

THE MASTER OF SCIENCE PROGRAM IN COMPUTER AND INFORMATION SCIENCE
AT SAN JOSE STATE UNIVERSITY

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Introduction

Recently, in the fall of 1974, San Jose State University (SJSU) launched a new master's program in Computer and Information Science (CIS). The main function of this paper is to describe the program -- detailing its origins, content, administration, present status and potential future. A secondary purpose is to present material about one of the program's options -- Management Information Systems (MIS). In order to accomplish the above goals, the paper is divided into five sections as follows: Background, Program Description, Current Results, MIS Option, and Summary.

Background

In the period 1970-71, a university-wide committee consisting of various deans and other university representatives was established to consider the establishment of a master's degree in computer science. This larger committee established a sub-committee which was to generate a degree proposal. This sub-committee had some difficulty agreeing on a common approach and after a year's discussion and debate, two proposals emerged. One was the traditional, quantitative approach to Computer Science as outlined in the early ACM Computer Science Curriculum Guides (see Communications of the ACM, September 1965, March 1968). The second approach attempted to broaden the scope and make the program a master's degree in computing and information science which would attract students from many disciplines, not just the traditional quantitative orientation which tends to attract mainly mathematics and engineering students. After another year of negotiating and compromising, a single program was developed and subsequently approved at all levels -- both locally and in the Chancellor's Office. The final form of the program, as it now exists, is given in the next section.

Program Description

The M.S. in CIS at San Jose State University is basically a multidisciplinary program which is administered by the Dean of Graduate Studies, with the assistance of a Program Coordinator and an Advisory Committee. Because of the multidisciplinary nature, it is not "housed" in any one school. The Advisory Committee is composed of the advisors for each option (currently six options exist) and the Coordinator is chosen on a rotating basis from among the advisors.

The program is designed to provide students with an opportunity to develop theoretical understanding and practical skills at an advanced level in all the options which now consist of: Computer Design, Computer Software, Computer Mathematics, Management Information Systems, Library Information Systems and Instrumentation Technology. The program provides intensive preparation in concepts and techniques relating to the theory, design and applications of Computer and Information Sciences. The intent of each of the existing options is given below.

COMPUTER DESIGN. This option will emphasize knowledge central to computer organization, computer architecture, computer logic, microprogramming, and computer design. Students will learn how to design general purpose computers, special purpose computers, mini computers, computer communications systems, and the art of computer memory products. Students will be prepared to do small- and medium-scale digital and analog designs as well as to do design of hardware for time-sharing systems. They will be able to delineate the interdependence of computer hardware and computer software. Opportunity to update their knowledge will be given for those already working in the computer industry. Students will be able to conceive, plan

and implement specific hardware and software modifications in existing computer systems. Such modifications might presumably be needed to satisfy specialized requirements of a particular computer user.

COMPUTER SOFTWARE. This option is intended to give students a solid foundation in software design, compilers, operating systems, computer languages, automata, and system simulation. Students will also develop skills necessary for the design of efficient and effective software systems. During the course of their study, students will design and test compilers, operating systems, new programming languages and applications software systems. For those already working in the computer software area, opportunity will be provided for updating their knowledge.

COMPUTER MATHEMATICS. Students will learn to formulate problems for solution on computers in this option. Specific techniques will be provided as well as theoretical background in those areas of applied mathematics where significant amounts of work are now being done, including numerical analysis, probability and statistics, ordinary and partial differential equations, graph theory, linear and dynamic programming. An understanding of what problems can be solved using computers will evolve which will include formal work in computability and solvability. Background in pure mathematics, particularly in analysis and algebra, will implement the course and the more advanced techniques of problem solution will accrue to the student.

MANAGEMENT INFORMATION SYSTEMS. Students will acquire the ability to view, describe and define management and business situations as systems and will specify components, boundaries, etc. They will receive knowledge of basic hardware/software components of computer systems and their patterns of configuration. Students will also formulate major alternatives in an information processing system, including data files and communications structures. They will develop specifications for the computer-based part of a major information system, with details of task management and data base management components. Students will be assisted with techniques of gathering information and in specifying several alternative sets of information transfers and processing to meet particular needs. Practice in addressing a given organization-need and determining the breakdown into manual and computer-based parts will ensue. Finally, students will be qualified to initiate use of the computer as a decision-making tool for large organizations, public and private.

LIBRARY INFORMATION SYSTEMS. This field now demands professionals with skills in systems analysis and design, file structure and design, indexing and its applications. Skills in information analysis and retrieval will accompany information theory and communication processes. Students will be equipped to understand basic hardware/software components of computer systems and their patterns of configuration. Those electing this option will have the opportunity of "first job" training in library automation programs.

INSTRUMENTATION TECHNOLOGY. This option will offer advanced system techniques of analytical problem solution, stressing conservation of time and energy coupled with the most humanistic approach possible and the most advanced tools of analysis. The student will apply his experience to a functional knowledge of computer concepts in industrial computers and in development processes, including mini computer applications. He will program digital computers to document, control, and assist systems; test reliability and accountability of various environments. In developing application programs in automated manufacturing processes, such as utilizing modern typical mini computers, he will practice testing, monitoring, production control and process control of analog functions. A broad conceptual and applications base will be provided for his functioning in a preferred place in the technological community.

Regardless of which option is selected, each student must complete a common core of four courses. These courses are:

CIS 242 Mathematical Concepts of Computer and Information Sciences

CIS 270 Computers and Information Systems

CIS 280 Data Structures

CIS 281 Computer Software

Each of these courses is three units. All CIS students take 12 units of core, at least 12 units in their selected option and up to six units of electives or thesis -- for a total requirement of 30 units. In addition to the course work, all students must pass

two comprehensive written exams. One is based on the core courses; the other is based on the particular option involved.

Because the core is common, a brief description of each core course is given below. A listing of the courses for each option will of course be supplied to anyone who is interested. The core content is:

CIS CORE

CIS 242 Mathematical Concepts of Computer and Information Sciences. 3 units.

Data reduction and the preservation of information, structure of information storage systems, pattern recognition, methods of optimization, computability and solvability, communication theory, theory of algorithms.

CIS 270 Computer and Information Systems. 3 units.

Processor organization; computer hardware description; programming and software; manufacturer supplied software, business and scientific processing, process control, time sharing and other applications; basic concepts; future trends in hardware, software, and applications. Prerequisite: Bus 191 or EE 174 or Math 144 or Engr 150 or equivalent.

CIS 280 Data Structures. 3 units.

Basic concepts of data. Linear lists, strings, arrays and orthogonal lists. Representation of trees and graphs. Storage systems and structure, and storage allocation and collection. Multi-linked structures. Symbol tables and searching techniques. Sorting (ordering) techniques. Formal specification of data management systems. Prerequisites: Math 144 or Bus 191 or EE 174 or Eng 150, or consent of instructor.

CIS 281 Computer Software. 3 units.

Introduction to software, assembly, macrocommand's assembly subroutine, IOCS preprocessor, buffer subsystem, supervisor leader and allocator. Prerequisite: EE 174 or Bus 191 or Math 144 or Engr 150 or consent of the instructor.

A few comments about prerequisites should be mentioned. First, the mathematical background required has been intentionally diluted. This essentially means that calculus is not a prerequisite as it is in many other straight computer science programs. This does not in any way weaken the program since those students who need the calculus (e.g., computer design or computer mathematics majors) would have already had it. The mathematical training required of all CIS students is up to and including elementary statistics and the fundamentals of probability. While a strong quantitative background is encouraged, it is not vital for performing many functions in the computer and information science field.

There are two other requirements of all students in the program. First, a knowledge of elementary computer programming which includes problem analysis and algorithm synthesis as well as competence in at least one higher level language. Second, at least 12 upper division units of undergraduate preparation which is appropriate to the option selected. The details of this for each option are omitted here.

The last major requirement of all students who wish to enter the program is to achieve a satisfactory score on either the GRE (900) or ATGSB (450) exam. Other normal requirements for admission to graduate school also apply but are not given in this paper.

Finally, it should be noted that, while the following were not adhered to completely, objectives, content and ideas for the overall program were obtained from the Curriculum Committee on Computer Science of the Association of Computing Machinery, the Curriculum Committee on Computer Education for Management of the Association for Computing Machinery, The Special Interest Group on Education for Information Science of the American Society for Information Science, and the joint Library Education Division/Information Science and Automation Division Committee of the American Library Association.

Current Results

The early program results have been most gratifying. Three of the six options, Computer Design, Computer Software and Computer Mathematics, were started in the fall of 1974. The entire program was officially approved in December 1974. It is interesting to compare the forecasted student demand for the program with the actual figures obtained to date. Table 1 below gives the projected data for the entire program prior to its start.

Table 2 gives the actual data by option through September 1975. Note that after essentially one year of operation, the program has exceeded its five year projection in terms of the total number of students in the program.

	<u>Number of Majors</u>	<u>Expected Graduates</u>
Year of initiation (1974-1975)	12	5
Three years after initiation	40	22
Five years after initiation	70	35

Table 1

The total number of graduates so far, six, is quite close to the first year figure. There were two graduates in December 1974 and four in May 1975. With the present enrollment and future growth, the number of graduates in the third year will most likely exceed the 22 stated in Table 1.

<u>Date</u>	<u>CD*</u>	<u>CS</u>	<u>CM</u>	<u>MIS</u>	<u>LIS</u>	<u>IT</u>	<u>UNKNOWN</u>	<u>TOTAL</u>
2/75	7	16	4	8	0	2	5	42
3/75	8	17	6	9	1	4	6	51
4/75	13	17	8	9	1	7	7	62
5/75	17	26	19	9	1	13	6	91
9/75	21	46	25	23	1	14	10	140

Table 2 Number of Students by Option

*KEY: CD - Computer Design MIS - Management Information Systems
CS - Computer Software LIS - Library Information Systems
CM - Computer Mathematics IT - Instrumentation Technology

The enrollments, so far, (see Table 2) have been well balanced. This is true because the computer design, software and mathematics options started in the fall of 1975. The LIS option has really not officially started yet. It should be underway in the spring of 1976.

This fall, 30 courses with a total of 45 sections are being offered in the CIS program. These courses are almost all offered in the late afternoon and evening since the CIS program is geared towards working people. While this is an ambitious offering for the number of students involved, it should be realized that many of these courses appeal to students in other degree programs who are encouraged to take CIS courses.

One of the real challenges in a multidisciplinary program such as this is to offer a meaningful core. This common body of knowledge is being examined and revised. The core must be challenging and relevant and yet broad enough to accommodate people with a wide variety of backgrounds. For example, there are students in the program with such diverse undergraduate preparations as English, Music, Electrical Engineering, Library Science, Management, etc. The basic philosophy is to have students from all disciplines get as much depth of the total CIS spectrum of material as possible in order to better understand and appreciate their own specialty. What subject matter to include and what to exclude in the core is difficult.

MIS Option

The EDP Analyzer, recently (May 1975) stated that the number one problem facing data processing was: "The growing credibility gap between general management and data processing management, coupled to the lack of effective direction and control of data processing by general management." It further stated that, "Technology obscures the picture for general management. In fact, deliberate 'technical camouflage' may be used by data processing management to keep general management out of decisions." The basic result of this problem is that quite often organizations do not get the desired value for the data processing dollars expended.

By providing a thorough education in the uses and abuses of computers for future managers, the MIS option contributes to the solution of the above problem. The MIS option has been largely modeled along the lines recommended by the May 1972 Communications of the ACM article: "Curriculum Recommendations for Graduate Professional Programs in Information Systems." Much of their basic philosophy is used. The key word to the MIS option at

SJSU is "applied." The program is not intended to be a strictly theoretical approach. Actual case studies are worked on. The major emphasis is to learn principles and apply them to real world problems. Although the option is termed MIS, it really focuses on how to utilize computer technology to design complex information systems for a variety of organizations (not just business): educational, medical, governmental, etc.

The option attempts to provide a sound technical background as well as a functional/managerial orientation so that future management will not be snowed by "technical camouflage." It intends to train information analysts who will be able to bridge the well-known communications gap which exists between the systems analyst and the end user/management. The information analyst acquires enough technical computer and systems development knowledge to communicate with the systems analyst; while he also specializes in a functional area in order to communicate with the end user. The information analyst is people/organization oriented, whereas the systems analyst is computer/technology oriented. To quote the ACM article referred to above: "The knowledge and abilities necessary to work effectively in this field may be characterized as obtainable by integrating concepts relating to people, models and systems for the application of computer technology in the context of organizations and society."

The MIS major selects four of the following five courses:

CIS 291 Business Information Processing and Simulation. 3 units.

A seminar in business and data processing. A variety of information processing topics are covered: real time systems, data base systems, communication systems, information structures, etc. A major emphasis in the course will be in the application of simulation techniques to business problems.

CIS 292 Management of Man-Machine Systems 3 units.

A study of problems in selection, acquisition, application, and management of modern computer systems. The course is designed to help students develop technical skills for analyzing the information-processing needs of an organization and for designing an efficient data-processing system to satisfy those needs. Prerequisites: CIS 242 and CIS 270.

CIS 293 File and Communication Systems. 3 units.

Function of file and communication systems, file systems hardware, file system organization and structure; analysis of file systems, data management systems; communication systems hardware; communication systems organization and structure, analysis of communication systems, and examples of integrated systems. Prerequisite: CIS 280.

CIS 294 Data Base Design. 3 units.

A study of the organization and design of computer database systems. Topics covered are: basic objectives of database organization, a review of existing and proposed database management systems and their logical views of data, physical storage structuring techniques and related access methods, and assessment of the impact of newer storage technologies on future database system developments.

CIS 295 MIS Design. 3 units.

A study of the analysis and design of complex computer based information systems. Basic design tools and objectives, hardware/software selection and evaluation; design and engineering of software; database development, program development; system implementation, post-implementation analyses, and long-range planning. Development of an actual system will be stressed.

These courses, like all option courses, are cross listed. They appear in the catalog with both the CIS designation and their school designation. The MIS courses, for example, are also listed as Bus. 291 - 295.

MIS students are advised to take CIS 292 - 295. CIS 291 is a course which was first established to provide a basic computer background for MBA students. Presently, MIS students are required to take CIS 294 and 295 and may select two of the remaining three.

The CIS program is basically a three semester program. However, it would be possible (although difficult) for a full time student to finish in one academic year plus a summer. Since most students are working, a longer time period is required in general.

Referring once again to the May 1972 ACM article, the MIS option comes closest to their

one year program. As suggested there, courses A1, A2, B1 and B2 can be taken at the undergraduate level. Table 3 below gives the ACM courses with the approximate equivalent MIS/CIS courses.

<u>ACM Course</u>		<u>MIS/CIS</u>	
A1	Introduction to Systems Concepts	Bus. 191	Electronic Information Systems
A2	Organizational Functions	Bus. 160	Fundamentals of Management
B1	Operations Analysis and Modeling	Bus. 168	Management Planning Systems
		Bus. 190	Quantitative Business Analysis
B2	Human and Organizational Behavior	Bus. 155	Organizational Behavior
C1	Information Structures	CIS 280	Data Structures
C2	Computer Systems	CIS 270	Computer and Information Systems
C3	File and Communication Systems	CIS 293	File and Communication Systems
D1	Information Analysis	CIS 294	Data Base Design
D2	System Design	CIS 295	MIS Design
D3	System Development Projects		

Table 3

Most of the parallels in Table 3 are fairly close. The one which is not is the D1/CIS 294 equivalence. CIS 294 concentrates on database technology and design with the ultimate goal of allowing the student to use this knowledge in the CIS 295 system development project. D1, on the other hand, only briefly touches on database theory and is really closer to Bus. 191 in its description.

The last MIS course which has not been described in detail and which really has no analog in the ACM proposal is CIS 292, Management of Man-Machine Systems. This seminar is concerned with the following problem: Management wishes to automate and choose some computer system. They are immediately confronted with any number of choices - a mini-computer, a SYSTEM 3 or 32; a time sharing service; facilities management; service bureau, medium scale computer, etc. Each salesman promises his system is the answer. How does management choose? This problem is not well researched although it is a very real one. What parameters should be considered? What rule of thumb can be established - volume, dollars, complexity, timing, etc.? The MIS option views this as an important step in the building of an appropriate computer based MIS system.

A few more points about the MIS option should be made. As mentioned in the Program Description section, each option has 12 units of undergraduate preparation required. Referring to Table 3, courses Bus. 160, 191 and 155 are required along with some other functional course of the student's choice. As with the entire CIS program, the initial response to the MIS option has been very good. There are approximately 25 students in the option in its first semester with, so far, very little publicity. Many of the students are foreign and some have unusual background such as music, english and economics.

No doubt, the curriculum in the MIS option will be modified with experience. Two of the courses (CIS 294 & 295) have already been revised. The expansion of computer systems and their applications to more and more diverse segments of society leads to a number of social, legal, ethical and privacy problems. These problems will be dealt with by offering periodic courses in the appropriate areas. It is the intent to have many of the MIS sections be given by part-time instructors who are full-time professionals active in some segment of the MIS field. In this way, the program will be kept up to date and reflect the real needs and experiences of the industry. This approach also will give the option the applied orientation mentioned earlier by bringing practitioners into the classroom.

Summary

This paper has attempted to describe the overall program philosophy of the new M.S. in Computer and Information Science at San Jose State University as well as to provide program details in order to convey as much information about it as possible. Program highlights and a few problem areas have been mentioned.

There are a number of features planned but not yet fully implemented. For example, a Campus and Industry Liaison Committee has been proposed but has not yet been established. This committee could serve the program and community in a number of ways: special projects could be established, program evaluation and feedback, work/study programs,

industrial grants, joint research programs, etc. Another feature which has not yet been fully established is an on-going seminar series which would invite speakers on a regular basis to interact with the students and faculty.

Your participation, criticism and inquiries are invited!