Integrating Computer Science and Information Systems

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Abstract

The Master of Science, major in Computing and Information Systems (CIS) is a graduate program offered jointly by the graduate faculties of the Department of Computer Science in the School of Engineering and the Department of Computer Management and Information Systems in the School of Business. We describe the nature of the program and emphasizes the advantages of a joint degree program that spans academic units. We also touch on problems that may be encountered and how they can be overcome. The successes realized and situations encountered by this merger may benefit other institutions that face similar resource constraints.

Introduction

In 1991, the faculties of the Department of Management Information Systems (MIS) and the Department of Computer Science (CS) discussed the potential for merging two graduate level programs. For several years, both departments had faced the reality of decreasing resources for both personnel and monetary facets. The initial meeting of the two faculties had two major outcomes. First, the faculties determined that the resources needed to continue to offer two separate graduate programs were inadequate. Further, it was highly unlikely that the situation would improve for the foreseeable future. Second, the faculties agreed that graduate education in the computing field was, and would remain a critical service that our educational institution should continue to make available to the citizens of the geographic region. Accordingly, the faculties agreed to the appointment of a joint committee to investigate the development of an integrated Master of Science, major in Computing and Information Systems (CIS) program.

The committee included two faculty members from each department. In retrospect, a four-person committee membership was a good, workable committee size. It facilitated the scheduling of meetings and the coordination of reviews for documents pertaining to the curriculum development effort. Additionally, final approval of the curriculum proposed remained with the entire faculties of the two departments.

The MS in CIS program that resulted from the curriculum development effort is unique. The committee decided to house the program for administrative purposes within the School of Engineering. It was recognized that this would also affect the curriculum content and type of students attracted to the program as the program would be viewed as having an engineering as opposed to a business emphasis. Indeed, the focus of the program blends characteristics of typical MS in CS and MS in MIS graduate programs quite nicely. The MS in CIS has a smaller theoretical component than a typical MS in CS. It also has a reduced emphasis on management and business than the typical MS in MIS program. The MS in CIS emphasizes the application of state-of-the-art computing technologies to the development of automated solutions for a variety of business and engineering challenges. The program focuses on the areas of software engineering, user and application interfaces, database management systems, computer system architectures, networks, and information systems project management. The curriculum provides graduate students with a solid technical foundation in computing. This foundation will enable them to grow and change as the discipline of computing and information systems evolves. This prepares students to work as practitioners in a wide variety of computing positions such as software developer, computer consultant, system integrator, technology manager, systems programmer, project leader, network administrator, and application software specialist. The comprehensive nature of the program also enables a program graduate to function as computing generalist in a small company environment.

Previous Computing Programs at the University

Computing programs were first introduced at Southern Illinois University at Edwardsville in 1969 as a computer science "track" in the undergraduate major in mathematical studies. The first Association for Computing Machinery (ACM) curriculum recommendation for undergraduate computer science was published in 1968 and it provided direction for the faculty. As we added new courses, we also created some advanced graduate-level courses for the

mathematics program.

Through the years, the direction of development of computer science offerings at the University was influenced by the employment opportunities available to graduates who completed the computer science track. For many years, the primary employers of graduates were major defense contractors who were developing aircraft and missile systems and other weapons systems. Consequently, the computer science offerings did not emphasize business data processing applications.

Planning for the management systems graduate program, the forerunner of the Master of Science, major in Management Information Systems graduate program, began in 1974. The initial program had a management science (operations research) orientation within the School of Business. The Master of Science, major in Management Systems program was initiated in 1976. The program was designed to educate students in information technology, and in structured methods for information systems analysis and design. The program consisted of business foundation courses, an information systems core, advanced business electives, and a capstone project-based course involving the design and implementation of an information system. Graduates of the program found jobs as systems analysts, project managers, database designers, and systems consultants.

Before the development of the CIS graduate degree, the two faculties collaborated in offering an interdisciplinary freshman-level course dealing with "Computers and Society." This general education course is offered and staffed by both departments, and follows a common syllabus. These collaborative curriculum development efforts laid the foundation for the spirit of cooperation that exists today between the two departments. Indeed, faculties considering the undertaking of a joint curriculum should realize that the spirit of cooperation is critical to the success of such an effort.

At the start of the new program, in late 1994, the two departments moved to co-locate their physical offices within the same office suite. They made the move to facilitate communications and to collaborate on joint teaching and research projects. It has had a clear, positive impact on the success of the program and the sharing of resources. This was admittedly a luxury that other institutions may not be able to enjoy, depending upon the availability and current utilization of building and office resources.

Impetus for Change

The Computing Technology Consortium concept envisions that students of computing programs play a major role in technology transfer. The two faculties found that the separate graduate programs were limited in the ways they could address computing technology. The MIS faculty in the School of Business needed new resources to broaden the coverage of computing topics beyond the emphasis on software engineering and information systems design. The computer science faculty provided these resources through existing graduate-level courses that would complement the existing information systems degree program.

At the same time, the University was carefully examining ways to fulfill its mission in an environment of very strict resource limitations. In the School of Business and the School of Sciences, this examination led to questions about the ability of the University to continue to provide adequate graduate-level work in computing with no prospect of new resources. A joint graduate program would allow the University to respond in an effective way to the need to promote computing technology transfer with the current level of personnel and computing resources.

It is important to understand that the CIS program is neither an interdisciplinary program nor the merging of two separate disciplines in a single graduate program. Rather, it recognizes that the two faculties represent different aspects of the same discipline. In the past, the MIS department did not have the resources to teach the more technical graduate-level courses in areas such as data communications and operating systems. The CS department did not have the resources to provide full graduate-level coverage of database systems, software engineering methodology, and information systems project management. By combining the strengths of the two departments, the new CIS program offers a comprehensive curriculum that covers both managerial and technical areas of the discipline of computing and provides students with a high-quality program. The most important implications are for the future; the combined resources of the two faculties made the incorporation of new computing technology merge into the program.

After we completed the initial curriculum proposal in 1991, two sets of consultants were asked to review the proposal. Edward Stohr and Zvi Kedem, chairs of the Information Systems Department and the Computer Science Department at New York University, completed one review. These two departments, one in the Stern School of Management and the other in the Courant Institute of Mathematical Sciences, were in the process of establishing a similar program. Alan Hevner, chair of the Information Systems Faculty in the College of Business and Management at the University of Maryland (College Park) provided a second review. At that time, Hevner was also co-director of the Master of Science in Systems Engineering program in the School of Engineering at Maryland. The reviewers provided valuable advice concerning curriculum and governance and we incorporated several of their suggestions into the proposal.

Program of Study

The program of study requires 33 semester hours and consists of six core courses, four elective courses, and a culminating software design project that serves in lieu of a thesis. Candidates for admission submit a "statement of purpose" that outlines their reason for proposing to study the area of computing. They also submit a detailed resume as part of the admission application process. Candidates must have an undergraduate degree in a computing field. Candidates with an inadequate academic background must complete selected program prerequisites as outlined below. The program director also requires candidates to submit the results of either the Graduate Record Examination (GRE) or Graduate Management Admission Test (GMAT). Based on

historic data, students scoring at least at the fiftieth percentile tend to be most successful in the program.

Courses for the degree are offered in an evening format. Scheduling is based on the assumption that many students will be completing the degree on a part-time basis as they will be already working within the computing field locally. This stems from the fact that the University is located within the greater St. Louis metropolitan area. The number and variety of courses offered each year are also sufficient to support full-time students. Core courses are offered multiple times through the school year. Some courses, such as topical seminars, are also offered during the summer term. A full-time student can complete the program within two academic years, while a part-time student who completes three courses per year can complete the program within three calendar years.

Program Prerequisites

Students entering the program need specific background knowledge. They can acquire this knowledge as part of a baccalaureate program or in post-baccalaureate studies. Due to the changing nature of computer technology, the faculty requires that the skills/knowledge taught in the computing courses within the program prerequisites must have been acquired within the past six years. The specific knowledge courses include:

C++ Language
Programming Proficiency in a second language
Data Structures
Computer Organization and Architecture
Information Systems Theory
Accounting Fundamentals
Calculus
Statistics
Ethics, Law, and Social Responsibilities

Program Core Courses

The program core consists of six courses that cover the major areas of computing for a program with an applied focus. In assigning faculty to teach core courses, the department chairs of the CS and CMIS departments coordinate scheduling to take advantage of the academic background strengths of the faculty within the two departments. Several of the courses can be assigned to faculty from either department. Generally, the six core courses are equally divided between the two departments with the CS faculty teaching a thorough technical coverage of algorithms [CIS 515], computer systems architecture [CIS 518], and communication systems [CIS 520]. CMIS faculty primarily teach the core courses that concentrate on the fundamental concepts and techniques of application software design and development including software analysis and design [CIS 570], database design and implementation [CIS 564], and project management [CIS 540]. These latter three courses approach computing from the viewpoint of a software specialist. They focus on current and applicable technology and describe the economic and technological reasons for trends, and thus complement the other core courses. Details of each of the required core courses appear in Appendix A.

Program Electives

Students select four elective courses that build on the competencies developed in the core. The program director interviews all new students. Students expressing an interest within a particular area of computing are assigned to a faculty advisor having the appropriate expertise. The faculty advisor approves the selection of electives by students and guides the student to enhance their educational experience. The CIS program electives are: human-computer interface design, rapid application development, expert systems, network programming, network planning and management, network construction seminar, software engineering seminar, database administration seminar, computing technology focus seminar, high performance computer systems, artificial intelligence, parallel computing,computer graphics, Ada programming, applied operating systems, and principles of simulation.

Culminating Project

The culminating project is a three credit-hour software design project accomplished independently by the student. The project involves the analysis, design, and possibly implementation of a system using technologies and methodologies that are covered in the program, and serves in lieu of the master's thesis. The student selects a faculty design project committee to oversee the student's work. The committee consists of a project chairperson and two committee members. While the project is normally completed during the student's final semester in the program, selection of the faculty design project committee and planning for the project must be accomplished before the final semester. In fact, students often complete the feasibility study and detailed analysis of requirements for the project in the term preceding that in which they will graduate. With proper guidance, students are then able to complete their project during their final term of study.

The design project report must meet standards defined by the CIS Graduate Committee. At the conclusion of the project, the student presents and defends the project before the faculty design project committee and other interested members of the University community. Only the members of the student's faculty design project committee determine if the project is acceptable.

Program Governance and Administration

The Department of Computer Science in the School of Engineering administrates the CIS program. Student records are maintained by clerical staff in a central administration office that serves both academic departments. Governance and administration, including student advising, is the responsibility of the program faculty.

The program director position rotates between the Department of CS and the Department of CMIS every two years. The CIS Graduate Committee has four members, two from each department. The members include the two department chairs and the program director. The committee is responsible for administration and curriculum matters including admission and retention decisions, assigning

students to faculty advisers, approving transfer credit and elective substitutions, approving faculty advisory committees for culminating projects, creating and maintaining the lists of acceptable elective courses, defining design project standards, and program evaluation.

The committee makes recommendations to the program faculty concerning policy and curriculum matters. The respective chairs of Computer Science and Computer Management and Information Systems make faculty teaching assignments through coordinated meetings. The department chairs, subject to ratification by the program faculty make appointments to the committee.

Modifications to the program, courses, and admission requirements, and retention standards require approval by the program faculty. Modifications that require external review are submitted for School and University-level approval after approval by the program faculty.

Advisory Board

The Master of Science, major in Management Information Systems, program that preceded our current CIS program had an applied research emphasis. From the beginning, this included an industrial advisory board consisting of leaders from local industries and businesses who provided guidance with respect to curriculum issues. With the new CIS program, the industrial advisory board was expanded to broaden the focus of the firms represented on the board, and was named the CIS Industrial Advisory Board. The Board facilitates personal contact between program faculty and local business and industry leaders. This supports efforts to market the CIS program. Companies on the Board also assist the CIS Graduate Committee with program evaluation, and provide financial support that enables the program to provide students with access to state-of-the-art computer technology. These firms also provide opportunities for students to complete their culminating projects in operational environments. Of course, they also employee the students upon graduation.

Results to Date

The CIS program has now been offered for over five years. Enrollments have been high, exceeding forecasted demand for the program. Initially core courses were offered once per year in an evening format with three of the core courses offered each semester. Student demand has led to an increase in offerings in the core courses. In order to control enrollment in the CIS courses, the courses have restricted enrollment such that until the first day of classes, only CIS major can enroll in the courses.

The majority of CIS students have come from the undergraduate disciplines of computer science, information systems, and engineering. The initial program proposal envisioned several categories of studies including: (1) recent college graduates from area universities in the fields of business, computer science, and electrical engineering; (2) computing professionals desiring to upgrade their knowledge and skills; and (3) individuals with non-computing backgrounds desiring to retrain into the computer field. This vision proved to be fairly accurate. The majority of the students have come from groups (1) and (2). Individuals from group (3) usually must complete the majority of the prerequisite courses in preparation for program admission. Most students taking course are part-time students employed on either a full- or part-time basis in local businesses.

The curriculum as initially proposed has been very stable. No major revisions have been required. Sufficient electives have been offered to satisfy student demand. Seminars, as originally planned, have provided students opportunities to study new technologies. Seminars have focused on a diverse set of topics such as Oracle database administration, Windows NT operating system, Novell networks, visual programming language developments, and other topics.

Challenges

Like any new program, the CIS program has faced its share of challenges. Most of the challenges have resulted from resource constraints. Keep in mind that one of the major driving forces behind establishment of this joint degree program was the desire to leverage existing faculty, personnel and computing resources. Still, enrollment demand has burgeoned with demand about double that which we anticipated.

We are challenged with finding ways to meet student demand while maintaining a satisfactory level of quality in our instruction. To a great extent, the combined resources of the two departments have served to meet student demand, although many graduate course sections have enrollments as high as 40 to 50 students per section. Still, if the two departments had not agreed to the merging of their graduate computing programs, we could not have met student demand.

The admission process has also challenged the faculty. The nature of the MS in CIS is that it attracts students with quite varied backgrounds as discussed above. The use of both the GRE and GMAT has both positives and negatives. On the positive side, students who have already completed one of the two examinations were accommodated because we have not required a single specific admissions examination. On the negative side, the CIS Graduate Committee must deal with the different information and results provided by the two examinations. The GRE/GMAT standard for admission is a major hurdle for most students who were not admitted to the program. Students do not seem to understand the need for verbal as well as quantitative and analytical skills as a basis for program success. More student admissions are denied for failure to achieve a satisfactory score on the verbal component of these standard examinations than for performance on the quantitative and analytical components. Student appeals tend to focus on their performance on the verbal portion of the standard examination that they elected to take.

Students admitted to the program who have completed most prerequisites have tended to perform well in their core coursework. Faculty have expressed concern with students who are admitted without an adequate C++ programming background. Some students have presented academic credentials that indicate their competency in the computer programming area, but have subsequently performed poorly

in their coursework. This is most often true of students who completed academic courses of study in computer programming outside of approved four-year accredited computing degree programs. We are currently examining the use of hands-on waiver examinations for the programming language prerequisite as a screening mechanism for testing actual student competency in the C++ and other programming languages.

Summary

The Master of Science, major in Computing and Information Systems, is a unique academic program that combines the strengths of the management-oriented information systems faculty in the School of Business and the technology-oriented computer science faculty in the School of Engineering. Strong student demand and strong employer demand for the program have provided the University with the opportunity to serve the geographic region. A detailed description of the CIS program is available at: <www.siue.edu/BUSINESS/depart/mis/msincis.htm> on the world wide web.

References

[1] ACM Committee On Computer Science, Curriculum 68: Recommendations for Academic Programs in Computer Science, *Communications of the ACM 11*, 3 (1968), 151-197.

[2] ACM Committee on Computer Science, Curriculum 78: Recommendations for the Undergraduate Program in Computer Science, *Communications of the ACM 22*, 3 (1979), 147-166.

[3] Tucker, A. B. A Summary of the ACM/IEEE-CS Joint Curriculum Task Force, Computing Curricula 1991," *Communications of the ACM 34*, 6 (1991), 68-84.

[4] Longenecker, H. E. Jr., and Feinstein, D. L., Editors. DPMA Model Curricula for the 1990s. Published by DPMA, Park Ridge, IL, 1991.

[5] Nunamaker, J. F., Cougar, J. D., and Davis, G. B. Information System Curriculum Recommendations for the 80s: Undergraduate and Graduate Programs, *Communication of the ACM 25*, 11 (1982) 781-805.

Reviewed Papers

Appendix A. Program Core Course Descriptions

CIS 515 is a course in algorithms and associated data structures. Systems analysts develop algorithms for, or tailor them to, specific applications. This course covers fundamental classes of algorithms and strategies for deriving algorithms. Parallel and distributed algorithms are included. Students learn to balance the ever-present trade-off of speed, cost, and size.

CIS 518 covers the topic of computer systems architecture. The underlying hardware and operating system are major factors in the performance of application software. A software specialist must understand the effect of various hardware options on performance and cost. The software specialist must be aware of hardware trends and the changing relationship between hardware and software in newer systems. The software specialist must also understand the application program and user interfaces of operating systems, since these serve as the base for application systems. This course provides a survey of hardware and operating system concepts, analyzes commercially important systems, and examines trends in this technology.

CIS 520 extends the material of CIS 518 to systems of multiple computers linked by a communications network. Today, very few computing systems are isolated systems and an increasing number of applications involve distributed data and computations. The course covers the fundamental data communications and network concepts that are the basis of distributed applications.

CIS 540 is a course in the management of information systems development process. Students learn theory and techniques for managing software development projects within the constraints of time and resources. Topics include project planning, cost estimating, human resource management issues, and quality control issues.

CIS 564 covers database design from an enterprise-wide perspective. Students develop competence in conceptual data modeling using a variety of modeling approaches, and in converting conceptual models to implementation models using the Oracle RDBMS. The course includes data administration concepts relevant to backup, recovery, concurrency control, and data dictionary management.

CIS 570 focuses on software systems analysis and design. Students learn process-oriented modeling and structured design concepts and techniques using Oracle CASE tools. The focus is on re-engineering, restructuring, and simplifying business processes, and on quality assurance, reliability, and flexibility in software systems.