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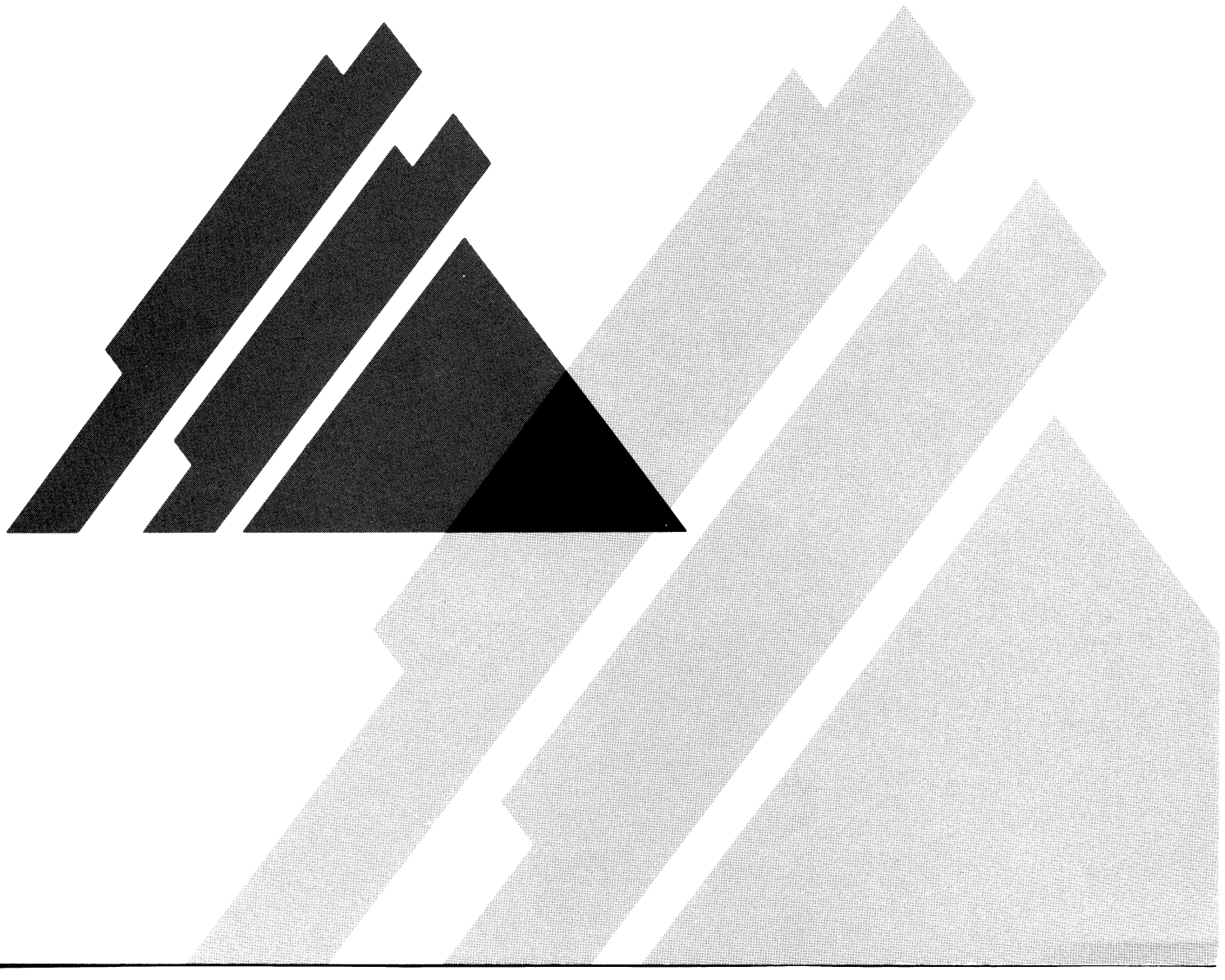
SCHOOL OF MANAGEMENT AT UCLA

Summary Report

IBM Management of Information Systems (MoIS) 1985-1990 Grant Program



PREPARING BUSINESS SCHOOLS TO MEET THE MOIS CHALLENGES OF THE 1990S:

A SUMMARY REPORT OF
THE IBM MANAGEMENT OF INFORMATION SYSTEMS
1985-1990 GRANT PROGRAM
SEPTEMBER 1990

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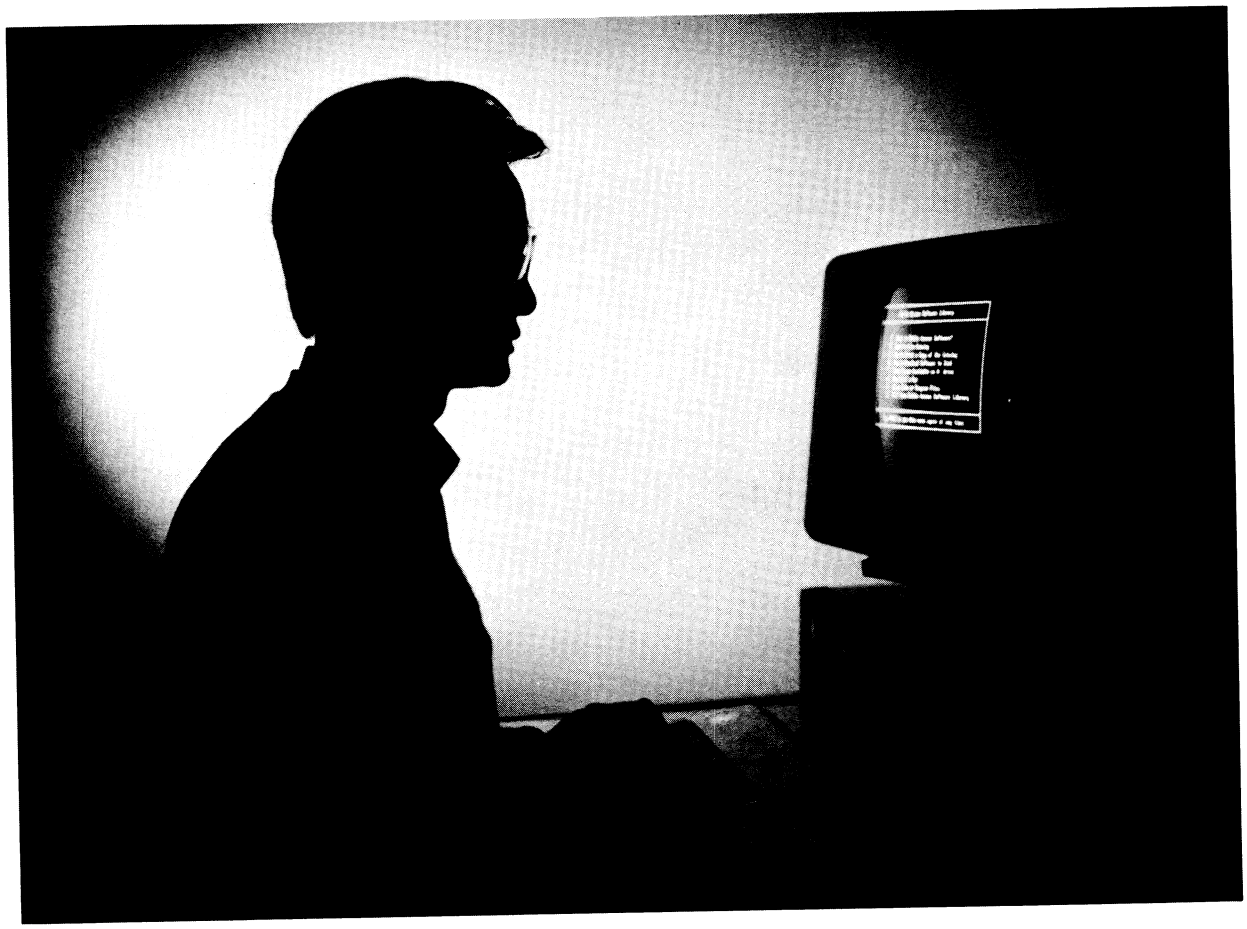

FOREWORD

We are happy to support Dr. Jason Frand and his associates at The John E. Anderson Graduate School of Management at UCLA in preparing these reports detailing the experiences of the schools which received awards in IBM's nationwide competition for graduate schools of management focusing on the Management of Information Systems (MoIS). One of IBM's initial goals in the competition was to serve the entire business school community. To accomplish this goal, IBM supported the preparation of this report that recounts the experiences of the grant schools and the lessons gleaned from these experiences. MoIS was one target of IBM's overall $100 million program to help universities keep pace with technology.

In early 1984, IBM senior management approved a $27 million program of support to help graduate schools of business update their curricula and research to keep pace with the rapid advances in Information Systems (IS) and the organizational changes they inspire.

We believed our support could help legitimize the Management of Information Systems as an area of study and research in business/management schools. We also hoped the competition, the planning grants, and major awards would increase the participation of MBA and Ph.D. graduates in the Management of Information Systems area. Higher than average starting salaries for MBAs in IS positions indicated an imbalance between supply and demand. Surveys by the American Assembly of Collegiate Schools of Business also indicated that there were far more faculty openings in this area than there were Ph.D. graduates to fill them.

We also hoped that funding of this magnitude would improve the quality of courses in those schools offering a concentration in MoIS as well as the information systems content in courses required in MBA curricula by American Assembly of Collegiate Schools of Business (AACSB) accreditation standards.

Finally, we believed our cash and equipment support would enhance faculty effectiveness in information systems and MoIS by increasing the scope and quality of research efforts and publications. The results of the competition have not disappointed us; for example, a recent survey by a professional publication to select the top ten graduate programs in MoIS recognized nine of the schools which received major MoIS awards from IBM. Each award consisted of $1 million in cash, $1 million in equipment, and selected IBM software.

In choosing recipients for the planning grants and the major awards, we used a judging process similar to that of the National Science Foundation. Each of the 218 proposals received a minimum of three separate evaluations by IBM Information Systems professionals and executives. Those graduate schools receiving the major awards received a minimum of six evaluations. The criteria used for the evaluation were:

1. Quality of faculty to be dedicated to MoIS
2. Quality of students likely to be enrolled in MoIS courses
3. Quality of MoIS research
4. Innovativeness and quality of proposal
5. "Track record" in MoIS
6. Commitment of university (funding, personnel, etc.)
7. Outside support (funds and people)
8. Adequacy of the physical plant

The competition announcement was sent to every graduate school of business and/or management in the United States. The selection process involved two steps: an initial proposal (in this phase of the competition, 40 planning grants were awarded); and a final selection of full scale proposals selected by an IBM panel

appointed by the senior vice president for Science and Technology. In April 1985, 13 schools (listed in the sidebar below) were each awarded a $2 million grant.

We hope this unique and close relationship between business/management schools and IBM will serve as an example for other countries as worldwide economic development and cooperation increases. In the United States we are justifiably proud of our higher education system. We believe support of this magnitude by industry is a form of enlightened self-interest.

Charles R. Bowen, Director
Plans and Program Administration
University Relations
IBM Corporation
Thornwood, NY 10594

IBM MoIS Grant Schools

Karl Eller Graduate School of Management
University of Arizona

The John E. Anderson Graduate School of Management
University of California, Los Angeles

The Claremont Graduate School

Graduate School of Business Administration
University of Georgia

College of Business
Georgia State University

College of Commerce & Business Administration
University of Illinois

School of Business
Indiana University

Sloan School of Management
Massachusetts Institute of Technology

Curtis L. Carlson School of Management
University of Minnesota

The Wharton School
University of Pennsylvania

Joseph M. Katz Graduate School of Business
University of Pittsburgh

William E. Simon Graduate School of Business Administration
University of Rochester

Graduate School of Business
University of Texas at Austin

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EXECUTIVE SUMMARY

This report explores the effects of the five-year, $27 million IBM MoIS grant on 13 diverse, research-oriented business schools in the United States. Four areas are discussed; general impacts of the grant, information systems research, information systems curricula, and policy issues regarding the introduction and use of information technology.

The participating schools experienced a massive influx of computers that, for most, fundamentally altered their perceptions of the role of information technology. An information age culture is evolving in which:

- State-of-the-art technological infrastructure is a "right" rather than a privilege.
- Information technology extends personal productivity and problem solving capabilities.
- Software tools can provide more easily attainable and integrated solutions to business problems.
- Data and information is readily available in electronic formats.
- Training and consulting are essential to achieve maximum benefit from new and more powerful information technology tools.

The grant stimulated changes throughout the schools by providing necessary resources. MBA curricula were modified and innovative programs developed. Microcomputer technology was introduced throughout the core MBA curriculum. The number of highly qualified Ph.D. students and faculty increased at the schools, resulting in a broad range of academic research activity in IS. Furthermore, the grant enabled a closer working relationship between IS faculty and faculty in other areas. Several books and texts were developed which solidify and distribute recent research work in information systems.

Most of the grant-related activity occurred in the areas of curriculum and research. Integrating computer and information technology into the instructional setting is a trial-and-error process and requires perseverance to develop the most effective learning activities. A strong support organization is essential to allow instructors to focus on course content rather than computer skills. The IBM MoIS grant schools modernized and reorganized their Information Systems curriculum, providing a more management-oriented focus.

A diverse array of IS-related research was supported at the IBM MoIS grant schools. The major emphasis within the IS area was on business applications and management. The most frequently investigated topics were related to electronic meeting systems, e-mail, voice-mail, and other group support systems, Decision Support Systems (DSS), human-computer interactions, and database design. Seven of the IBM MoIS grant schools established group decision support facilities to support their research programs.

Schools in the information age must make a fundamental decision regarding the role technology will play within the school. Following this, specific strategies need to be developed. Areas requiring strategic development include the technological content of the curriculum and support for research, the type and level of technological infrastructure, the organization of that infrastructure, and the funding for the curricular changes, research, and the infrastructure. The need for resources to maintain appropriate levels of computing support is the primary consequence of the introduction of information technology. External funding is now needed to support these computing services, a requirement that did not exist ten years ago.

A summary of the major grant-related events is included on the next page.

IBM MOIS GRANT RELATED EVENTS	
APRIL '84	IBM announced the MoIS competition and invited planning grant proposals from schools. Two hundred and eighteen proposals were received.
AUGUST '84	Forty business schools were awarded planning grants to provide assistance in the preparation of the final proposals.
JANUARY '85	Seventy-eight schools submitted proposals.
APRIL '85	Thirteen business schools were awarded $2 million grants.
JANUARY '86	Meeting of 13 schools (without IBM) in Boston; schools shared information on grant proposals and plans.
OCTOBER '86	Meeting of 13 schools and IBM executives at IBM facilities, Dallas, Texas. Each school made a presentation of their general overall program.
DECEMBER '86	Steering Committee, comprised of representatives from three schools and IBM, was formed to plan and conduct annual meetings.
NOVEMBER '87	Meeting of 13 schools with IBM at University of Arizona, Tucson: each school submitted a progress report; presentations by select PIs and IBM personnel; GDSS sessions focused on issues of IS management.
OCTOBER '88	Meeting of 13 schools with IBM at University of Georgia, Athens; presentations by select PIs and IBM personnel on strategic IS planning, telecommunications, EIS, and systems integration.
NOVEMBER '89	MISTIC meeting, Claremont; an extension of the original 13 to include several other schools with major IS programs; presentations by select PIs and IBM personnel, including Europe 1992 and telecommunications curriculum, GDSS sessions focused on "future directions."
FEBRUARY '90	*Syllabus Book* published.
APRIL '90	Official end of grant.
JUNE '90	*Research Guide* published.
SEPTEMBER '90	*Summary Report* published.

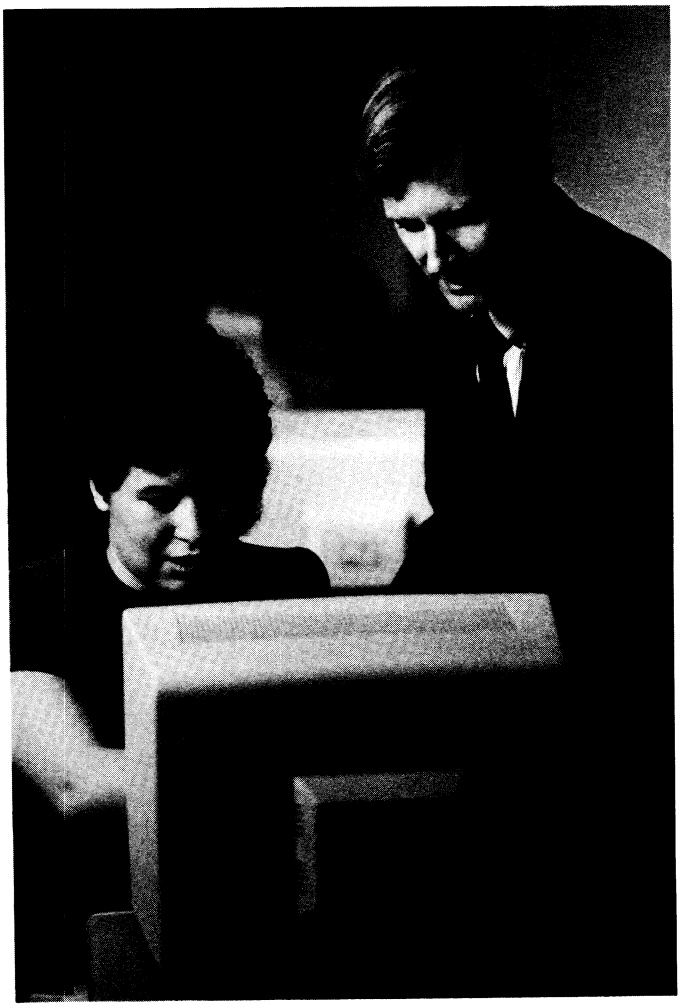
INTRODUCTION

In awarding the IBM Management of Information Systems (MoIS) grants, IBM presented 13 schools with a significant challenge:

> "...provide national leadership for graduate business education to improve the knowledge that management has of the role of information systems in the organizational and technological environments expected in the next decade."

In the information age, every manager is responsible for some computer and information systems decisions in addition to traditional duties. Microcomputers and end-user computing have become ubiquitous in the corporate environment. Today's managers work in a world of global economies and industries, a business environment made possible only because of the interconnecting communications network which, through computer technology, distributes information at the speed of light. Access to timely, pertinent, and accurate information is essential.

Preparing managers to work effectively in such an environment is the responsibility of our schools. Students entering business schools, especially at the MBA level, are keenly aware that computer skills are essential to gain access to corporate opportunities. They seek exposure to the most up-to-date hardware and software. The challenge for business schools is to provide these future corporate leaders with a more comprehensive understanding of the management of information systems. Imparting knowledge about managing information rather than simply increasing skill in using management software is the critical task.



PURPOSE

The purpose of this report is to discuss the impacts, policies, and issues related to the management of information systems based on the experiences of the IBM MoIS grant schools. These experiences, gathered from written materials, interviews, and surveys, were distilled in an attempt to identify important issues for the schools and their strategies for dealing with those issues. Every school is unique, reflecting the background and interaction of faculty, students, administrators, the school's culture and values, the technical support environment, and a multitude of other

variables. This report reflects the collective experiences of 13 diverse business schools, from which other schools may select ideas and approaches which are appropriate to their own environments.

ORGANIZATION

The report is organized into five sections. In this introductory section, the purpose, organization, and methods of the report are described. The four sections within the body of the report discuss the school-wide impacts of the grant, research activities in Information Systems (IS), approaches to IS curricula, and school-wide policy issues related to IS.[1]

The IBM MoIS grant had significant impacts on each recipient school through the intense introduction of computers and the support funds it provided. Section 1 presents those lessons and experiences which may assist other schools engaged in massive microcomputerization. The impacts of rapidly introduced technology on curriculum, technological infrastructure, research, and culture of the school are described, as is the long-term impact on resources arising from these changes.

Research efforts at the IBM MoIS grant schools span a variety of topics and approaches. Section 2 describes these research activities within an organizing framework of the MoIS field. Based on the interests of scholars at the 13 schools, future research directions are suggested.

Within the Information Systems area, an important impact of the grant has been on curriculum. Each of the recipient schools undertook a major revision of its Information Systems curriculum, adding and deleting courses, restructuring prerequisites, and updating material. Section 3 presents a capsule description of each school and its curriculum, discusses the core IS course for MBAs, the IS curriculum as a whole, and other curricular issues.

The massive microcomputerization and attendant curricular changes have raised policy and procedural issues for the schools. These include the role of information systems within the school and funding for the growing technological infrastructure. Drawing from the past five years' experiences of the grant schools, the final section of the *Summary Report* discusses these issues which business schools will need to address over the next few years and presents some recommendations.

METHODS

The purposes of this report require an approach that allows salient aspects of the schools' experiences to emerge. Accordingly, a qualitative strategy was used to capture and articulate the unique experiences of the diverse group of schools with respect to information systems. Additionally, these experiences were considered within the cultural environment of the business schools as well as within the larger context of industry and academic perspectives.

The strategy for collecting data on the schools' experiences entailed obtaining direct responses from the schools and information from other sources. To obtain direct information, principal investigators (PIs) were asked to submit a comprehensive narrative report of their schools' experiences and to complete a numerical information form. This narrative report included an overall description of school grant activities with specific comments on facilities, curriculum, research, special projects, community involvement, and future directions. In addition, site visits, which included semi-

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1 Schools use various names to identify their IS areas. These names reflect their orientation to the field, for example, MIS (Management Information Systems) and CIS (Computer Information Systems). In this report, IS is used to include all of the definitions.

structured interviews with the PIs, administrators, IS and non-IS faculty, doctoral and MBA students, and staff at each school, were conducted. Grant management, student/faculty recruitment, and student placement were among the topics guiding the interviews. As other issues were raised, they too, were explored.

Indirect information came from a variety of sources, including original proposals submitted to IBM, progress reports from schools, faculty publications, Group Decision Support Sessions at annual meetings, and data from annual UCLA surveys of business school computer usage. Information obtained from the schools' written reports and from the interviews was organized on the basis of recurring themes and patterns, and forms the basis of this report. The subjects discussed here were developed directly from issues, problems, and statements raised by the PI and others at the schools, and reflect topics which were of wide concern. Unique views or singular statements are included when, in our judgement, they provide an important perspective on the issue.

SCHOOL CHARACTERISTICS

Table 1 presents an overview of the schools' characteristics. The schools vary in size from a total full-time equivalent of 300 to over 8,000 students. Nine of the 13 IBM MoIS grant schools are public institutions. All of the schools grant Master of Business Administration (MBA) and Doctor of Philosophy (Ph.D.) degrees. Master of Science degrees are offered at eight schools and seven offer undergraduate business programs.

TABLE 1.

CHARACTERISTICS OF THE 13 IBM MoIS GRANT SCHOOLS

	NUMBER OF SCHOOLS
TYPE	
Public	9
Private	4
DEGREES OFFERED	
Undergraduate	7
MBA	13
M.S.	8
Ph.D.	13
SIZE (TOTAL STUDENT FTE)	
less than 1,000	5
2,000 to 4,500	4
greater than 4,500	4

SECTION 1

IMPACTS OF THE IBM MOIS GRANTS

The IBM MoIS grant had many positive impacts on the schools. By providing equipment and monetary resources, the grant created opportunities for change and development at the recipient schools. One such positive impact has been the increase and strengthening of Ph.D. programs in IS. As one PI noted, the need for American Assembly of Collegiate Schools of Business programs to train non-IS faculty to teach in the IS area has diminished. One school established a regional program for sharing curriculum information and joint research which involved 11 other schools with graduate management programs.

In addition, annual meetings among grant faculty and IBM executives have occurred. An outgrowth of these annual exchanges of ideas has been the development of a new group known as Management of Information Systems Technology - International Council (MISTIC)[2] which includes faculty from other schools. The schools felt that the grant increased the visibility of their programs nationally, helping to attract faculty and students. Almost all of the PIs reported increases in doctoral applicants. Several books and texts in Information Systems were published, as were over 300 research articles prepared under grant auspices.[3] Nine of the 13 IBM MoIS grant schools were listed in the "IS Honor Roll of Top 10 IS Graduate Programs" of *Computerworld News Weekly* (October 30, 1989).

While these and other positive impacts of the grant are important, this report focuses on the issues raised that still need to be resolved. In this section, the general impacts of the grant and the lessons distilled from the grant experiences are reviewed in terms of curriculum, the technological infrastructure, research efforts, and the changing culture of the schools. Throughout the report, summaries of the schools' experiences are given in tables. These tables present the advice, caveats, and recommendations of faculty at the schools in the various areas of courseware development, classroom use of technology, and specific design issues, such as electronic podiums.

Without a doubt, the most visible impact was the technological intensification which occurred within the schools. The rapid and substantial introduction of technology resulting from the $1 million equipment portion of the grant brought significant changes to the schools' curricula, research, computer classrooms and labs, and culture. For the most part, the 13 grant schools are further along in the microcomputerization[4] process as a result. They are not necessarily doing different or better things than other schools, rather they are doing them at an accelerated rate. The IBM MoIS grant helped accelerate the technological saturation of the schools, requiring adjustments and adaptations on the part of the faculty, students and administration.

Integrating Technology in the MBA Curriculum

Perhaps the most important impact of the MoIS grant, as noted by faculty at each of the schools, was on the school's MBA curriculum.

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2 Queries should be directed to the Chairman, MISTIC Steering Committee: Mr. R. E. Woodley, IBM Corporation, 140 E. Ridgewood Avenue, Paramus, New Jersey 07653.

3 MoIS Research Bibliography, part of the BQS software series.

4 Frand, J. L. and J. Britt, 1990, "Sixth Annual UCLA Survey of Business School Computer Usage." *Communications of the ACM*, v. 33, no. 2, pp. 445-465.

TABLE 2.

COMPUTER SKILL REQUIREMENTS FOR ALL MBA STUDENTS N = 13

REQUIRED USE OF:	NUMBER OF SCHOOLS
Microcomputers	13
Word Processing	13
Mainframe systems	7
Spreadsheet packages	7
Database management systems	6
Programming language	1
Computer proficiency exam	3

The grant enhanced and improved the entire curriculum by supporting revision and modernization of many courses. Two schools developed innovative MBA degree programs in MoIS.[5] All 13 schools made significant strides toward integrating computer skills throughout their MBA curriculum; however, the particular computer skills expected of and/or required of students varies among the schools. Table 2 provides information on specific skill requirements at the 13 schools. Mainframe usage is required at 7 schools, while 13 have explicit microcomputer requirements. Three schools require all MBA students to pass a proficiency exam demonstrating these skills. Eleven schools offer workshops on computer skills prior to the beginning of the school year, and in nine schools the skill workshops are offered throughout the term to supplement classes.

The technological intensification enabled faculty to provide more in-depth and realistic learning experiences. According to one faculty member, students "...no longer do toy problems on paper and pencil, but some significant analysis of fairly large marketing databases, using database tools." Deans were able to use the computer equipment to encourage and support curriculum change, and in some schools utilized the grant to provide course release or teaching assistant support. However, one dean expressed the concern that in a research-oriented environment, providing funds for curriculum development sent the wrong message to the faculty.

Faculty members from many diverse functional areas sought ways to integrate information technology into their classes. For example, hands-on microcomputer skills were integrated into core courses in accounting, economics, finance, management science, marketing, organizational behavior, and production; areas which previously lacked a computer presence. Eleven of the IBM MoIS grant schools require microcomputer use in at least 60% of their MBA core courses.[6] In areas where computers have traditionally been used, primarily Information Systems and Management Science, more realistic data sets and commercial applications packages were introduced. The complexity of mainframe operating systems and the lack of managerially-oriented, user-friendly software or consultants limited enthusiasm for the use of these systems.

With the infusion of technology, however, many IS and non-IS faculty alike raised the concern that "we don't want computers to drive the content." Experimentation with the use of computers to teach many different topics across disciplines led to the realization that computer support and use is inappropriate for some topics. Several instructors who had spent considerable time and effort experimenting with the use of

5 The University of Pittsburgh offers an MBA-MS/MoIS double degree and the University of Texas at Austin offers the MBA/ISM (Information Systems Management) degree.

6 Data taken from the "Sixth Annual UCLA Survey of Business School Computer Usage."

computers in their courses, suggested that "Computer use in class is good for practical procedures, examples which are concrete, but not for conceptual stuff. " Stated another way, "Technology lends itself to emphasis on usage rather than theory. For some situations, [computer] usage plays an important role in reinforcing concepts and allowing practical applications [of the theory]. In these situations, use it!"

Micro and Mini/Mainframe Computer Use

On average, about 85% of all reported computer use in the 13 IBM MoIS grant schools is microcomputer based.[7] Among the IBM MoIS grant schools, 45% recommended or required individual microcomputer ownership by their MBA students, compared to only 14% for all of the 163 schools responding to the "Sixth Annual UCLA Survey of Business School Computer Usage."[8] As one principal investigator said, "Requiring student ownership has removed our biggest obstacle [to expanded use], which was convenient access for students; even if we had the money [for microcomputers], we have no space."

Although all of the schools had direct access to mini/mainframe systems (10 schools acquired IBM 4300 series mainframes as part of their grant and the other three already had mainframe access), these systems played a minimal role in the instructional programs. One production/operations management professor's comment on why he did not like to use the mainframe systems typified the experience of several instructors. "A problem with full-blown commercial production systems on the mainframe, for example, MAPIC,[9] is that they do too much, and the class becomes a class in learning MAPIC and not in teaching the principles of production." Similar comments were made with respect to commercial mainframe database and expert systems application packages. Additionally, instructors commented that the technical complexity of the mainframe operating systems, communications, and overall operational support requirements discouraged mainframe use for instruction.

Given these operational and logistical difficulties, only five schools required mainframe usage by their MBA students. The PI in one school noted, "We wanted to provide our students with a real commercial mainframe environment, and the grant enabled us to do it using real commercial products." At this school, about one-third to one-half of the instructional computer usage is mainframe-based. A consequence of this imbalance between micro and mini/mainframe computer use was reflected in a concern raised at each of the IBM MoIS grant schools. An IS professor stated the issue as follows, "...[mainframe] computers and microcomputers are being seen as being equal.... there's a role for each of them, and learning about the different roles is really critical." The professor stated further, "If all they know is a micro, then all they'll ever use is a micro." Another IS professor indicated that the content of the course should dictate the choice of computer system, citing the example that teaching decision support works best with a microcomputer, while teaching transaction activities requires a mainframe environment.

Classroom Use of Software

Faculty members wanting to use commercial software in their classes, face formidable barriers. The problems identified were lack of incentives, time, and support. Despite the problems, however, faculty believe that software is an important teaching tool.

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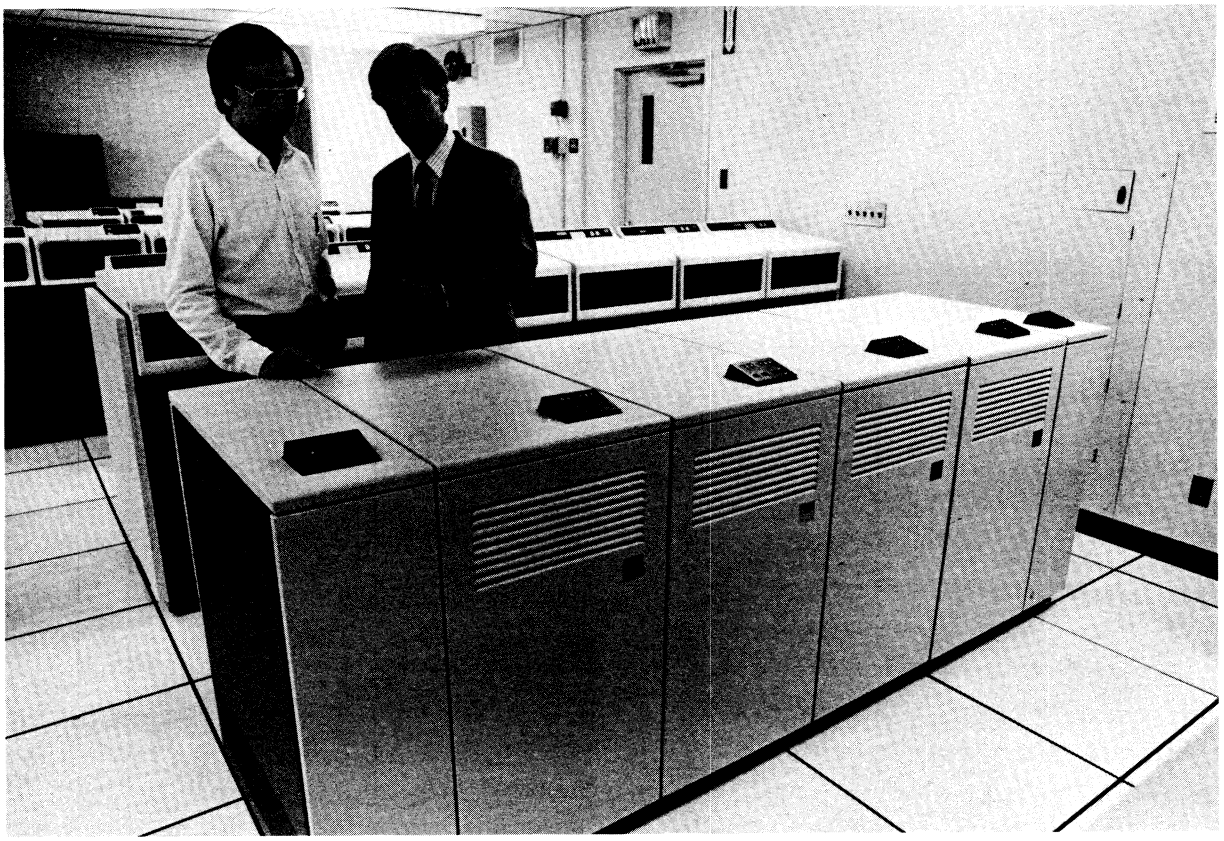
7 Data taken from the "Sixth Annual UCLA Survey of Business School Computer Usage" and interviews at the 13 schools.

8 Frand and Britt, op cit.

9 Manufacture and Production Inventory Control package.



One professor, who had invested considerable time "tinkering," said, "The time and effort are too large given the return. Furthermore, there are disincentives within a research environment." Another suggested that "Until the reward system changes or there's a technological breakthrough, commercial software use isn't going to happen."

Until such a breakthrough occurs, for instructors to use technology in their classes requires a substantive ongoing investment. "Teaching with technology is like teaching a tax class during 1986, 87, 88...everything is changing all the time. I have to redo my syllabus every time I teach to reflect changes in software versions, what's available, and how it's provided."

The following explanation of the demands of teaching using current technology provides some important insights into the critical elements of successful courseware and the potential this media has to offer. "It's not just the technology, but the implications and linkages between technology and managerial life and performance which must be identified....The challenge is to find non-contrived meaningful applications."

One professor indicated that each software package seems to have its own learning curve. "First I have to learn how the software tool works, how the tool applies to my discipline, and finally how to customize the tool to meet my instructional needs." This process takes experimentation and considerable time, "and it comes out of our hide," noted one assistant professor. And, commented yet another professor, "Once you know the software, you need to find cases, assignments, and books that can be used with the software, to tie it all together." Being an innovator has its

frustrations, and sometime things just don't work out. "We were given a big, big problem because of the poor technology and poor software...I was trying a simple econ/marketing game, but relative to what the students would learn, it just wasn't worth it."

Introducing the curricular changes was fraught with challenges. As one professor cautioned, "The question was, how am I going to do it? Incorporating the computer is time consuming and risky. There are no university rewards for developing materials, and if it doesn't work (with the students), my ratings go down." Only faculty with a computer in their offices, only those who were comfortable using them, were willing to "risk" using the systems live and in front of students. The word "risk" was used numerous times at almost every school and reflects the fact that the technologies are new, and effective means of delivering them to students are evolving.

In spite of the considerable problems and challenges, the faculty uniformly indicated that once hooked, they would never go back. "What is the default? Pencil and paper?" And often repeated was the phrase, "We can't afford to *not* do it!"

Courseware Development

A major benefit of the IBM MoIS grant was that it created an environment in which courseware experimentation could occur. Numerous faculty from almost every business discipline at the IBM MoIS grant schools participated in courseware development. Overall, as reported in the *IBM MoIS Syllabus Book*, the grant schools submitted 29 courseware packages they had developed as part of the grant. A list of the courseware may be found in that report. From the diversity of experiences, five major courseware lessons emerged and are listed in the sidebar.

Courseware is a computer application which engages students in using hardware, software, and data to achieve specific instructional objectives. For example, a faculty member at one school developed a data management and modeling system for the utilization, testing, and analysis of financial economics using corporate financial data from CRSP and Compustat databases. Another faculty member developed a set of three cases which used a spreadsheet package to analyze financial accounting issues. These cases, in the form of courseware, required students to analyze data to achieve specific instructional objectives.

Given the impetus of the grant, a very large number of courseware development projects were undertaken at the schools. Courseware development strategies took three different forms across the 13 schools. One strategy made courseware development an individual faculty member's responsibility; while in another, faculty were provided with some staff support, either students or professional programmers. The third strategy for courseware development involved hiring professional programmers to develop software for faculty.

Within each school, there were individual success stories in which faculty were providing students with exceptional experiences

GUIDELINES FOR CLASSROOM USE OF COURSEWARE

- How courseware may be integrated into a particular course is not obvious or intuitive.
- Using courseware requires significant effort on the part of the instructor, whether the courseware is developed, bought, or shared among faculty.
- Developing courseware entails a long-term, time-consuming, commitment by an instructor.
- Introducing and using courseware is a trial and error process requiring many iterations.
- Integrating computers into the curriculum requires a strong technological infrastructure.

in the use of technology. However, the long-term yield in terms of widespread dissemination is unclear. The first two strategies generally resulted in courseware tied to specific courses with minimal dissemination. Two schools used the third strategy and hired professional programmers to develop courseware for faculty. Out of the 50 courseware programs developed at one of these schools, only 7 remain (14%); at the second school only 2 out of 18 survive (11%). The consensus across these two schools was that it would have been better to invest in training and development workshops using viable commercial courseware packages than to undertake the development themselves.

Given these experiences, it appears that as one professor stated, "Our [initial] expectation level was too high, maybe even unrealistic." Another commented that "...some of the things we tried were too trivial and others too complex." Still another professor, heavily involved in the development, confirmed these views, suggesting that "...perhaps 50% of what an individual tries is really worth doing again, and maybe only 10% is good enough for further development so that others can use it."

In retrospect, many of the difficulties encountered with the development of courseware materials were directly attributable to the software that was available at the time of development. "If we had then what we have now, the situation might have been different," lamented one programmer. The limitations of the DOS operating system, the lack of adequate software authoring tools, and the introduction of so many different and competing variables, made meaningful development (which went beyond a "textbook on line") extremely difficult and costly. Frequently the material was developed for the "lowest common denominator" microcomputer system rather than for the newer, more powerful systems, because the older systems were more available.

Despite these problems, courseware development continues. Clearly, using technology raises additional barriers to experimentation, and hence a major challenge will be to find ways to continue the experimentation and support the dissemination of courseware which seems viable.

Support Requirements

Faculty using technology in the classroom indicated that support provided by a technological infrastructure is essential for success. The sidebar below indicates three critical areas of instructional support. One professor's comment reflects the statements of many, "Computer use by students requires outside organized support [beyond what instructors can provide themselves]. If there is no organization to assure this happens, then the obstacles are too great." At another school, the dean commented on the successful integration of technology as follows:

> "To get technology to be used throughout a school of management takes a real thrust from the Dean's office...and today, unfortunately...requires major dollars to do it right."

GUIDELINES FOR INSTRUCTIONAL SUPPORT

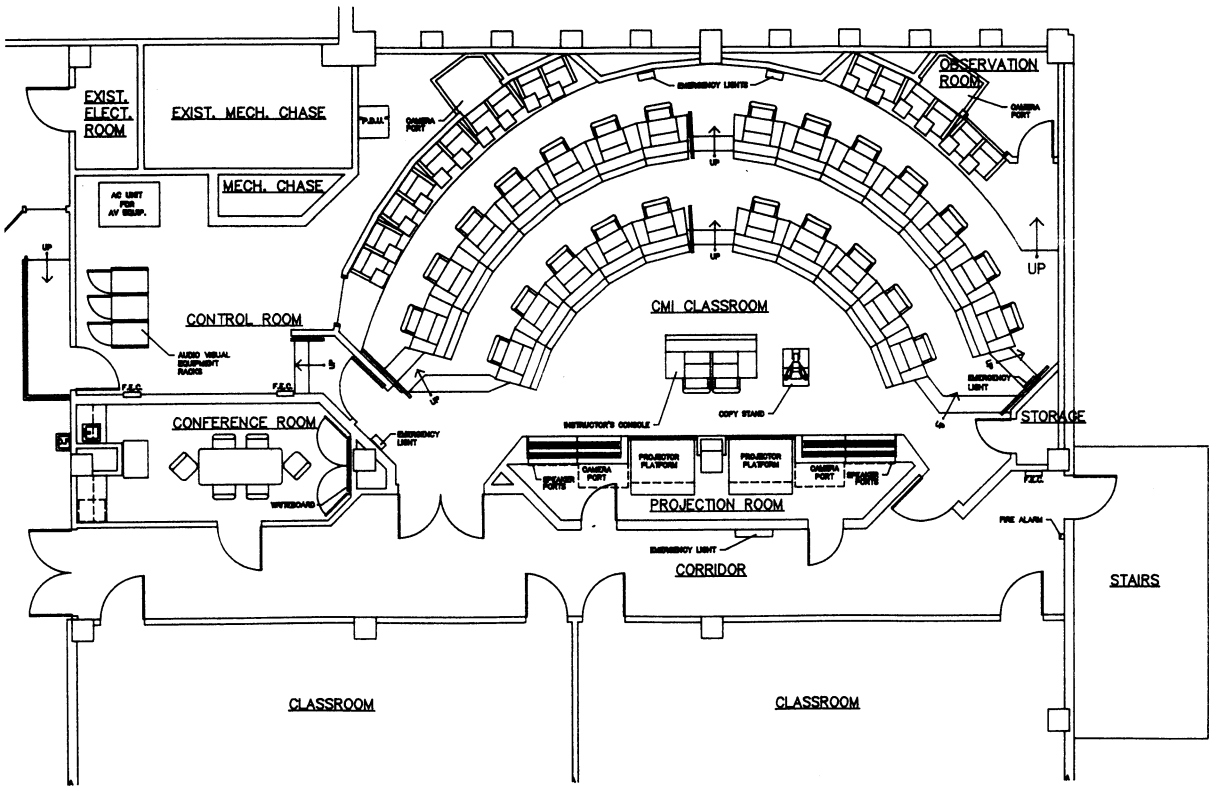
- Support staff are critical for installation of software, conversion of data files for student access (like Lotus files), classroom set up, assurance that equipment is working, preventing and handling of computer viruses, and maintaining software and data on networks.
- Students need training to use software beyond the time faculty have to commit to teach it in addition to teaching course concepts; extensive ongoing training and consulting programs are needed.
- Professional quality documentation tied to class materials, including information on how to use converted data files and analysis procedures, is a must.

Technological Infrastructure

The technological infrastructure consists of staff, computers, software, communications equipment, networks, facilities, and policies which enable the school to achieve its teaching, research, and administrative goals. Most of the IBM MoIS grant schools were faced with integrating the massive amount of equipment before the infrastructure was in place. Many of the problems these schools encountered were solved as the infrastructure developed.

Supporting a technological infrastructure requires major capital and operational commitments. Historically, business schools have required minimal expenditures for capital equipment. Deans were responsible for raising funds to support faculty research and student programs, for initiating new programs and expanding old, but comparatively little was required for equipment such as typewriters or calculators. This model of the business school has changed.

To compete for faculty and students and to provide a modern, relevant curriculum to train managers for roles in the information-intense corporate environment of the 1990s requires continuing equipment expenditures of a previously unimaginable magnitude in business schools. Introducing such large amounts of equipment demands an ongoing maintenance effort. In an environment of rapidly advancing technology, maintenance assumes new meaning. Software and equipment require upgrading to sustain the expected level of service. A staff is needed to furnish technological support for the software and equipment, and to provide training and consultation so that maximum benefit can be achieved from the investment in technology.



Facilities

Three distinct microcomputer facilities emerged at the IBM MoIS grant schools; lab spaces to meet the needs of the student population, electronic-classroom spaces needed for instruction, and specialty research labs to support researcher's projects. All 13 schools renovated space to create microcomputer laboratories for their students. These labs consisted of between 20 and 40 microcomputers arranged in such a way that the lab, or a portion of it, could double as an instructional classroom.

The primary issue in construction of these facilities was the physical environment. One instructor said, "The room interface is as important as the software interface." This comment, made in relation to the electronic classroom, is equally applicable to student and specialized research laboratories. This view was clearly understood at one school, the University of Arizona, which was able to successfully overcome most of the environmental concerns in its Decision Support Lab. (See picture on opposite page and diagram above.)

The lab represents a model of what can be done with sophisticated engineering design. For example, computer CPU's which generate heat and fan noise are enclosed in furniture which is attached to below-the-floor air conditioning; monitors are recessed into the furniture; keyboards have sliding desk covers; and the lab is tiered for maximum visibility. Dual large-screen monitors are used rather than projection devices so that ambient lighting is not a major problem. Carpeting and sound-absorbent wall coverings make the environment comfortable to work in for long periods. A detailed discussion of student laboratories, electronic classrooms, specialized laboratories, and podium design may be found in the Appendix section of the report.

Electronic-mail Systems

Electronic mail (e-mail) has enhanced and extended essential communication links among faculty, students, and staff at the IBM MoIS

grant schools. An e-mail system which is actually used by faculty, students, and staff represents a significant investment in the technological infrastructure. There are three critical hardware components necessary to create a local e-mail system; access devices, a host mail-server (mainframe or microcomputer), and the communication network (wires and switches) linking the first two elements. Also essential are e-mail software and staff to support the hardware and software and to provide training and consulting. This technological infrastructure is necessary for a successful e-mail system, but not sufficient. Success occurs when there is a critical mass[10] of people who use the system on a regular basis.

E-mail was the most common mainframe package used at the IBM MoIS grant schools. Universally, active e-mail users "swear by it!" Although Bitnet[11] was used and identified as an important component of inter-school communications, only three schools were making extensive use of electronic mail for intra-school communications. The primary reason given for disuse was the lack of a critical mass of users ("...most of the time when I sign-on there is no mail, so why bother"). Two other reasons commonly given by faculty for not using e-mail were difficulty in accessing the system and confusion about which system to use. "There's Bitnet and the school's system; I'll wait until they're combined," was a common attitude.

To encourage faculty to use the e-mail system, the dean at one school declared that telephone messages would no longer be distributed using "green slips" but only through the e-mail system. At another school, the dean stated, "When we got the grant, I didn't have a computer and never touched one. Now I'm the biggest e-mail user in the school." At a third school, to encourage faculty to use e-mail, the department chairman announced that all messages received via the e-mail system would be answered within one working day.

Students complained that e-mail access was difficult because terminals were not readily available around the school. As one student indicated, "I hate to go to the labs to find I don't have any mail." Students also reported that there was no e-mail for use with faculty or administrators, and no motivation for using the system. At one school, widespread student use was stimulated by making the e-mail system the primary method for distributing placement office and student affairs information. At this school, the system administration reported an average of 10 letters per day per student. After making the transition to an e-mail environment, there is no returning to the earlier paper-based mode of communication.

Professional Staff Support

Prior to the introduction of microcomputers, business school computer support generally was provided by a central campus organization which usually supported a centralized mainframe system. This changed however, with the large-scale introduction of microcomputers. As one PI characterized the situation at his school, "Campus computer support organizations have had to make significant changes to adapt to user expectations. Furthermore, if the central organizations cannot meet these expectations, then a local support center within the business school will have to emerge." Another PI expressed the following sentiment, "Don't do what we did badly, which is to have an amateurish approach to technology. Hire someone who is good and can manage that technology."

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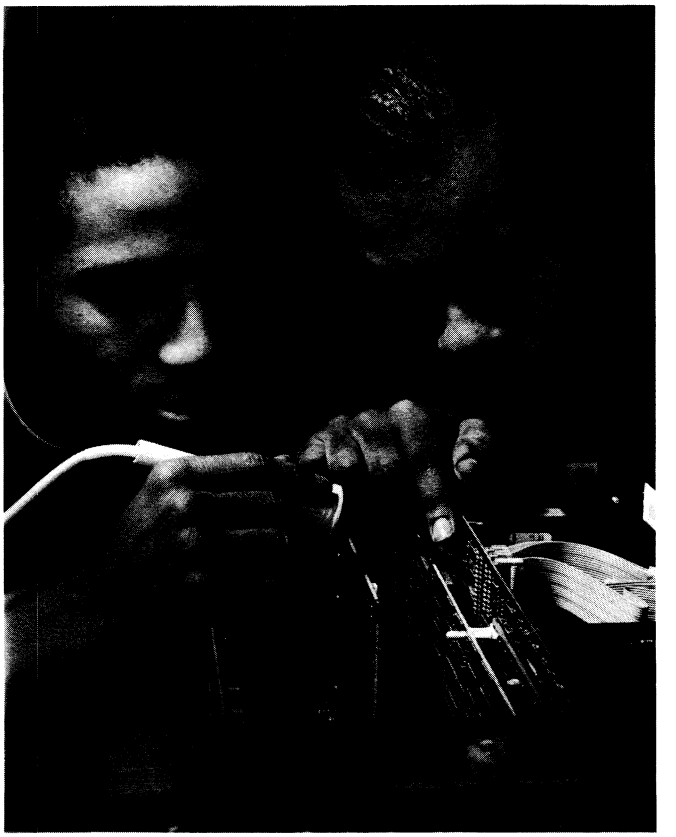
10 Markus, M. L., 1987, "Toward a 'Critical Mass' Theory of Interactive Media: Universal Access, Interdependence, and Diffusion." *Communication Research*, v.14, no.5, pp.

11 To be part of a broad based e-mail system such as Bitnet, a worldwide network, requiring additional links to other host mail-servers.

At the start of the IBM MoIS grant program, only five of the 13 schools had full-time professionals hired by the school to support their use of technology.[12] To meet service requirements, several of the IBM MoIS grant schools initially had used large numbers of student personnel to support the introduction, installation, and training on microcomputers. However, these schools found that over time (two to three years) reliance on student personnel became both a more costly and less efficient mode of operation. Schools hiring large numbers of MBA students incur regular start up and training costs of new employees, then suffer the disappearance of these trained personnel upon graduation. Significant supervision costs are incurred as students have conflicts which frequently cause absenteeism or the inability to keep prearranged schedules. Class assignments and job interviews frequently require changes in work schedules.

Within two years, all 13 schools had established a full-time professional position. As expressed by one faculty member, "A major impact [of the grant] was that it pushed the dean's office to realize that we needed a real director of the school's IS resources." The specific set of responsibilities accompanying such a position reflects a school's long term commitment to the role of information technology. At two of the schools this full-time professional has emerged as the school's chief information officer (CIO), responsible for an extensive school-wide support program with both full-time and part-time staff. At other schools the individual is a technically oriented programmer whose services in providing technical assistance to faculty are augmented by part-time student personnel. Most of the schools fall somewhere between these two approaches.



The range of support services provided by computing center staff is extensive. For example, staff is needed for user consultation and training, library services, networks, classroom technology, and strategic planning. Table 3 lists many of the services available from computing centers. Most support for faculty, students, and staff cannot be done remotely, and "the consultant almost always has to go to the person's office." The schools were using a combination of in-house servicing, campus support for service, and contracting with a service vendor; all of which requires someone within the school to coordinate and support the activity.

The introduction of computer technology, particularly in regard to microcomputerization, has placed multiple competing demands upon computing center staff. With the introduction of microcomputers, hardware and software installation for users became the most basic

12 Data taken from the "Second Annual UCLA Survey of Business School Computer Usage."

TABLE 3.

COMPUTER AND INFORMATION SUPPORT SERVICES

Training Services (to groups of users):
- Intro computing/word processing /spreadsheet
- Statistics
- Desktop publishing/graphics
- Communication/network/e-mail systems
- Database

Consulting Services (to individual users):
- Word processing/spreadsheet
- Statistics
- Desktop publishing/graphics
- Communication/network/e-mail systems
- Database
- Purchase recommendations

Instructional Support Services:
- Preparation of documentation
- Preparation of training materials/handouts
- Convert data formats
- Diskette reproduction of class materials
- Software library/distribution
- CAI/interactive video training
- Curriculum programming/maintenance
- Computer sales/discounts/leases
- Software site licenses

Mini/Mainframe Support Services:
- Hardware trouble shooting/hotline
- Daily operations/backup
- Hardware/software installation
- Maintenance/repair
- Software installation/system programming
- Administrative programming/maintenance
- Research programming/maintenance
- Database administration

Microcomputer Support Services:
- Hardware trouble shooting/hotline
- Inventory management
- Hardware/software installation for users
- Maintenance/repair
- Hard disc backup for user systems

Network Support Services:
- Maintenance/trouble shooting
- Administration
- Installation/software/cabling
- Programming

Strategic/Planning Services:
- Technological research
- Budget preparation
- User surveys
- Data/software security
- Newsletters/annual brochures
- Ethical uses of computers

Facility Services:
- Computer lab design
- Office design
- Security systems

Video Equipment/Computer Display Services:
- Delivery of systems to classrooms
- Maintenance/repair
- Purchase recommendations

Library Services:
- Online databases
- CD Rom
- Dial-up database access

support service, followed almost simultaneously by requests for training and trouble shooting. "The biggest problem is keeping the systems functioning." One school reported 100 hotline calls per month for the 450 or so microcomputers in use. These calls were "hardware, software, and just confusion-type questions," and all required assistance.

Over time, two parallel service requirements have emerged; ongoing hardware maintenance and repair services which require inventory management, and user training and consultation. These requirements are basic, with additional services such as programming support for research and administrative functions awaiting the allocation of resources to be put into place. The table of services indicates the variety of services which could be provided, as user expectations and sophistication grow.

Budget Concerns

The IBM MoIS grant provided the initial funds for the massive infusion of technology into the schools. Each of the schools received $1 million in IBM hardware and access to IBM logo software. Another $1 million was given for faculty, student, and staff support use, and excluded the purchase of non-IBM logo software. With services now up and running, a major concern for deans is the high support cost for this technology and the securing of ongoing funding. As one computer center director explained:

> "The delivery of computer support services often costs more than anticipated because initial budgets do not consider the maintenance and, more importantly, the replacement costs for running these services. If you are doing a good job, then there will be demand for increased and improved services. You must plan for the renewal of your facilities given the fairly short life cycle of the technology."

A major problem facing almost all the grant schools is obtaining the funding sources necessary for the constant upgrading of hardware and the purchase of new software versions that constantly enter the marketplace. At one school, the dean has been setting aside approximately $50,000 per year (from non-IBM MoIS grant sources) to purchase microcomputer systems for faculty. This dean established a committee to set a standard hardware configuration and review faculty requests for systems. Faculty members who needed to upgrade their current system were able to apply for funds, but were individually responsible for any upgrading beyond the standard configuration.

Software, while significantly less expensive than hardware on a per unit basis, presents a greater funding problem. The almost daily announcement of some new package and/or better version of an existing package, creates continual demand for expenditures. A lack of software standardization at many schools compounds the problem. In an effort to exercise some control over costs, the dean at one school explained that "the school will not purchase software for faculty." While achieving short-term cost savings, this approach could significantly increase long-term costs. Incompatible programs and systems require significantly more staff resources. The longer they exist, the greater the costs.

Research

Three distinct research support patterns emerged at the 13 IBM MoIS grant schools: seven schools supported research in any discipline, provided the project had an information systems orientation; two schools supported research for projects only in the department in which the Information Systems area was housed; and four schools used the funds to support research only within the Information Systems area itself. A description of the research output from the 13 schools is presented in Section 2.

Many of the schools rely on their relationships with corporations and firms to support and disseminate research. Several have utilized formal committees composed of faculty and corporate leaders to support research efforts. In four schools these committees predated the IBM MoIS grant program. Formal liaison with the corporate community was established at the remaining schools as a result of the grant. Through these committees, access to research sites is obtained, joint research projects are undertaken, and executive-faculty exchanges occur. In addition, ongoing seminar series involving members of the business and academic communities provide a forum for the dissemination of research findings.

One specific impact[13] of the grant on research at these schools was in the area of faculty funding. Overall, research productivity increased as a result of augmentation of equipment and resources. Funds became available for summer research support, outside scholars for colloquia, studies in industry issues, expansion of Group Decision Support laboratories (from one school to five schools as discussed in the Appendix - see *Specialized Laboratories*), and for financial support of doctoral students. Two schools took very aggressive postures with respect to doctoral student support, and provided funding for attendance at the International Conference on Information Systems (ICIS) for all their IS doctoral students as well as for research assistantships. Most of the remaining schools provided research assistantships and ICIS funding during the student's last year in the

13 These impacts were identified by the principal investigators from the 13 schools during a Group Decision Support session held during the 1988 MoIS meeting at the University of Arizona, Tucson, 10/88, and were subsequently reviewed during the 1989 meeting at the Claremont Graduate School, 11/89.

program. One school issued all doctoral students microcomputers for their personal use while in the program.

Another important impact of the grant was the strengthened communication among scholars at the 13 schools. The grant supported several group meetings where research and other issues in IS were discussed. Several PIs saw Bitnet as an important addition made possible by equipment obtained through the grant. Researchers at 12 of the grant schools are now linked and use Bitnet as a means for information exchange. One product of these collaborative exchanges was preparation of a text which presented an MoIS framework and appropriate collection of readings.[14]

Culture of the School

"Certainly our school is a far different place than [it was] six years ago, and in university terms, that's not a very long time." "Five years ago we were typewriter dependent and computer accessible, now we're computer dependent and typewriter accessible." These statements summarize what may be the most crucial long-term impact of the IBM MoIS grant program -- the fundamental change in the culture of the schools, with regard to information systems. These changes manifest themselves along two dimensions: a change in user expectations toward access to information systems and a change in the school's perspective of information systems management.

Changes in User Expectations

Perhaps the most critical impact observed at the IBM MoIS grant schools is a fundamental change in attitude on the part of the faculty and students toward access to information technology (hardware, software, and data). In the early 80s, faculty and students viewed access to information technology as a privilege. Only those individuals with a justifiable requirement were given access to the mini or mainframe computers, generally in a central campus facility. These systems frequently had a meter, counting every cycle used and line of output printed. Users had to go to the computer center and work in a public, usually noisy, open facility, accommodating to the hours of operation established by some distant bureaucracy. Support was limited and specialized (usually related to finding a bug in a computer program), and frequently provided by highly competent but intimidating computer gurus.

Users have changed their perspective -- access to information technology is now a right rather than a privilege. Coupled to this attitudinal change are significant resource implications. Microcomputers are viewed as truly "personal computers." Faculty members expect access to a microcomputer in their office, frequently with a second, compatible system at home. Students expect to have computer laboratory facilities and to develop the computer literacy skills necessary to attain their desired corporate positions upon graduation. They all expect the systems to be maintained, operative, and available whenever they choose to work. Users now expect the hardware to be augmented by the latest user-friendly software, and the entire support operation to be staffed by competent, user-friendly consultants. And, they expect these support services to be conveniently located, not at some remote site. A doctoral student's comment summarizes these changes, "The equipment is like air, we take it for granted. But, if it's not there, we suffocate."

The consequences of these changes in user expectations present an even more challenging demand. As users become more accustomed to whatever initial configuration of hardware,

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14 Gray, P., King, W. R., McLean, E. R., Watson, H. J., editors, *Management of Information Systems*. Chicago: Dryden Press, 1989.

software, and connectivity is provided, they want "more, better, and faster." "More" means additional peripherals such as laser printers, or connectivity to a network or an e-mail system. "Better" generally means newer versions of their favorite software and access to the available on-line databases. "Faster" refers to immediate system upgrades to newer processors and the ability to retrieve data, process a problem, or access a network in a shorter time.

In discussing the basic objective for information technology and what these changing expectations mean, one PI stated, "My vision for information technology is to extend our intellectual capabilities, and to enhance our ability for insight, creativity, and synthesis of ideas." Or, as an OB professor stated, "These technologies are great as something to help us think more clearly, but not to replace our need to think." A marketing professor described the change this way:

> "By [having access] to a lot of equipment and facilities...students...chose to do some analysis and modeling that they didn't necessarily have to do, because they were able to....People would use computers in courses on their own initiative in various ways, or in their thesis work in ways we didn't think about or plan."

To support these changed user expectations and demands, an overall MoIS philosophy for the school is needed, with a strategy for establishing and maintaining the technological infrastructure to support the philosophy. Issues related to these increasing user expectations are discussed in Section 4.

Schools' Perceptions of MoIS

Interviews across the 13 IBM MoIS grant schools revealed that the perceptions of MoIS varied considerably and were as diverse as the schools themselves. This diversity was also seen in the strategies used by the schools to allocate the IBM MoIS grant resources. In six schools the IBM MoIS grant funds were controlled by the PI for the grant, in two schools the funds were controlled by the department head (in which IS as an academic discipline resides) and in the remaining five schools the funds were controlled by the dean. At nine schools the funds were used at the department or school-wide level to support projects that incorporated IS concepts into any business school discipline. In four of the six schools in which the PI controlled the resources, only projects within the IS area were supported. Irrespective of the funding strategy, all of the schools implemented significant curricular change, conducted numerous research projects, and underwent the changes in user expectations already described.

These resource allocation strategies along with factors such as faculty, staff, and student views toward IS, together with the school's goals with respect to information technology, reflect the general perception of IS in an academic environment. One principal investigator commented that the grant had a "consciousness-raising effect and forced [non-IS] faculty and administrators to focus on the *management* of information systems. Before the grant they saw IS as Decision Support Systems only, but they now realize the field is much broader." This view was supported by an associate dean who said, "The grant has made non-IS faculty more informed and knowledgeable about evaluating IS people and understanding their potential roles and usefulness in a business school." A contrary view is also noted in the concern expressed by several IS professors that people now equate computers with information systems, that there is a prevailing attitude that computer technology/skill is equivalent to information systems. The view is also seen at the student level, as indicated in this typical statement made by both IS and non-IS faculty, "Some students have the idea that because they can

operate Lotus or dBase they know general MIS concepts."

Despite some continuing perceptions that information systems is synonymous with computer systems, a broader view of IS is taking shape at the schools; specifically, IS is being viewed as encompassing the spectrum of management activities related to technology within organizations. How a school perceives the management of information systems (MoIS) has major implications for the development of information policies in the school.

SECTION 2

INFORMATION SYSTEMS RESEARCH

Information systems researchers investigate the full spectrum of computer-based information systems. This includes their use and impact on organizations, the development, implementation, and maintenance of these systems, and the management of an organization's IS resources. Information Systems is a contemporary field, growing simultaneously with the practice it is investigating, rather than being a discipline studying well-established phenomena. As organizations and society make the transition into the information age, the opportunities for research will challenge academicians in every discipline. The IS research agenda identified by the IBM MoIS grant schools reflects this challenge, calling for inquiry into the alignment of the IS functional unit within organizations, and IS's role as an agent of change and leadership in this new era. Examination of the grant-supported research performed at the schools provides a perspective on the breadth and complexity of the IS field.

The focus of this section is the grant-supported research conducted at the 13 IBM MoIS grant schools during the past five years. This description is based upon citations and abstracts submitted by the schools. It does not capture all IS research undertaken at the schools. A classification framework of the IS field is used to facilitate analysis of the research. The section concludes with a discussion of IS research themes for the 1990s.

An Information Systems Framework

The framework for our analysis is a classification scheme of the IS field originally developed at UCLA.[15] In this classification, Information Systems encompasses four interrelated domains: Business Applications of Information Technology, Information Technology, Applications Development Activities, and Management of IS Resources.

I. *Business Applications of Information Technology.* This domain includes the contributions of information systems to the organization, the set of IS products and services used by the organization, and the impacts of these systems on the organization and its members. It covers a wide variety of systems to support strategic, managerial, and operational activities, allowing users to better organize, monitor, control, and plan. Examples are transaction systems, decision support systems (for individuals and groups), electronic meetings systems, executive information systems, expert systems, and applications developed by end-users themselves. This domain also covers issues related to human-computer interaction, the impacts of information systems on organizations, and the use of information systems to gain a competitive advantage.

II. *Information Technology.* This second domain focuses on technology, specifically the management implications of different hardware, software, and telecommunications technologies. Examples of issues within this domain are system architecture, system performance, operating system alternatives, database design, network design, the

15 The classification scheme is the result of discussions among IS faculty at UCLA between 1984-1986, including M. Lynne Markus, Ephraim McLean (now at the Georgia State University), Mark Silver, and E. Burton Swanson. A similar classification appears in the book *Management of Information Systems*, edited by four principal investigator's of the IBM MoIS grants, Paul Gray, William R. King, Ephraim McLean, and Hugh J. Watson (Dryden Press, 1989).

integration of emerging technologies, and the evaluation of systems performance.

III. *Applications Development Activities.* This domain represents a bridge between the users and the applications they need to have developed. It covers all phases of the system development life cycle, from project inception and analysis through implementation and maintenance. Included in this domain are Computer Assisted Software Engineering (CASE) tools, training approaches, IS project management, and the relations between users and developers.

IV. *Management of IS Resources.* The fourth domain concerns the management of the organization's IS resources, both internally and externally to the IS functional unit. This domain spans the day-to-day operational issues and strategic planning for corporate use of information systems. Within the IS functional unit, issues are related to how the IS services are organized (for example, centralized or decentralized), the management of IS personnel, the management of distributed systems, budget management, information resources security, and disaster recovery. Externally, this domain deals with the relationship between IS and the entire organization, and includes issues such as strategic IS planning, corporate information policy, and data management.

Analysis of Research Activities

Each IBM MoIS grant school was asked to submit references and abstracts for all grant-supported research that appeared in print, whether in journals, working papers, books, or conference proceedings. In response, 445 citations were received from 12 schools. Of these, 90 were excluded from the analysis as they did not represent mainstream information systems research. Most of the excluded papers concerned operations research modeling, job sequencing and shop floor control in manufacturing, or robotics. Others reflected organizational research (such as decision support in general), marketing, group behavior, and management theory. A third group was conceptual papers, presenting reflections on IS research and curriculum.

The remaining 355 citations form the foundation for this analysis. While the citations submitted do not represent all IS research conducted at these schools, nor the entire scope of IS topics which may be covered at other schools, it provides a substantial basis for a description of IS research at the grant schools. Analysis of the submitted citations and abstracts involved two steps in classification. First, each citation was placed in one of the four IS domains through several successive categorizations by two members of the report team until consensus was reached. In the second step, the citations were clustered according to the topic areas they represented. The final classification was reviewed and reworked by a third team member until consensus was again reached. It was possible to classify many of the papers into two topic areas in different domains. With the third iteration, however, each citation was assigned to the topic area that appeared to be the dominant theme.

The classification into domains and topics is displayed in Table 4. Also given is the number of citations for a given topic and the number of schools from which citations were received. The distribution of papers across the four domains is uneven. The number of topic areas covered, however, is similar for all four. *Business Applications of Information Technology* was the domain generating greatest interest, attracting researchers at 11 of the IBM MoIS grant schools and containing just over half of all the papers. Topics in the fourth domain, *Management of IS Resources,* were also of interest to researchers at 11 schools, and accounted for one quarter of the citations. The remaining quarter of the citations represent

TABLE 4.

INFORMATION SYSTEMS DOMAINS AND RESEARCH TOPICS
N = 355

I. BUSINESS APPLICATIONS OF INFORMATION TECHNOLOGY	CITATIONS N =182	SCHOOLS N = 11
Electronic Meeting Systems/ GDSS	58	6
E-mail, Voice Mail, & other Group Support Systems	28	5
Decision Support Systems	27	11
Human-Computer Interactions	21	6
End-User Computing	16	5
Expert Systems	12	7
Impacts of IS on Org's	8	4
Transaction Processing Systems	4	2
IS for Competitive Advantage	4	2
Strategic Planning Systems	2	2
Executive Information Systems	2	1

II. INFORMATION TECHNOLOGY	CITATIONS N = 34	SCHOOLS N = 5
Database Design	18	3
Network Design	7	2
Database Machines	3	1
Software Evaluation	2	1
Information Economics	2	1
Distributed Processing	1	1
Personal Computers	1	1

III. APPLICATIONS DEVELOPMENT ACTIVITIES	CITATIONS N = 51	SCHOOLS N = 8
IS Analysis and Design	14	6
CASE Tools	10	4
End-User Training	7	3
User-Developer Interaction	7	3
Determining Information Requirements	4	4
Application Maintenance	3	2
IS Project Management	3	2
System Implementation	2	2
Software Reliability	1	1

IV. MANAGEMENT OF IS RESOURCES	CITATIONS N = 88	SCHOOLS N =11
Information Resources Security	15	4
IS Performance	14	4
Data Resource Management	12	4
Strategic IS Planning	11	6
Organizing User Services	11	4
Adoption & Diffusion of Information Technology	8	4
Chargeback	6	5
Managing IS Personnel	5	3
IS Budget Management	4	2
Corporate Inform Policy	1	1
Disaster Recovery	1	1

research in the other two domains. Research in *Applications Development Activities* was conducted at eight schools and accounted for 14% of the citations while research in *Information Technology* was conducted at five schools, accounting for 10% of the citations.

Within each domain, the number of citations on a specific topic varied considerably. Nearly one-quarter of the citations fell into two topic areas related to group work. Five areas within three of the domains represent single citations.

Table 5 displays the 10 most frequently researched topic areas. Note that these 10 topics account for 223 (63%) of the citations in

TABLE 5.

TEN TOPIC AREAS WITH GREATEST NUMBER OF CITATIONS
n = 223

TOPIC AREA	DOMAIN	CITATIONS	SCHOOLS
Electronic Meeting Systems/GDSS	Bus Appls	58	6
E-mail, Voice mail, & Other Group Support Systems	Bus Appls	28	5
Decision Support Systems	Bus Appls	27	11
Human-Computer Interactions	Bus Appls	21	6
Database Design	Info Tech	18	3
End-User Computing	Bus Appls	16	5
Information Resources Security	Mgmt of IS	15	4
IS Analysis and Design	Appl Devel	14	6
IS Performance	Mgmt of IS	14	4
Expert Systems	Bus Appls	12	7

Table 3. Furthermore, six of the topic areas, accounting for 162 papers (46%), are from *Business Applications of Information Technology*. The ten topic areas are described below in more detail.

The most frequently investigated topic at the IBM MoIS grant schools fell within the general theme of computer support of cooperative work (CSCW). This includes, for example, electronic meeting systems, group decision support systems (GDSS), electronic mail, voice mail, and other group support systems. CSCW investigations account for 86 citations (24% of all citations). CSCW incorporates the design, use, and impact of information systems which supports both face-to-face and remote communications for groups. Specific topics investigated include alternative methods of supporting groups and the impacts of technology use on group processes. Technologies studied include electronic and voice mail systems, conferencing systems, document exchanges, calendar management, and sophisticated networking software specifically developed to support face-to-face group interaction. This latter software has features which facilitate presentations, the sharing of common screen displays, brainstorming, and the classification and ranking (voting) of alternatives.

The very large number of papers in the area of Group Decision Support Systems and Electronic Meeting Systems (15% overall) reflects the contribution of the IBM MoIS grant. The grant enabled schools to make the significant hardware, software, and personnel investments in specialized laboratories which were required in order to develop the software and conduct controlled experiments.

Decision Support Systems (DSS) are information systems designed to support individual decision-making activities. Computers are particularly helpful in allowing decision makers to access databases in *ad hoc* ways, sometimes after problematic situations have been identified by specially designed reporting systems. DSS generally includes decision models to analyze the data and generate alternatives that can also be used to track the results of decisions. The research in DSS involved development, comparison, and evaluation of DSS in specific situations.

End-User Computing (EUC) represents the shift in organizational control over information

resources from a centralized point to the non-IS professional users throughout the organization. These end users have or need control over what is analyzed and over direct access to data at their convenience, not according to the time schedule of IS professionals. Many end users access and analyze data using microcomputer-based packages like Lotus 1-2-3, new 4th generation languages, or desktop publishing. Researchers investigated how to manage and support EUC. Ten of the EUC papers also addressed topics in the *Management of IS Resources* domain, specifically related to organizing user services.

Information Resources Security research focused on studies of access authorization, protecting data transfers over networks (principally through encrypting), and the implications of computer viruses on data and programs.

Human-Computer Interaction research addressed such topics as the display of information to the screen (in terms of text, graphs, tables, and colors) and the means of communication between the human and the computer (for example, use of the keyboard, mouse, and touch screen).

Database Design research fell into two main areas; optimization of data storage and retrieval through better algorithms and data organization, and investigations into logical database design using semantic data models and expert systems.

IS Analysis and Design is principally concerned with the representation of information in data models and the study of model characteristics to determine the best ways of representing data, so that applications can be better developed and suited to user needs.

Corporate executives are increasingly concerned with the benefits received from their firms' investments in information systems. IS performance research concerned the relationship between investment in information technology and overall corporate performance, and the effects of IS on organizational productivity.

Expert Systems are closely related to Artificial Intelligence and may be considered an advanced form of DSS. It is differentiated from DSS in that expert systems have embedded rules for analyzing data, and sometimes making decisions. Expert Systems research focuses on knowledge acquisition and the development and use of appropriate shells for the system.

Future Research Themes Suggested by the IBM MoIS Grant Schools

At the IBM MoIS grant meeting held at the University of Arizona in 1988, the principal investigators and senior IS managers from IBM participated in a session using group decision support software to identify future IS research issues. Furthermore, each school was asked to submit, in a narrative report, its view of future research directions.

Drawing from the GDSS sessions and the narrative reports, seven broad IS research themes emerged for the 1990s. In reviewing these seven themes, it seems that the major thrust of IS research in the 1990s will be toward management of IS systems, with additional interest in applications, development, and technology. This sharply contrasts with the focus of the grant-supported research described in this report, where the submitted citations for research over the past five years were predominantly within the business applications category. The future research themes identified are:

- *IS as a Strategic Corporate Resource*

This research theme involves issues related to IS relationships external to the IS functional unit, such as the alignment of IS within the organization, strategic corporate and IS planning, and the role of CIO. The use of IS for competitive advantage is another component, investigating topics such as: what

constitutes strategic use of information technology (IT); how to identify strategic opportunities; the relationship between organizational characteristics and IT use for competitive advantage, and the utilization of emerging technologies for strategic advantage.

- *IS as an Organizational Change Force*

Closely linked to IS as a strategic corporate resource is the growing role of IS within the firm. Executive education and leadership with respect to IS and the cultural and organizational changes that occur are the focus of studies related to this theme.

- *Managing IS Resources*

Research in this area focuses on the internal management of the IS functional unit and organization of the IS functional unit in relation to its ability to meet the changing needs of an organization. Topics in this area will include IS personnel career paths, organizing to support end-user computing, selection and evaluation of IS components, IS budget and last, but certainly not least, the management of IS technologies (discussed below). Security and protection of IS resources is also expected to receive attention as more and more users and applications become linked over local-area networks and wide-area networks.

- *IS Applications*

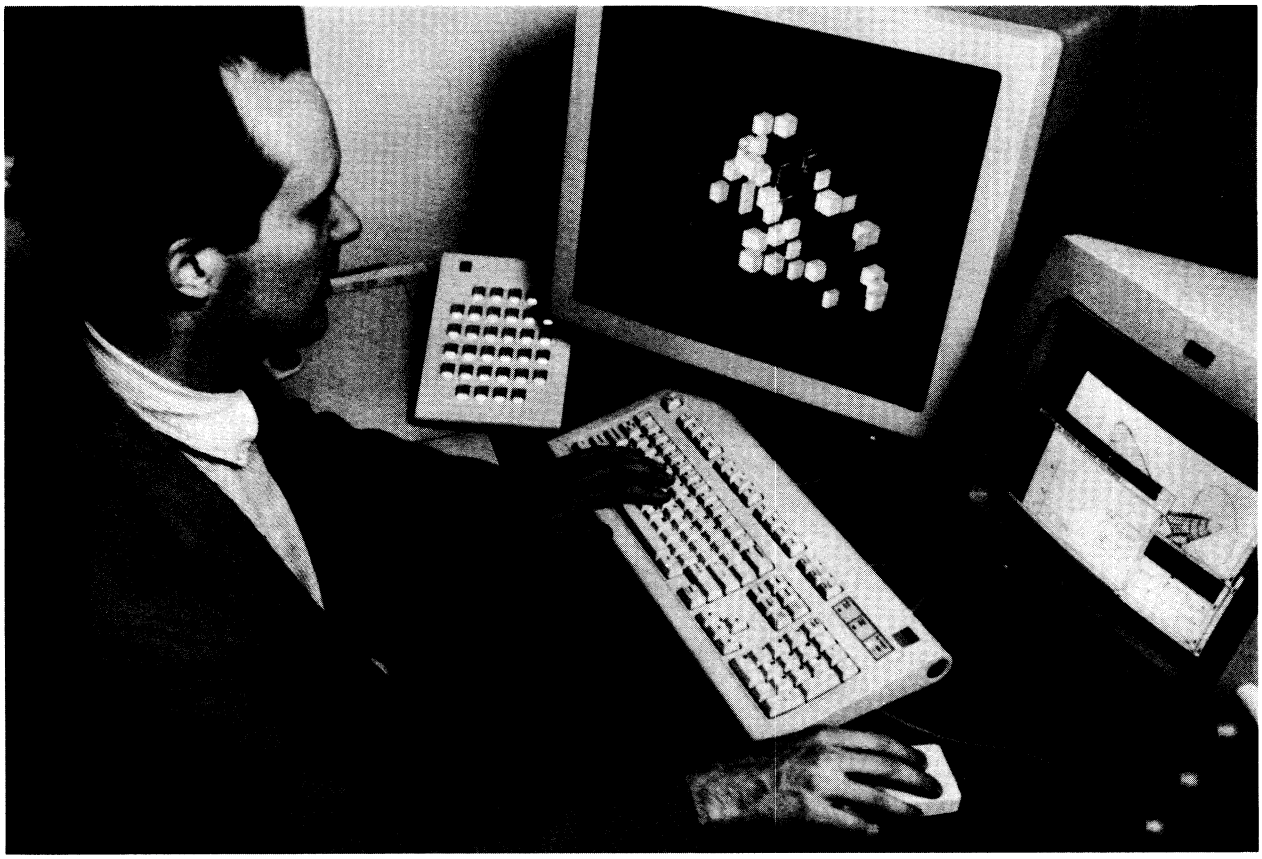
The uses of Information Technology will continue to receive much attention, as will applications aimed at increasing intra-organizational and inter-organizational communication and integration. The subjects of interest generally center on the increased and adapted use of computers to support organizational activities. Researchers will continue to study all aspects of Computer Support of Collaborative Work. The support of individual decisions through Decision Support Systems also remains on the agenda of some universities, in terms of design, modeling, and the effects on decision-making behavior. Analysis and design issues associated with Executive Information Systems (EIS) provide an important research focus, particularly in terms of identifying what is needed by information executives and assessing the impacts of EIS on senior management work. Systems design and the role of the analyst are also identified as research subjects, as are the factors influencing design success and failure. Finally, presentation systems represent an addition to IS research issues. Some researchers have expressed the need to evaluate and compare the effectiveness of different types of presentation systems combining text, image and sound in a seamless presentation, and to look at room and facilities design.

- *IS Development*

Issues in this area relate to enhancing development productivity, including methods for eliciting requirements; programmer productivity; and the use of CASE tools. Specifically addressed is how Case tools can support the whole life of applications (analysis, design, programming and maintenance), how they can improve productivity, how to measure their costs and benefits, and how they can be used by end users.

- *IS Contribution*

This area investigates and studies the contribution of IS to the organization, identifying value and justifying expenditures. Knowledge-worker productivity is very different from the concept of manufacturing productivity and finding ways to measure the contribution of IS to the organization is critical. Evaluating IT and IS costs and benefits is also an important research issue, whether in terms of specific applications and uses of Information Technology, or in a more general sense. Researchers intend to look at quantitative and qualitative methods, and at charge-back systems for a distributed and networked environment.



• *Management of Information Technology*

How to determine the fit between new technologies and organizational needs and capacity represents another research area. The management of global telecommunication networks is a one component of this area. It includes issues such as how to plan, design, and implement networks; how to evaluate their costs and benefits, and charge for user access; how to evaluate public, private, and hybrid networking strategies; how to measure the impacts of different network architectures, layered communication models, and protocols; how to connect networks, and how to do it in a seamless way; and how to measure the impacts of transmitting text, voice, and image, as well as data, on network management.

Some researchers have also expressed interest in the emerging European community in 1992, in terms of information exchanges between countries, standardization of protocols and technologies, and the integration of networks. Database design issues concern the effective design and implementation of databases to better support the development and maintenance of applications, as well as to improve productivity in software development.

SECTION 3

INFORMATION SYSTEMS CURRICULUM

As noted earlier, one of the most significant impacts of the IBM MoIS grant has been on the schools' curricula at the master's level. The grant provided opportunities for the schools to revise and update the IS content in the IS concentrations and in the general MBA program. Through curriculum development and improved technology, all of the grant schools have designed new courses and modified others. This section of the report describes and discusses the IS curricula at the 13 IBM MoIS grant schools. An overview of the programs at the schools is given, the programmatic approach taken by the schools is discussed, and brief summaries of the first introductory IS courses are presented. Using the ACM categories[16], short descriptions of the most commonly taught courses across the schools is included. A summary of each school's IS program follows.

Overview of Schools and Curricula

All 13 MoIS grant schools offer MBA and Ph.D. programs. Ten schools have a formal IS concentration or specialization; six are offered within the MBA degree program, one offers an IS specialization with the MS degree, and three offer an IS specialization as part of either the MBA or MS degree. Three schools[17] do not have explicit IS concentrations, although students can elect to take several IS courses , in effect providing an informal concentration. Table 6 presents an overview of the degrees, specializations, and IS course requirements at each school.

The number of courses MBA students must complete for IS specializations or concentrations ranges from 3 to 10. The IS specializations with the MS degree generally require at least 10 IS courses. One school without a formal IS concentration encourages an IS-based field study for interested students. The number of IS specialty courses taught at the schools ranges from 4 at one school to 25 at two schools to 24 at another. Those schools with specializations average approximately 17 IS class offerings.

The number of faculty supporting the IS programs varies from 16, 14 and 13 at Texas, Arizona, and Georgia State respectively, to 5 at Pennsylvania and 6 at UCLA, Georgia, MIT, and Rochester. The average is 8 full-time tenure track faculty representing approximately 7.5 percent of the total faculty. Almost all of the schools rely heavily on part-time lecturers to meet the teaching load.

The organization of IS also varies among the schools. In five of the schools, the IS area is an autonomous entity with its own chairperson. In the remaining schools IS is part of one or more separate academic units.

Programmatic Approaches to IS for the MBA

In reviewing and revising the curriculum, faculty were challenged by the significantly different IS training requirements of future managers. Faculty needed to consider both the functional area manager who requires some IS skills and concepts, and the IS manager. In providing this differentiated education for managers, the schools took three programmatic approaches; preparation of the non-IS manager, preparation of IS professionals with a

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16 Nunamaker, J.F. Jr., J.D. Cougher, and G. B. Davis, (1982) "Information Systems Curriculum Recommendations for the 80s: Undergraduate and Graduate Programs." *Communications of the ACM*, v. 25, no. 11, pp. 781-805. These are currently under revision.

17 UCLA does not offer formal concentrations in any area, Illinois is considering offering an IS concentration, and Wharton offers IS as a subspecialty area within Decision Sciences.

TABLE 6.

IS COURSE REQUIREMENTS FOR THE MASTER'S DEGREE

SCHOOL	MASTER DEGREES OFFERED	REQUIRED IS COURSES	TOTAL IS COURSES OFFERED
Arizona	MBA	1	25
	MBA/IS	6	
UCLA	MBA	constrained elective†	17
Claremont	MBA	constrained elective†	30
	MS/MoIS	7 + practicum	
	MS/CIS	8 + practicum	
	MS/Telecommunications Mgt	8 + practicum	
Georgia	MBA	1	11
	MBA/IS	3	
Georgia State	MBA	1	24
	MBA/IS	5	
	MS/CIS with subspecialty in:	5+	
	Mgt Sys Devel	5	
	Expert Dec Systems	5	
	Mgt Sftwr Engin	5	
	Design of Comm Sys	5	
Illinois	MBA		9
Indiana	MBA	1	11
	MBA/MIS	3 + practicum	
MIT	MBA	1	12
	MBA/IS	3	
Minnesota	MBA	1	12
	MBA/MIS	6 + practicum	
Pennsylvania	MBA	0	4
Pittsburgh	MBA	1	25
	MBA/MIS	4 + practicum	
	MS Telecommunications	12 + practicum	
	MBA-MS/MoIS	11 + internship	
	MS/MoIS	–	
Rochester	MBA	1	15
	MBA/CIS	5	
	MBA/CIS+Acct	7	
Texas	MBA	1	17
	MBA/ISM	6	

† Students choose two out of three courses, one of which is an informations systems course.

technological focus, and preparation of IS professionals with an organizational focus. In general, the IS manager with a technological focus works within the IS function and manages the selection, introduction, and operation of large, complex, telecommunications and computer environments. The IS manager with an organizational focus operates as an information systems consultant to the functional areas and the organization as a whole.

Information Systems for the Non-IS Manager

A critical issue faced by IS faculty was how to approach the first course in IS; a course that must be the initial course for those interested in IS and, at the same time, probably the only course in IS for the vast majority of MBA students. All 13 schools implemented programs to address the needs of the non-IS manager. The strategy used by 12 of the IBM MoIS grant schools was to have an introductory IS core course taken by all students seeking an MBA, with or without an IS concentration. The needs and requirements of these two audiences would suggest very different orientations for the course. However, except for the three schools which identified separate IS and non-IS tracks initially (Pittsburgh, Texas, and Claremont), all MBA students took the same first course. One school, the University of Arizona, approached the responsibility for providing information systems skills and concepts to all MBA's in a significantly different way. At Arizona, the entire MBA core was re-examined, and a new core emerged comprised of one IS core class (focusing on computer skills and general IS issues) and five multidisciplinary, team-taught, functional courses. In each of these five courses, faculty members in each functional area introduce computer skills as appropriate to the content of the course. Functional specialists in accounting, finance, economics, and so forth, usually do not have the background to address information systems concepts and issues, thus one-third of each course is taught by an IS faculty member.

Syllabi from eight of the introductory courses[18] were examined for content using the four domains of the IS field; Business Applications of Information Technology (Applications), Information Technology (Technology), Applications Development Activities (Applications Development), and Management of IS Resources (Management). (See Table 7.) The specific focus, content, and topics covered in the introductory IS course for MBA students varies across the schools. Six schools include topics from all four of the IS domains in this introductory course. Two schools include topics from three of the domains (applications, development, and management), deferring discussion of technology topics to specialty courses for students specializing in IS.

In addition to these differences, the courses are further distinguished by their inclusion of the user perspective. Course content at three of the schools appears oriented specifically to the non-IS manager and covers such issues as centralization/decentralization of information technology and transactions across organizational boundaries. At the other five schools, the course presents an overview of IS topics; for example, Decision Support Systems, End-User Computing and Office Automation. The range of topics covered in the first course at each school is given in the sidebar.

Grading policies for the courses include mid-term and final examinations at all of the schools except MIT and Wharton, where written papers are used. Individual papers are required at most of the schools; limited use is made of group papers.

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18 MIS 501, University of Arizona; Mgt 404, UCLA; Man 941, University of Georgia; S504, University of Indiana; 15.562, MIT; BA660, University of Pennsylvania; BS MIS 202, University of Pittsburgh, CIS 401, University of Rochester.

TABLE 7.

EXAMPLES OF INTRODUCTORY COURSE CONTENT

SCHOOL	FOCUS	HANDS-ON EXPERIENCE	APPLICATIONS	TECHNOLOGY
ARIZONA	professional skills building	Lotus 1-2-3 Dbase	ESS DSS	Data/Database
UCLA	managerial and organizational IS issues	Expert Systems Hypermedia	Bus Appl	Microcomputers
GEORGIA	applications portfolio	Mainframe Finan. Planning Systems E-mail	DSS AI / Expert Systems	---
INDIANA	issues faced by corporate IS managers	E-mail	Strategic Inform Systems	Software Sys Networks Inf Architecture
MIT	management issues surrounding IT	---	Knowledge-Based Sys	Interaction Technology
MINNESOTA	managerial information literacy	Lotus 1-2-3 Dbase Pagemaker	Transaction Systems Modeling DeskTop Publ	Microcomputers Database Systems
PENNSYLVANIA	systems analysis and design	---	Office Automation Meas/Rptg Sys	Telecom Distributed Sys
PITTSBURGH	applications and organizational issues	E-mail Lotus 1-2-3	Airline Rsv Sys GDSS Org Inf Systems	---
ROCHESTER	using IT to solve business problems	Lotus 1-2-3 Dbase	AI / Expert Sys	Architecture Networking

Information Systems Curricula

In preparing students for the IS professional roles, four schools offer degree programs (both the MBA and MS) that clearly differentiate between the two IS professional management roles; that with an organizational focus and that with a technological focus. The syllabi for the five schools offering MBA-IS specialization degrees are organized so that a student can prepare for either option.

Syllabi submitted by the schools reveal two shifts in the focus of IS programs. First, there has been a shift toward an organizational perspective of IS management topics. IS management courses tend now to discuss more fully the numerous ways in which IS can be applied to the support of organizational activities. Discussions include the strategic

APPLICATION DEVELOPMENT	MANAGEMENT
System Devel System Design	End-User Computing Change Mgt Planning & Policy
Application Devel Topics	Appl Failure & Obsolescence Implementing IS
---	Mgt of Computer-Based Inf Systems
Traditional System Devel Prototyping	End-User Computing
System Devel	End-User Computing Strategic Use of IT
Database Design	Strategic Uses Mgt of End-User Computing
Systems Design	Econom of Inform MIS Strategies
Personal Infor Sys Analysis & Design	IS & Org Systems End-User Computing
File vs Database Systems MIS Devel	System Evaluation & Acquisition Resource Economics

value of IS in addition to design and operational considerations of maintaining IS technology. Second, it is apparent from the number of courses and content covered within these courses that there has been a shift in emphasis from mini/mainframe applications to microcomputer applications. The movement toward relatively simple microcomputer applications has reduced the emphasis on topics involving computer architecture, program structures and operating systems.

The framework for this discussion of courses is the 1982 ACM recommendations, which identified ten categories or types of courses as important for the preparation of master's students in IS. One school offers a class in each category, while another offers classes from all of the categories except the practicum. Courses from 6 of the 10 ACM categories are taught by at least 9 of the schools; *IS in Organizations, Database Management Systems, Data Communications Systems and Networks, Modeling and Decision Systems, IS Systems Design Process, and Information Systems Policy.* Seven schools have courses in *Artificial Intelligence,* four schools require a practicum with the IS specialization, and seven offer special topics courses. All of the 13 grant schools offer courses in the *Information Systems in Organizations* category.

IS in Organizations Course

Syllabi for 23 courses falling within the *IS in Organizations* category were submitted by the schools. The courses are designed to provide an introduction to IS concepts. In fact, six of the eight syllabi for the introductory course for non-IS managers belong in this category.

Syllabi from ten of the courses include topics from all four IS domains. Four other syllabi cover topics from Business Applications of Information Technology and Management of IS Resources domains. Only four syllabi are organized around very specific subjects such as social issues of computing, end-user computing, systems approach to IS, and computer audit, security and control.

Seven of the course syllabi include hands-on computer experience such as use of electronic mail systems, spreadsheets, data bases, financial planning systems, and/or development of a small application. At the end of the course students are expected to be able to identify potential uses of Information Technology, recognize differing approaches to application

development, participate in the development of applications, and be aware of the managerial issues raised by Information Technologies.

Finally, all of the courses emphasized class participation, primarily through case discussion of real-world situations. Participation accounts for between 10% and 35% of the final grade, while case reports account for as much as 55% of the grade. Final examinations are given in 13 courses.

Database Management Systems

Courses in this category focus on the technical and managerial issues involved in design and use of database systems. (See sidebar.) Emphasis is placed on relational database management systems (DBMS), although hierarchical and network databases are also covered. The sidebar below presents the most frequent topics covered by these courses.

Topics Covered in Database Management Systems Course

- File Organization
- Entity-Relationship Models
- Hierarchical Models
- Network Models
- Relational Models
- Relational Theory
- Structured Query Language (SQL)
- Data Management
- Distributed Databases
- Computer Assisted Software Engineering Tools (CASE)

Three of the 15 database syllabi reviewed concern the in-depth study of database related issues such as database machines, query optimization, database reorganization, data security and recovery, and distributed databases.

Syllabi for 12 of the courses include exercises involving the design and implementation of a small application using relational systems, either on a microcomputer or mainframe. Exercises and projects count for between 12.5% and 60% of the course grade.

Data Communications Systems and Networks

The telecommunications area within IS is expanding rapidly. The time given to discussion of telecommunications at the annual MoIS PI meetings is a reflection of its growing importance. Telecommunications courses are offered at ten of the schools. These provide students with a technical and managerial understanding of telecommunications and networks. The sidebar below presents the topics covered in the 14 syllabi for the data communication courses reviewed.

Topics Covered in Communications and Networks Course

- Data Transmission
- Communications Hardware
- Communications Software and Protocols
- Networks Architecture and Topology
- Local Area Networks
- Wide Area Networks
- Applications (Voice, E-Mail, ISDN, Image, Distributed Systems, etc.)
- Networks Design and Implementation
- Networks Management
- Networks Planning
- Communications Staff
- Networks Security
- Communications and Organizations
- Telecommunications Industry

Telecommunications classes involve the study of network components and design through cases or projects. Syllabi for five of the courses also involved computer exercises.

Three schools offer master's degrees with Telecommunications concentrations: Claremont, Georgia State, and Pittsburgh. These three schools have taken different approaches to their master's program. Claremont offers seven courses in this area with an emphasis on technical issues and tactical issues that telecommunications managers face. At Georgia State, the emphasis is on developing telecommunications specialists who will eventually be managing the telecommunications function. Pittsburgh offers a unique program that has resulted from collaboration among five schools within the university; Computer Science, Communications, Electrical Engineering, Information Science, and Business. The curriculum is designed to prepare a telecommunications professional who may work in a corporate setting, in radio or TV, or in a multimedia educational setting.

Modeling and Decision Systems

This category encompasses two aspects, Decision Support Systems (DSS) and Simulation or Modeling. These courses are primarily microcomputer based, using spreadsheet tools for modeling. Course objectives for both of these aspects concern understanding how they can be used to support organizational decisions, development of computer-based DSS or simulation models, and selection of appropriate tools for a given situation. Additionally, course activities for both aspects include use of real-life examples and 82% of the courses in this category include hands-on computer exercises. The sidebar which follows presents the topics most frequently covered in DSS courses.

There are, however, differences between the two aspects of this category. For example, DSS courses emphasize user-interface design, while modeling classes are more oriented toward learning simulation programming languages and the validation of models. DSS courses are oriented toward a user/manager audience, while modeling courses appear to be oriented toward the specialist. Finally, while teaching methods for both subjects often involve mid-term and final examinations, exercises, term projects, class participation and presentations are more frequent in the DSS courses.

Topics Covered in Decision Support Systems Course

- Human Decision-Making Processes
- Decision Support Systems (DSS) Frameworks
- Information Requirements Determination
- DSS Development
- Interface Design
- DSS and Expert Systems
- Group DSS

Information Systems Design Process

The 16 course syllabi falling within this category are characterized by their diversity. Nine of the current syllabi focus on a knowledge of systems development activities and tools -- including the systems development life cycle (SDLC), process and data modeling, CASE tools, and project management. Structured methodologies and prototyping are emphasized. Variation is seen in the teaching strategies as well. A textbook presenting the phases of the SDLC in sequence is used in one course. Three syllabi indicate the sole use of articles. These, in general, cover the same topics as the textbook, but focus on the issues involved in developing information systems rather than the developmental activities themselves. Five of the syllabi include both textbook and article references.

The courses described by the remaining seven syllabi in this category provide students with a more specialized knowledge. The areas covered include methodologies evaluation, trade-offs and choices at major stages of systems development, audit procedures and controls in computer-based information systems, and new approaches and techniques in analysis and design.

Students have hands-on experience in seven of the courses. They may either use analysis tools or develop all or part of an application using fourth-generation languages. These projects count toward 15% to 50% of the student's final grade. Between 15% and 35% of the final grade in 11 courses is based on a paper on systems development.

Information Systems Policy

The 11 syllabi falling within this category from 9 of the schools emphasize a variety of topics. Five of the syllabi focus on the management of information resources within the IS function or broader organization. Some of the topics included are IS planning, end-user computing and information centers, distributed systems, operations management, IS personnel management, and the organization of the IS department. All of these syllabi indicate that students are involved in a study of some aspect of organizational IS activities. The studies accounted for between 15% and 30% of the final grade.

The remaining six course syllabi cover more specific subjects. Two are focused on how information technologies can be used to improve an organization's strategic positioning. Others emphasize topics such as the impact of new technologies on the management of information systems (particularly issues of system software and operating systems), telecommunications policy in the United States, and enhancement of organizational effectiveness through use of telecommunications. User-related issues of

information systems development, user support services, and the application of microeconomic analysis and methods to a variety of problems in computer management were other topics covered. Half of these courses allow students to study an aspect of an IS organization, the others use case studies or require term papers.

Individual School Summaries

University of Arizona

The Karl Eller Graduate School of Management at the University of Arizona is a public institution offering undergraduate, Master of Business Administration (MBA), and Doctor of Philosophy (Ph.D.) degrees. The school has 317 master's and 127 doctoral students.

MIS is a separate department within the school with Decision Science as a subunit. There are 14 tenure track IS faculty members out of 114 at the school. The school offers 25 courses in IS. The Center for Information Management Research coordinates funding for four major research projects; Electronic Meeting Systems, Information Center Expert, Integrated Office Information Systems, and Multi-User On-Line System for Analysis of International Computing.

Information Systems is the "flagship" program at Arizona, with the MBA core redesigned with significant IS content. In the first semester, all students in the MBA program take the core course in IS, Management Information Systems, which covers the four areas of IS. All students, regardless of specialization, take five core multidisciplinary, team-taught courses in which the management of IS has been integrated into specific functional areas. In the second semester, students are required to take Design and Control of Production Systems, and Management and Evaluation of Information Systems along with their other core classes. The third semester's integrated core classes are Decision Support Systems for Accounting, and Environmental Planning and Control. In their last semester, the capstone integrated core class is Business Strategy and Policy Making. These five courses give students experience with the use of IS applications for problem solving and decision making.

Introductory computing skills are learned in business school workshops prior to the beginning of the first term and then are covered more extensively as part of the MIS 501 course. These skills are reinforced and extended throughout the school year through the workshops and IS courses. Students are required to learn microcomputer applications (word processing, spreadsheets, and database). The school encourages students to buy their own computers by providing a computer fair where students can try out various systems, and by offering discounts on purchases.

MBA students concentrating in IS take six courses in the area.

University of California, Los Angeles

The John E. Anderson Graduate School of Management at the University of California, Los Angeles is a public institution offering Master of Business Administration (MBA), Master of Science (MS), and Doctor of Philosophy (Ph.D.) degrees. The school offers six joint degrees, including a joint MBA-Computer Science degree. There are 900 master's and 150 doctoral students.

IS is a separate area within the school with 6 tenure track faculty out of 86 for the school. The area offers 17 courses. The Information Systems Research Program, with its associates program has supported the research effort in the IS area for over 10 years.

Students in the MBA program can take the IS core course, MGT. 404, Information Systems, which covers the four areas of IS;

applications, technology, applications development, and management. Students are required to select two courses from IS, Macroeconomics, or Managerial Model Building during the second quarter of the first year.

Computing skills are learned in non-credit orientation workshops prior to the beginning of the first term. IS skills classes are developed and provided by the school's computing center staff and are reinforced and extended throughout the school year through various optional workshops. Students are required to know microcomputer applications (word processing and spreadsheets). Students make extensive use of an e-mail system, a major mechanism for student/administrative communications. The school encourages students to buy their own microcomputers and conducts a computer fair in the autumn where students can try out various systems. Discounts on purchases are available to faculty, students, and staff year-round.

All courses in the IS area are organized into the four IS domains. Students with a professional interest in IS are encouraged to select at least one course (beyond the core course) from each domain and to complete an IS-focused field study project. MBA students must complete a Management Field Study, a six month team consulting project for a specific company. The field study may be done in the IS area.

The Claremont Graduate School

The Claremont Graduate School is a small, private institution located in Southern California. The school offers degrees at the master and doctoral levels. Specifically, it offers Master of Science in Management of Information Systems (MS/MoIS), Master of Science in Computerized Information Systems (MS/CIS), Master of Science in Management of Telecommunication Systems (MS/MTS), Master of Business Administration (MBA), and a Doctor of Philosophy in Management of Information Systems (Ph.D.). The school has 85 master's and 50 doctoral students in IS.

The Information Science program is administered separately from the MBA program. There are 6 tenure track out of 20 Management and IS faculty members at the school. The school offers 30 courses in IS, with most courses offered once each year. The Information Science Applications Center (ISAC) coordinates sponsored research, student practicums, colloquia, and the working paper series.

Non-IS students in the MBA program may elect to take the core IS course for MBAs, DMC 380, which covers the four areas of IS. Executive MBA students do not have a specific IS requirement, but may select from seven IS courses offered.

MS/MoIS students are required to take eight IS courses, three MBA courses, and three electives. Students in the MS/MTS program take six required IS courses, three MBA courses, three required telecommunications courses, and two electives. The MS/CIS students take nine required courses, two MBA courses, and three electives. All MS students take a practicum as one of the required courses. It involves working in a team on a real project for an outside client against a time deadline. Practicum projects are oriented to the student's area of interest.

University of Georgia

The College of Business Administration of the University of Georgia is a public institution, offering undergraduate and Master of Business Administration (MBA), and Doctor of Philosophy (Ph.D.) graduate degrees. The college has 130 master's, and 130 doctoral students.

IS is spread between three groups: the School of Accounting, the MIS group in the Department of Management, and the Department of Management Sciences and Information Technology. There are 6 tenure

track IS faculty members out of 130 at the College of Business Administration. The college offers 11 courses in IS.

In the spring quarter of the first year, all MBA students are required to take the IS introductory course, MAN 941, Information Systems for Management, which covers two areas of IS: applications and management.

All entering MBA students take a computer skills course before the fall quarter begins. Students are expected to become familiar with microcomputer word processing, spreadsheets, and database managers.

There are three required courses and three electives offered for MBA/IS students seeking a career in consulting, sales, or in a liaison role. Another three-course sequence is required for those MBA/IS students seeking a career as an MIS specialist. In addition, there are three elective courses offered.

Georgia State University

The College of Business Administration of Georgia State University, a public institution, offers undergraduate, Master of Business Administration (MBA), Master of Science (MS, including a CIS specialization), and Doctor of Philosophy (Ph.D.) degrees. The college has 6000 undergraduate, 575 master's, and 147 doctoral students.

The Computer Information Systems Department is an autonomous unit with 13 tenure track faculty members out of 205 at the College of Business Administration. The college offers 24 courses in IS. INTEC, the Information Technology Management Center, was launched as a direct result of the MoIS grant; it supports the research program, and coordinates the colloquium and working paper series.

Master's students concentrating in CIS (MBA/CIS and MS/CIS) are offered the IS introductory course, CIS 800, Information Systems Concepts, which covers the four areas of IS; applications, technology, applications development, and management. Information is lacking on the required/elective status of CIS 800 as well as information on the IS requirements for MBAs not concentrating in IS.

Students are required to have computer skills on the mainframe/mini platform and the microcomputer platform. They are expected to know a mainframe programming language, and are required to know a microcomputer-based spreadsheet program as well as a database management system.

There are five IS-required courses for MBA students specializing in MIS. For an MS/CIS degree, there are ten required courses, five as in the MBA/CIS series and an additional five in a subspecialty.

University of Illinois

The College of Commerce and Business Administration of the University of Illinois is a public institution offering both undergraduate and graduate degrees at the master's and doctoral levels. Specifically, Master of Business Administration (MBA), Master of Science (MS), and Doctor of Philosophy (Ph.D.) degrees are offered as well as ten joint MBA degrees with other professional schools. Among the joint MBA degrees offered is a joint Computer Science/Master of Business Administration degree. The college has 3500 undergraduate, 575 master's, and 231 doctoral students.

IS is spread between the Accountancy Department and the Decision and Information Sciences group within the Department of Business Administration. There are 7 tenure track IS faculty members out of 175 at the College of Commerce and Business Administration. The school offers nine courses in IS.

There is no required IS course for MBA students, although IS concepts are introduced in the core Managerial Accounting course taken in the first semester.

Computing skills training is handled by the Office of Information Management, which was developed with the MoIS grant. All MBA students are required to take 16 weeks of short non-credit courses. Students are required to have microcomputer skills in word processing, spreadsheets, and database managers. A certificate of completion is awarded to all participants.

Indiana University

The School of Business of Indiana University is a public institution. The school is located on two campuses at Bloomington and Indianapolis and offers undergraduate, Master of Business Administration (MBA), Doctor of Philosophy (Ph.D.), and joint MBA/JD degrees. The school has 1450 undergraduate, 375 master's, and 144 doctoral students.

IS is part of a newly reorganized Department of Decision Sciences and Information Systems. There are 10 tenure track IS faculty members out of 158 at the College of Business Administration. The school offers 11 courses in IS. The research program in information systems is supported by the Institute for Research on the Management of Information Systems (IRMIS), created as a result of the MoIS grant.

By their third semester, all MBA students are required to take an introductory IS course, S504, Information Technology for Managers, which covers all four areas of IS.

Computer skills training of entering MBA students is handled by the MIS student organization. In addition, the campus offers introductory sessions for a variety of software packages. Ownership of a computer is required. Skills are required for the mainframe/mini platform as well as for the microcomputer platform. Students are expected to become proficient in a programming language and a database manager. They are required to be proficient in word processing and spreadsheets. For students seeking the MBA/MIS degree, completion of five IS courses and an IS practicum is required.

Massachusetts Institute of Technology

The Sloan School of Management of the Massachusetts Institute of Technology, a private institution, offers Master of Business Administration (MBA) and Doctor of Philosophy (Ph.D.) degrees. The school has 450 master's and 89 doctoral students.

The IS area is part of the Management Science department within the school. There are 6 tenure track IS faculty members out of 78 at the Sloan School of Management. The school offers 12 courses in IS.

All students are required to take 15.562, Principles of Management Information Technology, which covers the four domains of IS; applications, technology, applications development, and management. This course is part of a required three-course DSS sequence, with Statistics and Modeling being the other two courses. An attempt is made to link the content of the three classes as appropriate.

Students seeking the MBA/IS degree are required to take three IS courses.

University of Minnesota

The Curtis L. Carlson School of Management of the University of Minnesota is a public institution, offering Master of Business Administration (MBA) and Doctor of Philosophy (Ph.D.) degrees. The college has 1400 undergraduate, 1515 master's, and 108 doctoral students.

IS is contained within the Information and Decision Sciences Department. There are 11 tenure track IS faculty members out of 107 at the Carlson School of Management. The school offers 12 courses in IS. Research and business interaction is supported by the Management Information Systems Research center, which has been in existence for over 20 years.

In the fall quarter of the first year, all MBA students are required to take the IS introductory course, MBA 8025, Decision Sciences and Information Systems for Management.

For the first five weeks of the first year, all MBA students are required also to take a computer skills course, MBA 8005, Computer Access. Students are expected to become familiar with the mini/mainframe platform and microcomputer platform, and are expected to become proficient in word processing and spreadsheets. This course is coordinated with a required communications class, and students have a quarter-long case preparation which meets the requirements of both classes, stressing the use of IS as part of the tool kit for making presentations. All students are given a mainframe Bitnet account and discounts are available for microcomputer purchases.

The MBA/MIS degree specifies six required concentration courses and four additional electives. An IS practicum is also required.

University of Pennsylvania

The Wharton School at the University of Pennsylvania, a private institution, offers undergraduate and graduate degrees. At the graduate level, the Master of Business Administration (MBA), Master of Science (MS), and Doctor of Philosophy (Ph.D.) degrees, as well as 13 joint degrees, are offered. The school has 2500 students at the undergraduate level, 1600 at the master's level, and 380 at the doctoral level.

Information Systems is located within the Decision Sciences area. There are 5 tenure track IS faculty out of 218 at Wharton. Ten IS courses are offered.

All students in the MBA program can take the introductory course on IS, BA 660, Management Information Systems, which covers three areas of IS; applications, applications development, and management.

Before the second term, students must pass an exam to demonstrate proficiency in microcomputer applications (DOS and spreadsheets). If needed, required DOS and spreadsheet skills are learned in non-credit classes after the examination has highlighted deficiencies. However, mainframe and minicomputer applications are not mandatory. The school encourages students to buy their own computers and provides incoming students with an MBA Personal Computer Guide to help them with their computer purchase.

University of Pittsburgh

The Joseph M. Katz Graduate School of Business at the University of Pittsburgh, a public institution, offers a Master of Business Administration degree (MBA) in Information Systems , a Master of Science degree (MS) in telecommunications (jointly with four other schools of the university), a double MBA/MS degree in MoIS, and a Doctor of Philosophy (Ph.D.) in MIS. The School has 1050 master's and 149 doctoral students.

IS is a separate area within the school having 8 tenure track faculty out of 61 in the school. IS offers 25 courses.

Early in the first term, MBA students are required to take the introductory IS course, MA MIS 202, Computer Based Information Systems, which covers three areas of IS.

Before the beginning of the school year, students take two non-credit computer literacy workshops on microcomputer software and the use of the school's networked system of microcomputers and mainframes.

MBA students specializing in IS take seven electives in the area during their 11-month course. Students working towards the MBA/MoIS degree take IS courses early in their 18-month tenure in order to prepare for a 4-month internship. After their internships,

MBA/MoIS students take advanced MoIS courses. For the MS in telecommunications degree, students take 12 courses in telecommunications, electives in telecommunications and business, and a practicum.

University of Rochester

The William E. Simon Graduate School of Business Administration at the University of Rochester, a private institution, offers the Master of Business Administration degree (MBA), the Master of Science in Business Administration degree (MS), four joint MBA degrees, and a Doctor of Philosophy (Ph.D.) degree. The school has 750 master's and 50 doctoral students.

IS is a separate area within the school having 6 tenure track faculty members out of 36 in the school. The IS area offers 15 courses.

In their first year, MBA students must satisfactorily complete the introductory IS course, CIS 401, Information Systems for Management, which covers all four areas of IS. The course requires mainframe, minicomputer, and microcomputer usage skills. Students are also required to learn spreadsheets, modeling concepts, and database applications. The business school offers workshops on computing skills prior to the beginning of classes. Students interested in improving computer skills can take short, non-credit courses that are offered throughout the year. These courses are given by the computer center staff and Ph.D. students.

Discounts on purchases of microcomputer hardware and software are available to faculty, students, and staff. The Simon School invests in site licenses for many packages to encourage use of more advanced applications.

MBA students with a Computer and Information Systems (MBA/CIS) concentration take four required IS courses and two advanced electives. MBA students in the Accounting and Information Systems Concentration take several required courses in Accounting and IS concepts and two electives.

Beginning in fall 1991, two new Master of Science in Business Administration degree programs will be offered to students. These will specialize in information systems and manufacturing information systems with an interest in the strategic contributions and integration of information systems into organizations. Students will be required to take 12 IS courses distributed over the required and elective courses of the programs. The Computer and Information Systems area offers a course with the Finance area in Financial Information Systems that is unique among business school offerings.

University of Texas at Austin

The Graduate School of Business at the University of Texas in Austin, a public institution, offers Master of Business Administration (MBA), Master of Professional Accounting (MPA), and Doctor of Philosophy (Ph.D.) degrees. The school has 8733 undergraduate, 1254 master's and 191 doctoral students.

IS is within the Department of Management Sciences and Information Systems. Additionally, IS faculty participate in the multidisciplinary Information Systems Management Program area. There are 16 IS tenure track faculty out of 150 in the school. The school offers 17 courses in the IS area with an additional 10 IS-focused courses offered by faculty in other departments.

There is no required IS course for MBA students. IS concepts are introduced in the core management science course taken in the first semester.

Computing skills workshops are offered in the beginning of the year. Students are required to learn mainframe, minicomputer, and microcomputer usage skills. In addition, students are required to learn word processing,

spreadsheets, and database packages. The school conducts computer fairs, and vendors offer discounts on purchases to faculty and students.

Students wishing to obtain an MBA with a concentration in IS management are invited to apply for separate admission to the Information Systems Management program. These students can pass a waiver exam on computing concepts and skills or take six semester hours of undergraduate coursework. Aside from 30 semester hours of MBA coursework, students in the Information Systems Management program take eight required courses in MoIS and OR and two elective courses.

SECTION 4

ISSUES REQUIRING INFORMATION SYSTEMS POLICY

"The major impact [of the grant] has been in...institutionalization -- an awareness of the importance of IS to management education." This comment, made by the principal investigator at one of the IBM MoIS grant schools, was representative of all the schools. Compounding the issue of institutionalization is the complexity of information systems and its technology. As was illustrated previously in the report, even seemingly small decisions have a myriad of implications. Each decision has a ripple effect. For example, the decision to integrate computers into classroom instruction requires decisions related to acquiring the equipment, which requires decisions around equipment maintenance, which requires support personnel decisions, which requires funding decisions. The IBM MoIS grant schools dealt with this Pandora's box creatively and identified issues which other schools will face.

The experiences of these schools underscore the need for a planned approach to utilizing information technology. According to one dean, schools are having to "...think about how to invest themselves for the future." The effective utilization of information technology requires information policies consistent with the school's goals and objectives. Numerous alternative strategies exist, and each school needs to evolve the response appropriate to its unique environment.

In order to achieve some clarity on the complex issues facing schools, this section presents the major three areas requiring information policy development; instructional requirements, organization of the technological infrastructure, and funding for information services. This report purposely omits specific recommendations or a particular course of action. Rather, it articulates the questions schools need to address in the information age.

Instructional Requirements

Information policies in the area of instruction encompass several topics; IS content for MBA students, faculty instructional responsibility for teaching IS, and technological support of instruction. The IS content issues focus on what an MBA needs to know about information systems. The issue of instructional responsibility involves who are appropriate instructors for different aspects of IS content. The core of the technological support issue is the provision of staff and equipment to enable faculty to meet their instructional objectives.

Information Systems Content

The information systems content issue encountered consistently in interviews at each school concerned the focus and balance between computing skills and information systems literacy within the MBA curriculum. Many individuals confuse knowing *how* to use a computer with understanding *when* it is appropriate to use a computer. Students tend to think that knowledge of spreadsheet skills extrapolates to understanding the issues related, not only to microcomputer use, but also to mainframe and information systems in general. Identification and appropriate use of information technology and systems for solving business problems is the objective of the introduction of technology, and this is far more than being able to run projections on a microcomputer-based spreadsheet.

Managers are involved in complex issues related to the utilization of technology in the workplace, such as the convergence of telephone and computer technology in the office environment, setting priorities and budgets for IS resources, monitoring effective IS use,

assessing potential strategic IS applications, and data management, integrity, priority, and security concerns. Given the critical reliance of the corporate world on information systems, the expectation of industry is that students will not only have requisite computer skills but be information systems literate as well. Computer skills focus on the use of specific hardware and software packages for specific business problems. Information systems literacy is understanding the implications of the use of technology in an organizational context.

Computer skills may be considered a toolkit for knowledge-workers, analogous to the toolkit of a skilled production or manufacturing worker. During the past ten years the knowledge-worker's toolkit has been transformed from paper and pencil and an occasional calculator and typewriter to a sophisticated array of computer-based applications. Today's toolkit includes, but is not limited to, both mainframe and microcomputer software for word processing, spreadsheet, data management and retrieval, modeling and statistical analysis, electronic mail, telecommunications, and expert system shells. The manager with computer skills is able to select and use various applications appropriately in a variety of business situations.

In contrast, information systems literacy refers to knowledge of applications, issues, and strategies related to the use of information technology in organizations. Today's managers need to understand the organizational and financial implications of using information technology and systems, not in a technical sense, but as it applies to and impacts their functional area. As professionals in various functional areas, non-IS managers are called upon to perform several roles within their organizations, from isolated end-users to contributors toward larger system design projects. Several different roles are outlined in the sidebar above.[19] These roles call for managers who are disciplined users of the knowledge-worker's toolkit and who are information systems literate. They are able to select appropriate resources and processing techniques as well as conduct the basic analysis necessary in making decisions.

IS Roles of Non-IS Managers

- **user role** as a supplier of data or recipient of output
- **user-developer role** in small end-user applications
- **participant role** in projects to develop and implement large-scale organizational systems
- **specifier role** in identifying and specifying information requirements for systems to be developed by information system professionals
- **user-specifier role** as a designer of database requirements and specifier of retrievals for a variety of databases
- **evaluator role** as a judge of quality and appropriateness of data and information for a given purpose or use
- **decision-maker role** regarding investment in information technology
- **reviewer role** in pricing/incentive schemes for IS services

A mix of computer skills and information systems literacy is appropriate as part of the education of managers. Key information systems content issues to be addressed include:

- What is the appropriate balance of computer skill and information systems literacy?
- What types of software applications belong in an MBA's toolkit?
- What levels of toolkit proficiency are necessary?

19 These roles and the concept of a knowledge-worker's toolkit were suggested by Gordon Davis, University of Minnesota.

- Which components should be mainframe based and which microcomputer based?
- What information systems literacy concepts are important for all MBAs?

Instructional Responsibility

Related to the issue of instructional content is the issue of instructional responsibility. Students require three types of instruction; computer skills, application to the functional area, and information systems literacy. The first type of instruction involves teaching students how to use the individual software packages in the knowledge-worker's toolkit. The second type of instruction involves students' use of the toolkit in solving business problems in a specific functional area. The third type of instruction provides students with the ability to understand and manage IS technological issues within a broad organizational context.

Traditionally, instructors available to teach these skills are functional area and IS faculty. Another potential teaching resource is the computing services staff who teach computer skills in workshops ancillary to courses. Faculty in functional disciplines outside of IS who utilize computer technology are the appropriate instructors of the software toolkit as applied to their functional area. For example, use of spreadsheets for financial analysis is the appropriate responsibility of the finance faculty. The development, implementation, and management of information technology in an organization involves specialized knowledge and skills. Faculty with this specialized knowledge in information systems are needed to address the organizational and technological interactions non-IS managers should understand.

A clear review of the particular type of instruction required at a school will lead to a more efficient and effective utilization of available instructional resources.

Instructional Support

In addition to questions regarding course content and instructional responsibility are issues related to computing services support for instruction. Faculty experiences at the 13 MoIS schools indicated that integration of computers into classroom instruction requires an inordinate investment of time. Availability of support personnel and equipment is a critical element for success, enabling the faculty to focus on instructional objectives. In light of these experiences, schools need to formulate policies regarding the extent of technological support for instruction. Within those policies, specific questions must be addressed:

- What are the school's responsibilities to provide training and consulting for students?
- What hardware and software is needed for instruction?
- Should there be explicit computer skill entrance requirements?
- Should students be expected to own a microcomputer?
- Should the school provide software for student use?
- How will the school provide assistance to students in using the knowledge-worker's toolkit?
- How are emerging instructional support technologies identified and introduced?

Organization of the Technological Infrastructure

The instructional goals for computer skills and information system literacy require a technological infrastructure. In addition, the degree to which this technological infrastructure is used to support the research and administrative functions must be considered. As one PI commented, "The...major benefit [of the grant] was the creation of an infrastructure. In spite of severe financial pressure, the dean has allocated additional funds for the support of computing in a generic sense." In developing this infrastructure schools need to address the role of technology within the school and how the infrastructure is organized and maintained.

Role of Technology

Creation of an effective infrastructure demands that schools articulate the role technology will play in their schools. This essential task is exacerbated by the uncontrollable aspect of technology -- rapid change. Society is experiencing an unparalleled explosion of information and technological intensity. Each year a new generation of equipment and software with improved capabilities is introduced. Today's graduates will spend the majority of their working lives in the 21st century with a technological

environment impossible to project. Schools are obliged to prepare them for a technologically sophisticated workplace and to look for the means to keep abreast.

In determining the role of technology, schools must address issues such as:

- What level of technological sophistication is appropriate for achieving the school's goals and objectives?
- What are the consequences of not utilizing available technology?
- What is the scope of services to be provided to faculty and students?
- Is there a strategy for maintaining technological currency?
- How can computing support services adapt to the increasing sophistication and expectations of users?
- What are appropriate hardware and software standards?
- How can hardware and software standards be enforced?
- In what way can available resources be maximized?

Organization and Maintenance

A PI at one grant school commented that "The grant seeded a school-wide desire for more support, requiring senior people from the school to respond by hiring appropriate staff." Unfortunately, for many schools, development of a technological infrastructure is occurring haphazardly, resulting in an incompatible mix of equipment, software, and staff.

The scarcity of resources at most institutions mandates a deliberate, planned approach. Consideration needs to be given to each element of the infrastructure, and to the interrelationships among the components. Equipment, communication networks, software, training and consultation, and user interfaces are critical components in a technological infrastructure. Introducing computers into a business school requires that someone manage the inventory, service the systems, and train the users to gain maximum benefits from them.

Specific areas for policy consideration in developing the technological infrastructure are:

- How should computer policies for the school be determined?
- What are the specific mainframe, microcomputer, telecommunication, and network requirements of the school?
- Which services should be provided by a local and which by a central computing support group?
- What structure for computing support staff is most effective for delivering services to faculty, students, and staff?
- What are the staff requirements for the level of services to be provided?
- Who is responsible for scanning to identify potential technologies which would assist the school?
- How does the school integrate emerging and future technologies such as CD-ROM, CD-I (interactive television), and multimedia.
- How does the school maintain staffing levels for computing services given current compensation packages?

Funding of the Technological Infrastructure

The challenge in coming years will be obtaining funds to establish and maintain the technological infrastructure in support of the school's goals and objectives. This may entail gaining the central university administration's backing for the significant, continuing cost and investment required. The effect of increasing technological support is revealed in this comment by an associate dean, "[Our] school is so far along the path that there is no turning back." Once the ball starts to roll in the development of the technological infrastructure, expectations rise and business schools are committed to its support.

Diminishing support is analogous to shutting down highways and cutting power lines.

Deans of business schools are unaccustomed to the large capital expenditures necessary to maintain the technological infrastructure. Traditional funding sources are not adequate for these additional requirements. Schools will need to identify and pursue additional funding sources as well as examine their traditional allocation practices. Several grant schools initiated computing fees as a source of funds. Other possible funding sources include selling services to off-campus and alumni users, and receiving grants and contributions of hardware and software. Several questions which will need to be considered are:

- What level of support does the technological infrastructure require?
- What are the short-term and long-term commitments requiring funding?
- What type of funding is needed, e.g. for equipment and maintenance, capital expenditures, personnel, software and data acquisitions, and/or consumables?
- Where/who are potential external funding sources?
- Should students contribute directly to support of the technological infrastructure?
- What is the impact of the increasing student microcomputer ownership?

CONCLUSION

In establishing the MoIS grant, IBM challenged the schools to improve management's understanding of the role of information systems as we enter the last decade of this century. In response to this challenge, the IBM MoIS grant schools have undertaken a variety of research projects, curricular innovation, and development of the infrastructure needed to support these activities. This report has documented the major lessons and issues regarding the integration of technology into their academic environments.

A change in the understanding of IS has occurred at the schools themselves as they have experienced the significant transition of the past five years. The massive introduction of microcomputers brought many important benefits. In addition, it greatly expanded faculty, student, and administrator expectations of information technology in a way analogous to the introduction of the automobile. As the automobile fundamentally changed the perception of distance, the microcomputer has fundamentally altered the way we deal with information.

The complexity of information systems as an organized body of knowledge and the rapidity with which the underlying technological infrastructure changes presents significant challenges. The IBM grant afforded schools the opportunity to study these complex problems and issues, and assisted in the expansion of IS doctoral programs. Current research interest is primarily focused on the ways in which Information Technology can be integrated into organizational activities and how IS resources can be managed more efficiently and effectively. With the increased number of IS doctoral students, continued research in these areas can be expected.

In addition to the research thrust, the IBM MoIS grant schools were able to experiment with the curricula and the technology required to prepare business leaders in the information age. IS curricula have been adapted to the need to prepare students as managers of information technology, focusing on the organizational and management issues rather than the technology. The curriculum improvements which occurred will have far-reaching effects. Students are being equipped not only with computer skills, and a "toolkit" of computer applications, but also with information systems literacy, knowing how to manage IS use in organizations. As these new graduates enter the job market, they will encourage their organizations to provide the technological infrastructure they know is available.

Business schools around the world are entering the information age. The experiences at the 13 IBM MoIS grant schools highlight the need for schools to:

- develop a vision for the role of IS in business schools,
- carefully plan for its implementation, and
- organize an appropriate infrastructure.

The decade ahead will see business schools meeting the challenges posed by the introduction of technology in many ways. This report is intended to assist them as they respond to the challenges of the information age.

APPENDIX

FACILITIES DESIGN CONSIDERATIONS

The MoIS grant provided the opportunity for the schools to develop considerable experience with the creation of facilities. This appendix details some of the key lessons and concerns expressed at the schools in developing student labs, electronic classrooms, specialized laboratories, and in podium design.

Student Laboratories

At the time the schools were establishing microcomputer laboratory facilities, little guidance was available. The schools were learning as they were doing. Responses to the question, "What would you do differently if doing it over now?" evoked many comments such as, "We were not just building a computer lab, but creating an environment, and needed to think about comfort, noise level, and lighting." This sentiment was expressed over and over, regardless of whether the focus was on labs, classrooms, or specialty laboratories. "We wanted to create a room where people from business could say, 'this is a room I belong in,' as opposed to concrete floors and the sense of a computer lab." Almost all the IBM MoIS grant schools were able to create labs with this professional ambience. The sidebar presents some of the lessons learned by the schools in designing student laboratories.

Faculty were consistent in recommending that optimally, the laboratory and the electronic-classroom should be separated. Classrooms need to be equipped with projection capabilities and media integration, and arranged to focus attention on the instructor. In labs, the design needs to promote individual and/or small group work.

GUIDELINES FOR STUDENT LABORATORIES

- **Cables:** raised floors with carpet squares should be used to manage cabling; however, most of the schools were forced to use alternative methods including cable trays along the walls, or tracks attached to or hidden under the furniture.
- **Workspace:** provide adequate desk-top space for books, papers, and other materials students need besides the keyboard; maximizing the space for people, not machines.
- **Lighting:** provide indirect or track lighting, and whenever possible, avoid fluorescent, ambient room lighting and natural light; however, cost becomes a major factor here, and schools can use a voltage regulator or anti-glare covers for existing fluorescent fixtures.
- **Noise:** install sound absorbing partitions between workstations, and create small group work areas for more than one user at a terminal.
- **Assistance:** consultants need to be available to answer questions; shelf or cabinet space is needed for software documentation.

Electronic Classrooms

Two schools built electronic classroom environments -- rooms for regularly scheduled classes with a computer for each student and a projection system for faculty to display work to the entire class. Faculty members who teach in these rooms generally consider them to be great 80% of the time, but noted several frustrations. A professor at one school tried lecture notes on-line with limited success, "...[It was] just too big of a hassle." However, many of his problems were resolved by using a different software package. Another too-frequently encountered problem was equipment breakdowns "that can really ruin a lecture. Having paper backups for all of your lectures is a must - be prepared!" Collectively, these frustrations may be summarized as difficulty in accomplishing ordinary instructional tasks.

From a student perspective, electronic classrooms were initially very appealing, but students also found them frustrating after long periods of use. Specifically, complaints included insufficient desk space for books and paper-oriented work (due to space taken up by the keyboard), monitors that were too high above the desk (requiring students to constantly move their heads from side to side in order to see the professor or classmates), and a projection screen at the front of the room (usually too difficult to watch for long periods as images were frequently blurry or too small). Glare on the microcomputer screen was also a problem, as was computer noise which frequently made it difficult to hear instructors, especially those who did not use microphones. Students who used the electronic classrooms frequently found that the computer was ineffective for taking notes, as they could not draw graphs, figures, or tables that instructors put up. Finally, students complained that the air conditioning never seemed to be right for both computers and people, a problem also seen in the lab environments.

To provide interactive computer output display in traditional lecture or seminar-style classrooms (without ceiling-mounted video projector equipment), 11 of the grant schools[20] reported using mobile carts with a microcomputer and overhead projector with an LCD device. Six of these schools had staff who would deliver and pick up the mobile units, while at the remaining five schools, faculty needed to pick up and return the units. Instructors perceived these carts as an interim solution, and believed that with time, better display capability would emerge. Some of the schools also used large-sized monitors, but found these to be more cumbersome than overhead systems for large classes. Several unresolved issues remain such as what kind of projection equipment should be used -- LCD/overhead projection systems versus video projection systems?

20 Data taken from "Sixth Annual UCLA Survey of Business School Computer Usage."

GUIDELINES FOR DESIGN OF ELECTRONIC CLASSROOMS

- **Line of sight:** individual monitors should be recessed so that students can see the instructor and other students, and the room should be tiered.
- **Equipment noise:** silent keyboards and sound-absorbent wall and floor coverings help considerably; a microphone system is essential when competing against 20 - 30 computer systems; keyboard controls from the podium could also prevent students from typing during lectures (which then prevents students from taking notes on the system).
- **Blackboards:** "overhead projectors, electronic writing tablets, and a camera projection system restrict you to only one page at a time, and when they don't work, you're stuck."
- **Room layout:** if possible, use a square-shaped room or physically distribute the equipment in a square to minimize distance from the instructor.
- **Equipment control panels:** make the control panel for lights, screens, projectors, etc., "user-friendly" (see discussion which follows on podium design).
- **Projection systems:** "Be sure that the projector has sufficient lumens so that the room lights can be on and you can still see the screen." The most effective lighting with the video projectors seems to be *task* lighting (individual incandescent track lights over each work area). Another frequent complaint regarding projection systems was that they go out of focus easily.

Specialized Laboratories

As a direct result of the equipment and funds provided by the IBM MoIS grant, seven schools created a specialized research facility for faculty projects. Of these, four were designed specifically to support Group Decision Support Software (GDSS) and three were used for particular projects.

Group Decision Support Systems (GDSS) is now being used at four schools in addition to the University of Arizona[21] where it was developed. "GDSS is one area where business schools have been able to take the lead, and corporations are turning to us for direction." Researchers at the GDSS schools noted that the creation of the labs enabled them to use a physical science model for conducting controlled and replicable experiments which was heretofore impossible.

There were some additional suggestions regarding the use of technology in the GDSS facility: furniture should be designed to make the technology as non-imposing as possible; equipment should fold up or be stored when not needed; back-screen technology can help keep technology out of sight; and for GDSS sessions, two display screens are better than one (e.g., one for pros and one for cons).

Other Research Labs. Three of the schools allocated restricted access space for research projects requiring specialized equipment and/or software. At one of these schools, this lab was seen as strategic for assisting faculty with their research, and a full-time career programmer was hired. The lab was viewed as a permanent resource, and faculty were asked to contribute to its support from their grant overhead. This lab was primarily used for economic simulation modeling and marketing research. In renovating this space, careful consideration was given to environmental needs such as those discussed above.

One issue arising from the use of specialized research facilities concerned using the labs for a dual purpose, a problem also found in joint lab/classroom facilities. Several researchers were concerned about labs being used for research projects as well as being open to students. "Labs will be structured differently if being used for research or production....We need to leave software and data and not be concerned about someone coming along and reformatting the disk." At schools with separate facilities, students use the general computing labs for class assignments. When space and equipment allocations permit, maintaining separate facilities is highly recommended.

Podium Design

Five schools experimented with different types of podiums for the front of their classrooms and labs. Four have fixed podiums, while one school installed a computer podium on an umbilical cord which was kept in a locked closet in each of several classrooms. Each approach to the podium system has benefits and drawbacks. Three of the fixed podiums are quite large (several feet long) and contain an extensive amount of equipment (microcomputer, overhead, VCR, microphone amplifier, etc.), while the fourth appears as a standard lectern.

Several issues related to the design of electronic podiums emerged. One concern related to the obtrusive nature of the podium which created a distance and barrier between the instructor and students. Instructors thought the podiums were too large and made walking around them difficult, that they decreased an already small teaching space, contained unneeded equipment, and were too complicated to operate. Simple things became a distraction and challenge, like six different switches to dim the room, too many electric gadgets (lower screen, dim lights, etc.). Many of these concerns were addressed at one of the schools where the electronic podium was designed with a touch

21 The schools with GDSS facilities are; The University of Arizona, The Claremont Graduate School, The University of Georgia, Indiana University, and The University of Minnesota.

GUIDELINES FOR PODIUM DESIGN

- **Design consistency:** podiums in each classroom should be identical so instructors don't have to learn to use different switches, knobs, and plugs as they change classrooms.
- **Size:** podiums should be standard lectern size and have minimal equipment.
- **Equipment:** video controls, amplifiers, etc., should be mounted on a wall; overhead, computer keyboard, monitor, should be on a side table (preferably on wheels) which can be rolled into appropriate locations. This equipment should not be permanently bolted to a floor as it creates barriers.

screen to serve as both the instructor's monitor and the control panel for the entire room environment. In this system, the instructors can preset the room conditions according to their preferences so that when the "projector screen" button is pressed on the monitor, both the projector screen is lowered and the room lights are dimmed.

The sidebar above details several aspects that need to be considered in podium design. Current arrangements for podium design create several difficult problems which have not yet been resolved. How should the equipment be secured to tables, and how should the table be secured in the room? Is there a good way to handle rolling and unrolling electrical and computer cables? Before truly functional electronic classrooms emerge, we need to spend considerably more attention on human factors. The following statement summarizes the thoughts of many instructors who use these electronic classrooms, "[I] wouldn't trade for a traditional classroom. Technology isn't the problem, but infrastructure and timing are problems."