are best for the application they are

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involved in and how this interacts with the larger systems of the company or organization which will use their systems.

Profile of the Graduate

The last decade has seen tremendous change in information technology. Powerful computers are now pervasive in offices and homes, telecommunications have become faster and cheaper, information is increasingly available at many levels. Internet and World Wide Web have expanded beyond the expectations of most everyone in the profession. The next generation of information specialists must be able to work in the current environment and be able to adapt to the developments of the future.

The business and industry people on the task force represent aerospace, communications, government, finance and technology organizations. Surprisingly, their requirements of graduates they hire are quite similar. The differences are only in some special technologies which support their particular industry.

The reduced and restructured workforce which is seen in many businesses today is also more team-based and relies more on information technology for almost all aspects of business, e.g. services, distribution, and production. Graduates must be prepared to face the challenges of this workplace.

In the working paper prepared by the industry members of the task force, they state clearly "The graduate is expected to have acquired the set of attributes essential to success in the workplace, i.e., ethical standards, personal discipline, risk taking and problem solving skills, perseverance and the ability to think critically. In addition, there are specific attributes essential to an Information Systems Engineering practitioner:

- systemic thinking
- curiosity
- coping with change

The Challenge - How to teach the skills, provide the knowledge and nurture the personal attributes through a curriculum that produces excellence through education, and that begins a process that continues through a lifetime."

The Knowledge-base of the Graduate

1. Information abstraction, representation, and organization:
   realization of data and the logic to manipulate it, concept of abstraction levels, information organization, the mathematics of abstraction.

2. Enterprise computing architectures and delivery systems (currently, this includes processors, end-user devices, servers, storage systems, security, large-scale systems, high-performance systems, and operating systems):
   includes hardware (and associated technologies), organization, information architectures and systems perspectives (including globalization), locating and evaluating off-the-shelf systems.

3. Concepts of distribution
   includes network structures, client-server technologies, work and IRM (including information distribution, retrieval, and management) databases and datamining, security, communication systems, networks and routing, products and services, network performance analysis, the mathematics of distribution.

4. a. Human Behaviors:
   dynamics of individual and group behaviors, human-computer interaction, ergonomics, ethics of information systems, influences of multi-cultures, behavioral sciences that support study of humans.
   b. Information Presentation:
      user interfaces, visualization, virtual reality, multimedia, organizational image (including Web presence).
   c. Intelligent Systems:
      intelligent agents, expert systems, virtuality, robotics, machine problem solving, speech processing, neural networks.

5. Dynamics:
   includes concepts and dynamics of complexity, design for change, experimentation as a means of capturing dynamics,
modeling processes and systems.

6. Process Management and Systems Development: concepts of processes, and external influences on processes such as
   software engineering,
   system development methodologies and tools,
   project management,
   deployment,
   systems evaluation,
   metrics,
   verification and validation,
   concepts of imbedded quality.

7. Domain Knowledge - Concentration on specific knowledge bases where information systems are widely applied such as:
   manufacturing,
   aerospace,
   telecommunications,
   finance,
   transportation,
   government,
   service and retail industries,
   medical and health care.

While not all topics will be covered to the same breadth, there is agreement that all except domain knowledge should be covered to some level for all students. As we put the upper level courses together, the level of coverage of each area will be specified.

Deliverables

This project will develop a detailed curriculum for Computer Information Science, supporting materials, and new learning paradigms for educating the information specialist by providing him/her with skills in problem-solving, communications, teamwork, and experience and methods for working with large, complex applications.

The curriculum will be designed to use, where possible, those courses already extant in colleges and universities. With the representatives of business and industry, specific case studies and laboratory projects will be designed so that students can experience first in an academic environment and later in collaboration with industry, the processes, methodologies, and growing responsibility and complexities of problem-solving in information science.

New Learning Teaching Paradigms

Research to date suggests that current computer information systems oriented curricula do not effectively deal with large grain software and hardware modules, [complexity in the small complexity. While graduates are prepared to define, development and implement sizable software and hardware modules, [complexity in the small], they are seldom provided with experiences in solving large information systems problems [complexity in the large]. Clearly this must be a part of the curriculum.

A major element of this project is the development of a bold, new learning paradigm. This new learning paradigm involves electronically linking the university classroom/laboratory with an active project environment in industry. The collaborating company will identify a meaningful and significant large information system project, identify its working team, and establish the electronic two-way links with the university working team that will collaborate on the project. The university will identify a lead faculty member (and other faculty participants, if appropriate) of the team, and the upper division students who will participate in the project. The project will progress according to the company's established plan, with active, continual participation by the university team members. The lead faculty member will organize the classroom/laboratory material and lectures in a manner to support the project learning being experienced by the students on the team at the time.

The first pilot project testing this teaching learning paradigm has just been completed with the Boeing Company and the University of Washington carrying out the Repository Application Project. Ms Kathleen Williams was the lead for the Boeing Company and Dr. Nancy Leveson was the faculty member from the University of Washington. This project was completed in June, 1996. Evaluation by students, faculty and company personnel involved in the project will be available shortly. Initial impressions and the final presentations by the students indicate that this was a great success.

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