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AUTHOR	Marshall, Patricia
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ABSTRACT

This survey of 239 colleges and universities identified as minority institutions was designed to determine both the current status and the desired status of instructional computing in each school. Needs of the minority institutions were assessed by means of a questionnaire survey, in-depth campus interviews, and an analysis of data from FICHE (Fourth Inventory on Computers in Higher Education). Objectives emerging from these data served as a basis for strategies to meet the needs as perceived from an external viewpoint. The first of two volumes, this report describes the procedures used and provides a summary of the survey findings. Discussions of both the current status and the desired status of instructional computing in the responding institutions are followed by a summary of priorities and alternative strategies identified by the study. This volume also includes the first two of seven separate reports which comprise the remainder of the report: Computer Education Goals at Minority Institutions of Higher Education by Arthur Luehrmann, and Strategies for Improvement of Educational Computing at Minority Institutions by Judith B. Edwards. (BK)

INSTRUCTIONAL COMPUTING IN MINORITY INSTITUTIONS

A NEEDS/STRATEGY ASSESSMENT

EXECUTIVE SUMMARY OF FINAL REPORT/NSF SPI 7821515

PRINCIPAL INVESTIGATOR: Sister Patricia Marshall
Xavier University of Louisiana
New Orleans, Louisiana 70125

EVALUATORS: Donald L. Alderman, Judith B. Edwards, Richard M. Jaeger, Arthur Luehrmann, Thomas J. McAlpine, Hugh Poynor

TABLE OF CONTENTS

TABLES

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SECTION I

PREAMBLE

The 239 colleges and universities identified as minority institutions in this needs/strategy assessment of instructional computing have come a long way since computing entered the world of higher education in the late '50s, and they have a long way to go. What is new about this study? Nothing much, but at least the information about where the 239 are now in instructional computing, and the information about where they might be headed, is all together in one source: this executive summary of a National Science Foundation-funded study of the needs and possible alternatives.

SURPRISES AND NON-SURPRISES

Readers will not be surprised to learn that the production of minority degrees in computer science lags far behind that of non-minority institutions, and even farther behind the national need. Nor will they find it surprising that students in minority institutions are less likely to be exposed to computers in their course work than students in non-minority institutions. (This is partly due to the generally small size of most minority institutions — and the consequent small size of their science programs — but also due to staffing problems and the lack of *appropriate* hardware.) It may come as a surprise, however, to learn that about 14% of the minority institutions (small baccalaureate schools) actually spent more on computing than their non-minority counterparts (on the average) in 1977, and that both minority and non-minority schools had acquired computer hardware to about the same extent by 1977. But most minority institutions had acquired computers relatively late — since 1974 — and start-up costs may have inflated that picture. Obviously, though, minority institutions are aware of the potential of computers for enhancing the instructional process and are, for the most part, making efforts to begin or to improve academic computing programs.

ALTERNATIVES

Alternative strategies available to colleges and universities in the early '80s are not only more cost-effective than those available in the '60s and '70s; they are also much more attractive to educators. Despite inflation and other fiscal challenges, the potential for minority — and all — institutions to acquire educationally sound computing resources for instructional purposes may be better today than ever before. If the problem of the shortage of computer science degrees can be nationally addressed, with special attention to the production of minority degrees, the ¾ million students in minority colleges and universities may have a chance to become computer literate during the coming years. The message arising out of this study is clear. Help is needed, but the problems can be solved; and the minority institutions themselves are one of the resources that can help solve them.

SECTION II

INTRODUCTION

MINORITY INSTITUTIONS

For this study 239 colleges and universities were identified early in 1979 as minority institutions. Although these institutions are sometimes viewed as a subset of all the small postsecondary institutions, they differ from the small schools in at least some of the following ways:

MINORITY COMPOSITION: At least fifty percent of the student body are members of one or more educationally disadvantaged minority: Black, Hispanic, or American Indian. Most of the schools in the sample were originally founded to provide viable educational opportunities for these students, and this rationale for their existence tends to be valid today.

LEGAL MILIEU: The legal milieu of most minority institutions (in some cases their legal status) differs significantly from that of the typical small college. (a) Public Black colleges and universities located in states targeted for federal action to facilitate desegregation either have been or will be affected by plans to desegregate. Planning within such an institution is difficult, at least until after the action has taken place. (b) Indian educational institutions are usually responsible to both tribal and federal authorities. State governing bodies from more than one state may also enter the picture whenever a reservation covers territory in more than one state. The Bureau of Indian Affairs (BIA) may also give direction. Thus, for Indian institutions unusual complexities are inherent in everything attempted.

LOCATION: (a) Urban minority institutions, unlike most small colleges, are often located next to poverty pockets. This typically affects programs, security, and physical access. (b) Most Indian institutions are located on reservations, which may be a hundred miles or more from the nearest airport and in some cases accessible by occasionally unnavigable roads. This extreme remoteness has implications for faculty stability, as well as for computer maintenance.

STABILITY OF FINANCIAL RESOURCES: (a) Average endowment in the typical minority school is well under $1,000 per student. On the other hand, the average endowment reported for 21 smaller colleges and universities in 1978-79 by Brakeley, John Price Jones, Inc. was $20,408 per FTE student; and for nine non-minority women's colleges it was $11,900. (1) (b) Minority school alumni are only beginning to contribute to their alma maters in significant amounts and numbers because it is within the last twenty years that employment patterns have begun to allow minority graduates the opportunity to find their way into the mainstream. (c) Heavy reliance on federal funding, common at present in all minority institutions in the effort to correct past injustices, brings with it an excessive burden of reporting and insufficient additional personnel to carry it out. Operating in that kind of a present, while attempting to plan adequately for the future, puts strains on most minority administrators that are far greater than those on administrators in other small schools.

PERSONNEL: Affirmative action, by drawing minority faculty and administrators to non-minority institutions, makes recruitment of needed minority role models extremely difficult for minority institutions. In addition, turnover rates tend to be high, especially in the Indian institutions where it is necessary to depend heavily on BIA personnel. In Black schools, employees often gain entry-level experience and then move on to more lucrative positions in larger, non-minority schools that are aiming to fill quotas.

INSTRUCTIONAL COMPUTING

The term "instructional computing" is used in the title of this report rather than "educational computing," because it is less ambiguous, encompassing the concept of academic computing but not that of administrative computing. In this study the term "instructional computing" (sometimes called "educational computing" or "academic computing") includes the following: (a) the use of the computer by students and/or faculty as a tool of learning or instruction (problem solving, simulation, drill and practice, tutorial, etc.) in any discipline; (b) the use of the computer to manage instruction (tracking individual student progress); (c) the use of the computer as a tool in scientific research; (d) the use of the computer as an object of instruction, as in computer science or data processing courses; and (e) the use of the computer in familiarizing students with the uses of computers and their effect on society (computer literacy.)

In higher education the term "academic computing" does not include "administrative computing" (fiscal accounting, student record keeping, admissions, etc.). Since recent technological advances have brought costs of instructional computing within reach of all schools (at least with respect to hardware), there is adequate justification for treating instructional computing separately from administrative computing. However some schools, especially those using the same hardware for both purposes, do not yet budget separately for these different uses of the computer, although NACUBO (National Association of College and University Business Officers) suggests that this be done. Until practice catches up with theory, it is necessary to define carefully the distinctions among terms as we have done here.

BACKGROUND LEADING TO THIS STUDY

In the search for a bottom line in the use of computers in education generally, the questions are no longer "Should we use computers?" or "Do we have the technology and is it cost effective?" but rather "How should we use computers?" or "How can we improve our use of computers in education?" In less than a generation we have seen the advent of four inventories of computers in higher education, a number of national studies, and — more recently — the appearance in many American homes of microprocessor-based educational tools and toys. The technology is in place. It can no longer be considered a limiting factor, and not only college and university administrators but also pre-college school administrators can no longer comfortably ignore it.

Today the questions are being asked, and answers sought, at the national level. Legislation has been introduced, (2) and nationally known experts and grass roots panels have testified (3) on the urgency of establishing a coherent national policy that will facilitate our understanding of the implications of information technology (largely computing but also including other technologies such as telecommunications, videodisc, satellite, cable televison) for education and for the nation. In this context the entire spectrum of education, elementary through university, is the ball park. Since the Pierce Report of 1967, (4) a whole new game has developed.

Against this backdrop, let us look now at the growth of computing in minority institutions. The roots of this development are threefold:

GROWTH OF HIGHER EDUCATION COMPUTING GENERALLY: Although a few minority institutions began their computing efforts as early as the middle '60s, most minority institutions were unaware of the National Science Foundation and its computing programs, for which they might have been eligible in the '50s and early '60s. The programs within NSF that enabled institutions of higher learning to acquire computer hardware prior to the early '70s were curtailed at approximately the time that most minority institutions became aware of their existence and how to apply. Only five Black institutions had acquired computers through NSF by the late '60s (three through the Small College Computing Experiment under a regional grant). Researcher John W. Hamblen estimates that even as late as the early '70s there was still a gap between minority and non-minority institutions in computer hardware acquisitions of somewhere between 10 and 35 percent. Thus minority institutions were only beginning to respond to the impetus of general progress in instructional (or any other kind of) computing until the mid '70s.

ECMI (EDUCATIONAL COMPUTING IN MINORITY INSTITUTIONS): A second development influencing the growth of computing in minority institutions took place over a three-year period between 1975 and 1977. Known as ECMI (Educational Computing in Minority Institutions), a series of three working conferences and one intensive workshop for minority faculty were aimed at improving computer literacy on the minority campuses. Faculty participants numbered 921 altogether (estimated at nearly four percent of faculty at minority institutions — less than half the estimates for non-minority institutions). In addition, 56 presidents attended special sessions at ECMI/3; and eighteen graduates of the first two conferences spent six weeks in an intensive workshop one summer developing courseware. At the three working conferences, faculty attended discipline-based sessions, short courses on computer languages, and general sessions. The presidents were exposed to an overview of computing and success stories in minority institutions, educational impact of computers, funding sources, the relationship between computing and liberal arts, and an open forum. The impact of the ECMI conferences is discussed in more detail in Section III below. Although this impact is seen as insufficient in comparison with the need, it was a good beginning and did raise the level of computer awareness among the participants.

TITLE III FUNDING: A third development which helped to bring about the presence of computers on minority campuses was the Title III funding made available to developing institutions during the '70s. Grants required that at least ten percent of the funds go toward improving planning, management and evaluation systems on the campuses. Many acquired computers in the middle '70s to establish facilities that would assist them in making these improvements. A few used the funding to develop computer-aided instruction, and some attempted to initiate both administrative and academic computing. An analysis of hardware reported on the campuses in 1976-1977 shows that nearly two-thirds of the minority schools reporting acquired their computers after 1974. (5) This relatively late acquisition, although it brought hardware expenditures and acquisitions in line with national trends for the minority institutions, has not yet resulted in parity with respect to personnel and instructional use. This report will discuss this situation in Section III below.

The National Science Foundation sponsored an evaluation of the effect of MISIP (Minority Institution Science Improvement Program) and RIGS (Research Initiation Grants), through which an increasing number of grants were beginning to provide computing hardware to minority institutions. This study was published in 1979. However, of the 91 minority institutions funded by the time of that study, only a few had been funded for computer-related projects. Fewer than half the 91 responded to a question on computer acquisition; of these, 64 percent reported an increase in expenditures for computer hardware between fiscal 1970 and 1977. (6) Beyond this the study makes no reference to instructional computing. No attempt was made to document the increase in computer-related proposals to MISIP which has been mentioned by MISIP officials as having taken place since the middle '70s.

In 1978 the ECMI Steering Committee proposed to make the study being reported here, which would assess the needs of minority institutions in instructional computing, determine some alternative strategies for meeting the needs in educationally and fiscally sound ways, and evaluate the impact of the ECMI conferences on faculty and institutions. In other words, the Committee proposed to find out where the minority institutions are now (with respect to instructional computing), where they should be headed, and how they can get there.

HOW THIS STUDY WAS MADE

In educational evaluation jargon, the context (needs) and input (strategies) portions of the Stufflebeam CIPP evalutation model (context, input, process, product) were used because they might serve decision situations at the national level. The instructional computing needs of minority institutions were assessed by means of a questionnaire survey, in-depth campus interviews, and an analysis of data from FICHE (Fourth Inventory on Computers in Higher Education). Objectives emerging from these data served as a basis for strategies to meet the needs as perceived from an external viewpoint. These objectives may also serve as a background for evaluation of later projects aimed at meeting the needs, should this situation arise. Meanwhile, evaluation of the ECMI conferences has assessed the impact of what has already been done to meet some of the needs. Professional evaluators were employed at all levels of the study to ensure objectivity. For more details, see the sections of this report which follow.

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(1) *Higher Education and American Philanthrophy, A Report for 1978-79* (New York: Brakeley, John Price Jones, Inc., 1980), p. 20.

(2) H. R. 4326.

(3) Hearing before the Subcommittee on Science, Research and Technology of the Committee on Science and Technology, U. S. House of Representatives, 96th Congress, October 9, 1979; and Hearing before the above-mentioned Subcommittee and the Subcommittee on Select Education of the Committee on Education and Labor, April 2-3, 1980. (Washington, DC)

(4) President's Science Advisory Committee. *Computers in Higher Education.* Washington, DC: U. S. Government Printing Office, 1967.

(5) John W. Hamblen, Clinton Jones, Jesse Lewis, and Sister Patricia Marshall, "Computing in Minority Institutions: 1976-1977," *Proceedings of NECC 1979, National Educational Computing Conference*, ed. Diana Harris (Iowa City: The University of Iowa, 1979), p. 71.

(6) *Evaluation of the Minority Institutions Science Improvement Program (MISIP)* (Washington, DC: Arthur D. Little, Inc., and Opinion Research Corporation, 1979), pp. 28, 66.

SECTION III

CURRENT STATUS OF INSTRUCTIONAL COMPUTING IN MINORITY INSTITUTIONS

To determine the current status of instructional computing in minority institutions, four major procedures were used: a questionnaire survey, in-depth campus-wide interviews, an analysis of existing FICHE data (Fourth Inventory of Computers in Higher Education), (7) and an evaluation of the EC-MI conferences (Educational Computing in Minority Institutions).

QUESTIONNAIRE SURVEY (8)

WHO WAS SURVEYED BY WHOM: A mail survey of presidents, academic vice-presidents, department heads, and academic computing directors in 239 minority postsecondary institutions was conducted in 1979. Detailed research questions, survey questionnaires, analysis of data, and documents linking questionnaires to research questions and analysis were developed by Richard M. Jaeger at the Center for Educational Research and Evaluation, University of North Carolina at Greensboro, and his assistants.

PROCEDURES AND RESPONSES: The survey was designed to elicit information on the status and likely short-term growth of academic computing in the institutions. It covered a broad range of topics, including institutional investment in academic computing, the availability of computing hardware and software for academic purposes, the present and short-term-future computing skills, capabilities, and activities of faculty and students, the presence and activities of computing personnel, and the general status of education in the sciences in minority institutions.

Altogether 152 of the 239 institutions responded in time with usable data to one or more questionnaire forms, for an overall response rate of 64%. Respondents included 96 presidents or chancellors, 83 academic vice-presidents or deans, 178 heads of departments in 87 different institutions, and 55 heads of academic computing (in some cases the latter were simply those most knowledgeable about computing on campus).

QUESTIONNAIRE FINDINGS: To summarize a report that numbers almost 700 pages without appendices and includes more than 500 tables of data on as complex an issue as academic computing in minority colleges and universities is close to impossible. Nevertheless, the following highlights did emerge and shed light on the current status of instructional computing in minority institutions:

(a) The study provided clear evidence of linkages between the size and scope of science programs and academic computing capabilities in the institutions reporting. For example, the institutions were far more likely to have made efforts to improve their academic computing if they employed a large number of faculty members in the sciences.

Responding institutions varied widely in the number of science faculty they employed. The smallest institutions had no full-time science faculty, and the largest (University of Puerto Rico, which is not typical) has close to 500. The smallest fourth had no more than 35 full-time science faculty, and the largest fourth had at least 160. Virtually all responding institutions offered some science courses. Just over half reported associate or bachelor degrees offered in science, and almost two in ten reported offering science master degrees.

(b) Hardware and software data are somewhat inconclusive. Fewer than a fourth of the academic computing directors responded, and some of these were substitute respondents. However, it is significant that most of these respondents reported the availability of very few input/output devices for student/faculty use at their institutions.

(c) Since data on expenditures also came from the same small sample of academic computing directors, it is difficult to draw conclusions. In 1977-78 almost half the responding academic computing directors reported spending less than $10,000 on hardware; and 88 percent reported spending less then $50,000. Software expenditures were less than $1,000 for two-thirds of those reporting for the same year. About the same proportion spent less than $10,000 to support computing personnel that year. Median expenditures for hardware over the five-year period 1973-1978 were in the $100,000 to $250,000 range, and for software, $5,000 to $10,000. Of the institutions that reported receiving any federal funds during the 1977-78 year, over two-thirds received less than $20,000 for computing.

(d) Campus-wide planning for acquisition or improvement of academic computing had taken place at two-thirds of the institutions whose academic vice-presidents or deans reported. Sixty percent of the science department heads reporting said that study groups at the departmental level had met for the same purpose. Almost two-thirds of the responding presidents reported long-range institutional plans for improvement of academic computing services.

(e) Heading the list of problems, predictably, was budget limitations, according to academic computing directors. More than half the responding presidents felt that forces external to their institutions hampered development of academic computing. Federal and state governments were cited as sources of restrictions by about one-fourth of the respondents. A few noted that funds were available, but that there were barriers to using them for computers.

(f) Every institution responding to the survey reported enrollment of at least 80 percent minority students. Close to 60 percent were predominantly Black, and more than 40 percent reported at least 90 percent Black enrollment.

The data supplied by the academic computing directors are consistent with data found in the Fourth Inventory of Computers in Higher Education as analyzed by Hamblen, Jones, Lewis and Marshall. The latter showed, for example, that although hardware expenditures in fiscal 1977 for minority institutions in the 2,500-10,000 range were higher than for non-minority institutions (apparently due to start-up costs, since more than ⅔ had acquired computer hardware since 1974), computer-related expenditures by all minority institutions during fiscal 1975-1977 were considerably less than for non-minority institutions. **(9)** Likewise, the reporting by the academic computing directors of very few input/output devices being available to students or faculty is consistent with the small percentages of on-line (as compared with batch) applications reported in the FICHE data. **(10)**

INTERVIEWS

GENERAL PROCEDURES: Nine institutions using a variety of approaches to academic computing were interviewed campus-wide and in depth late in Fall, 1979. The interviews, designed by evaluator Hugh Poynor, were conducted by most of the professional evaluators with the assistance of some ECMI Steering Committee members as outlined below in Table I. Faculty, students, and administrators were questioned on computing development, use, problems and successes.

TABLE I

INSTITUTION	EVALUATOR	STEERING COMMITTEE MEMBERS
1	Jaeger	Watkins
2	Alderman	Williams
3	Poynor	Martin
4	McAlpine	Lewis
5	Poynor	Martin Barreras
6	Jaeger	Watkins
7	- -	Marshall
8	McAlpine	Jones
9	Alderman	Miller

Institutions, identified here by number for confidentiality, were selected to obtain as broad a cross section as possible within time and financial limits and parameters such as ethnic composition, type of control, date of establishment, highest level of offering, academic orientation, enrollment, type of access to hardware, and experience. While not all of the most successful institutions were chosen, an effort was made to include schools which had had at least enough experience to identify factors inhibiting and promoting progress. The institutions interviewed, and some key parameters used in their selection, are listed in Table II on page 9.

FINDINGS: A detailed report and analysis of institutions 1-4 was made by Marshall in June, 1980. **(11)** Interview reports from institutions 5-9 were analyzed by Mason, **(12)** who summarized all the interviews under these headings:

Acquisition: "What do they have and how did they get it?"

Diffusion: "How are they using what they have?"

Synthesis: "What is needed and what is the chance of getting it?"

These headings, says Mason, correspond roughly to past, present, and future. They were chosen to focus attention on the process of incorporating a new technology in an existing academic setting.

Mason draws three major conclusions: First, all nine institutional studies are illustrative of the powerful role of the initiator. In most of the institutions, one purposeful faculty member essentially single-handedly acquired a system and made it operational. The entire job required a significant expenditure of time and effort — many times without initial administrative support. The crucial phase, notes Mason, comes once the computer is in a usuable state. The administration must then decide whether to provide an operations staff, and the initiator must decide whether to turn into a missionary/philanthropist. In the misionary role, knowledge of computing use is extended to interested faculty. As philanthropist, the initiator turns over effective control of the computer to an operations staff (whether professionals, a consortium of concerned faculty, a users' committee, etc.). No effective progress will occur until the diffusion of knowledge and control has occurred.

Secondly, says Mason, recent changes in computer technology offer the potential of materially affecting the role of the initiator. Microcomputers now exist with significant power and almost insignificant price. Therefore, future acquisition of computing power — either as the sole source or as a complement to an existing system — can occur without the gut-wrenching initiator efforts that were all too common (and necessary) in the past. The low cost of these instruments allows for incremental growth that is easily accommodated by all levels of faculty expertise. Furthermore, the operational requirements are nil.

Third, according to Mason, the importance of effective academic computing to the preservation and growth of minority institutions must not be underestimated. To have truly effective computing in an academic environment, the computer must be essentially transparent to the field; that is, detailed knowledge of the tool must not be essential for its use in acquiring detailed knowledge of the primary (or discipline) field. In addition there must be a relatively low intrepreneurial burden in acquiring the new technology. Otherwise, too much time and effort are expended outside of one's professional career path with a potentially detrimental effect. The acquisition of mainframes has been a traumatic experience for many of the nine institutions, says Mason. The acquisition of microcomputers can eliminate most of the trauma while retaining much of the effectiveness.

Marshall found (11) that despite the variety of approaches, certain factors surfaced as common ingredients of success in academic computing on the first four campuses. These ingredients included campus-wide planning (or at least planning beyond the walls of a single department or class), dedication on the part of key faculty or administrators [Mason's "missionary/philanthropist"], careful budgeting practices, the ability to put together funds from various sources, the ability to learn by experience (as well as by capitalizing on the experiences of others), and the will to get maximum mileage from the resources at hand.

Mason made the following specific comments about each of the nine institutions:

(#1) Computing expertise has diffused through the institution. The planning process exists, and opportunities are available for decentralization.

(#2) Computing expertise is strong within a segment of the college and at the top levels of the administration. Opportunities are available to spawn new computing efforts.

(#3) Still within the "initiator" stage is institution #3. Potential for diffusing expertise is minimal because of the dominance of the data processing department's program.

(#4) Significant acquisition has occurred. The challenge now is to provide an effective management.

(#5) Adequate computing power exists. The need now is for effective management and administrative support of faculty development.

(#6) The computing power is not adequate, but it cannot be extended until the current "one-man" management is replaced by a workable form of governance. Only then will faculty expertise be increased.

(#7) Adequate computing power exists. Expertise is widespread in administrative computing and could conceivably spread to academic applications.

(#8) The existing computing power is saturated by faculty expertise and is sufficiently diffuse to allow efforts to decentralize.

(#9) The major source of computing power will always be the central computer center provided by the governing body of the institution. Research projects are needed to obtain local processing power.

FICHE
FOURTH INVENTORY OF COMPUTERS IN HIGHER EDUCATION

PROCEDURES: Hamblen's series of inventories of computers in higher education represents the most comprehensive source available on computing in colleges and universities, and the data base from the fourth such inventory (7) was made available for use in this study. The fourth inventory (FICHE) was conducted in June, 1977. Alderman's analysis for the current study of instructional computing in minority institutions (13) extends the original summaries and analyses by considering minority and non-minority institutions separately and by offering comments on the status of computing according to this distinction.

MAJOR FINDINGS

DISPARITY IN DEGREE PROGRAMS: The computer science degree program disparity between minority and non-minority institutions far exceeds the proportional representation of minorities in the population. Especially at the baccalaureate and master degree levels there is a need to initiate and to expand degree programs in computer science and related fields at minority institutions.

TABLE II

MINORITY POST-SECONDARY INSTITUTIONS INTERVIEWED ON ACADEMIC COMPUTING, FALL 1979

Institution	Date Established	Ethnic Type	Type of Control	Highest Level of Offering	Academic Orientation	Fall 1978 Enrollment	Hardware Accessible by Students and Faculty
1	1947	Black	Public	2-year	Career	9,152	Univac 9480 IBM 1620 APPLE II (5) DEC 10* TRS-80
2	1873	Black Women	Private	4-year	Liberal Arts	600	HP 2000 IBM 1130
3	1969	Spanish	Public	2-year	Technical/ Vocational	876	DEC 10* PDP 11/70* PDP 11/34 IBM 360* IMSAI 8080 TRS-80
4	1891	Black	Public	4-year/ Master	Liberal Arts and Engineering	5,395	DEC 10 HP 1000 Micros
5	1884	Indian	BIA	2-year	Career	1,013	DEC 11/34 IBM 1401
6	1867	Black	Private	4-year	Liberal Arts	1,526	DEC PDP 11/34** IBM 1130
7	1968	Indian	Tribal	2-year	Career, Cultural	839	DEC PDP 11/45
8	1881	Black	Private	4-year Master	Liberal Arts and Engineering	3,296	HP 2000 IBM 370/158* SOL (3) SWTP
9	1966	Black/ Spanish	Public (City System)	4-year	Liberal Arts	4,315	IBM 3031* IBM 3033* AMDAHL 470*

* Remote access to this system
** Serves additional institutions by remote access

LACK OF DISPARITY IN PRESENCE OF HARDWARE: Despite their smaller enrollments and lower numbers of degree programs, minority institutions have computers of some kind to the same extent that non-minority institutions do. However, the fact that roughly only two-fifths of all institutions provide interactive computing suggests that all colleges and universities should seek to increase accessibility to their computing resources, says Alderman. (14)

SIMILARITY IN PATTERNS OF USE: Computer installations dedicated to specific applications in administration, instruction, and research show much the same pattern of computer use in both minority and non-minority institutions. (For example, most of both use one installation to serve academic and administrative users.) There is also a similar pattern in the frequencies with which minority and non-minority institutions offer particular programming languages. Furthermore, comparable percentages of minority and non-minority institutions support remote modes of computing and interactive computing.

DISPARITY IN ACADEMIC EXPOSURE: It would appear that students at minority institutions do not receive as much exposure to computers in their academic studies as do students at non-minority institutions. Differences in student enrollments and in degree programs account for some of the disparity in the total numbers of students using computers in their courses, but minority colleges and universities reported only one-fortieth the total number of students with exposure to computers in academic courses reported by non-minority colleges and universities.

DISPARITY IN APPROPRIATELY DEGREED COMPUTER SCIENCE FACULTY: The 105 minority institutions responding to the FICHE survey (51% of those identified as minority institutions at the time of the survey) reported a total of 35 full-time faculty members with doctorates in computer science or related programs; the 1,707 non-minority institutions responding reported nearly 1,800 such faculty members. The underrepresentation of certain minorities in the computer-related professions may be attributed, in part, to the scarcity of appropriate degree programs at minority institutions; and the scarcity of such degree programs may, in turn, be due to a lack of key faculty members.

HIGHER EXPENDITURES OF FOUR-YEAR COLLEGES AND RECENT ENTRY INTO COMPUTING: Small baccalaureate minority institutions spent more on their computer installations than did comparable non-minority institutions. The greater average computer-related expenditures of this small sample of minority institutions (14%) arose primarily from capital costs for computer hardware and from operating costs from software services. These cost categories would be consistent with acquisition of computer equipment and with expansion of support services, perhaps indicative of recent entry into the computer field.

CONCLUSIONS: Alderman concludes that "these findings suggest that the initiation and expansion of degree programs in computer science and in related fields receive the highest priority for attention at minority colleges and universities. Concommitant with this attention to curriculum programs should come concerted efforts to recruit faculty members in these disciplines. The underrepresentation of certain minorities in the computer professions seems less a problem of access to computing resources than of access to relevant degree programs and faculty members."

ECMI CONFERENCE EVALUATIONS

Participants in a series of three working conferences on educational computing in minority institutions were surveyed about their reactions to the conferences and their subsequent activities related to computers. The conferences had been held to acquaint faculty (especially those knowing little or nothing about computers) from minority institutions with computer applications in teaching and learning. Then the faculty could return to their campuses and begin developing or adapting computer materials for their own courses, thus providing exposure to computers for their students.

An ECMI Steering Committee, composed primarily of directors of computer centers and other advocates of computer uses and drawn principally from minority institutions, organized and offered the three conferences. Each conference lasted four days and included sessions focusing on particular programming languages and computer applications within specific disciplines. Altogether 921 faculty (a little under four percent) attended these conferences as shown in Table III below.

TABLE III

		FACULTY		PRESIDENTS	
Year	Conference	Applicants	Participants	Applicants	Participants
1975	ECMI/1	245	197		
1976	ECMI/2	607	345		
1977	ECMI/3	735	379	98	56
		1,587	921	98	56

In addition, during a six-week session in summer, 1976, eighteen graduates of ECMI/1 and /2 developed courseware which they were able to take back to their own campuses and use in their own disciplines. Presidents from 56 of the institutions (Table III) attended special sessions at ECMI/3 in 1977.

An attempt was made, by pre-testing and post-testing at the times of the conferences, to determine the extent to which participants felt they had benefitted. Another instrument was mailed to participants of ECMI/3 nine months after that conference had ended. These faculty had been back on their campuses a full semester after ECMI/3. In 1979, as part of the current needs assessment, another questionnaire was sent to a random sample of ECMI/1, /2, and /3 participants who were still at their original institutions. Data from the last two instruments (January 9, 1978, for ECMI/3; and Spring, 1979, for all three conferences) were analyzed by Thomas McAlpine and Donald Alderman. (15)

FINDINGS: The analysis of data from evaluation instruments administered to ECMI participants some time after their participation yielded information on current academic computing needs of the institutions viewed from the perspective of those closest to both the present status and the future potential of computing at minority colleges and universities. These data can also provide constructive guidance for subsequent efforts in developing greater faculty familiarity and expertise in educational computing. Computer-related classroom activities of participants in the ECMI conferences perhaps constitutes the most important evidence of the conferences' success in fostering computer applications at minority institutions.

Nine months after ECMI/3, the participants of that conference responded that 20 percent had actually used the computer to illustrate concepts in their courses (63% had expected to do this). On the other hand, nearly three-fourths (74.3%) of the participants had at least mentioned computers in their courses after the conference (only one-fourth had expected to do so). Analyst Alderman concludes that participants had underestimated the obstacles to educational computing on their campuses (e.g., inadequate or inappropriate computing facilities for academic purposes, lack of support staff, difficulties inherent in the development of appropriate computer-based curricular materials — of which time would be especially necessary).

In the most recent survey, each successive conference received more favorable ratings. Three-fourths of the respondents from ECMI/1 viewed their conference as "very worthwhile" (41.5%) or "worthwhile" (34.0%). Eighty-four percent of respondents from ECMI/2 (44.3% and 39.3%) and ninety percent of the respondents from ECMI/3 (44.9% and 45.1%) gave these same responses. Alderman concludes that the longer the elapsed time from the original conference the greater the opportunity for participants to pursue computer applications in their courses and thus realize a benefit from participation in ECMI conferences.

The 1979 survey showed that nearly forty percent of respondents from all three conferences had used computers in their courses to illustrate concepts, and another twenty-three percent mentioned computers in their courses in connection with some material. Only six percent never mentioned or used computers in their academic work. These may have been professors who have subsequently become administrators. It is clear from the data that the ECMI conferences played a key role in early faculty development in instructional computing since they at first represented the only assistance given to nearly 45% of participants and were additionally rated the most important influence among others by nearly 15%.

Among the problems in faculty use of computers at the institutions, respondents to the 1979 survey cited such common ones as absence of encouragement for faculty to learn and use the computer (21.6%), the demands of administrative rather than academic computing on existing resources (17.0%), lack of knowledge (13.6%), and lack of access to a computer or terminal (5.1%). But 34.7% of the respondents cited problems other than those anticipated by the response alternatives in the questionnaire.

These centered on a need for further faculty development on campus, usually in the form of release from a heavy teaching load, and on a need for more terminals on campus. These same themes occurred again in response to another question.

In his conclusions, Alderman suggests that institutions should plan each step in response to meeting these needs so that they complement one another and build toward appropriate and attainable goals for instructional computing, whether computer-assisted instruction, computer-managed instruction, computer literacy, or computer science, for the institution.

SUMMARY OF CURRENT STATUS

In assessing the needs of minority institutions in instructional computing, evaluators looked at the current status in the institutions, using a questionnaire survey, campus interviews, a comparison of non-minority and minority data from the Fourth Inventory of Computers in Higher Education, and an evaluation of the ECMI conferences. Although they found no disparity in the presence of computer hardware or in patterns of use or availability of terminals for students in minority and non-minority institutions, they did find a severe disparity in the number of computer science-degreed faculty and in expenditures for computer hardware (with the exception of small four-year schools — 14% of the sample (16) — in 1977 with start-up costs apparently playing a role.) There is also a lower level of academic computing activity in minority institutions. The disparity in academic exposure to computing may be partly due to budget limitations and size, but staffing problems (rooted partly in the shortage of computer science-degreed minorities) may also be responsible. Staffing problems may be partly due, in turn, to the scarcity of computer science degree programs at minority institutions. In general the larger the institution and its science program, the more efforts it is likely to have made to establish and/or improve instructional computing.

The acquisition of mainframe computers has been a traumatic experience for many of the minority institutions. ECMI graduates view lack of support, insufficient terminals, and lack of time and expertise as problems in improving academic computing on their campuses. The ECMI conferences are considered very helpful by those who have participated in them, but it is generally felt that more such efforts are needed. Approximately two-thirds of the minority institutions have or are making long-range plans to establish or improve academic computing services.

(7) John W. Hamblen and Thomas B. Baird, *Fourth Inventory of Computers in U. S. Higher Education, 1976-77* (Princeton: EDUCOM, 1979).

(8) Richard M. Jaeger, *Academic Computing in Minority Colleges and Universities* (Greensboro: University of North Carolina, Center for Educational Research and Evaluation, October, 1979).

(9) John W. Hamblen, Clinton Jones, Jesse C. Lewis, and Sister Patricia Marshall, "Computing in Minority Institutions: 1976-1977," *Proceedings of NECC, 1979 National Educational Computing Conference*, ed. Diana Harris (Iowa City: The University of Iowa, 1979), pp. 71-75.

(10) *Ibid.*, pp. 76, 78, 79.

(11) Sister Patricia Marshall, "Academic Computing: A Sampler of Approaches in Minority Institutions," *Proceedings of NECC/2, National Educational Computing Conference 1980*, ed. Diana Harris and Beth Collison (Iowa City: The University of Iowa, 1980), pp. 238-244.

(12) Thomas W. Mason, *Reports of Interviews at Nine Minority Institutions on Academic Computing* (Tallahassee: Florida A&M University, June, 1980).

(13) Donald L. Alderman, *Access to Computing Resources at Minority Colleges and Universities* (Princeton: Educational Testing Service, February, 1980).

(14) *Ibid*, p. 20.

(15) Thomas J. McAlpine and Donald L. Alderman, *The Impact of Conferences on Educational Computing for Minority Colleges and Universities* (Normal: Alabama A&M University, June, 1980).

(16) Hamblen, Jones, Lewis and Marshall, *op. cit.*, p. 67.

SECTION IV

DESIRED STATUS OF INSTRUCTIONAL COMPUTING IN MINORITY INSTITUTIONS

NEEDS FROM THE INSTITUTIONAL PERSPECTIVE

STUDENTS: Students interviewed would like to see improved access to equipment. Usually this was expressed in terms of "more terminals".

FACULTY: Faculty expressed a need for "more terminals" too, but a more strongly felt need that was expressed, especially in the ECMI evaluation, was for time: time to locate, acquire, and adapt materials (in some cases to develop courseware); time to learn more about the hardware; time to plan courses. Linked with the needs of time and access was an additional need expressed by many faculty, especially in the ECMI evaluation, for support and encouragement from administrators. This support, it was felt, could be expressed in terms of release time, computing expertise made available to faculty, and sufficient access to hardware.

ADMINISTRATORS: Presidents, deans, and department heads, responding to both the questionnaire survey and interview questions, would like to see computer literacy for students, with department heads looking for higher levels of skills among students. Access was also considered important, especially for faculty. Computing directors, for the most part, wanted a greater variety of hardware and more terminals and printers. Software needs expressed most often were for the language PASCAL (which is not widely provided in minority institutions), an author language (a variety of these were mentioned), and statistical packages.

NEEDS IDENTIFIED BY FICHE ANALYSIS

Needs as seen from within the institutions by way of the questionnaire survey, the interviews, and the ECMI evaluations are expressed in subjective terms. Nevertheless, they are generally in harmony with the picture that has emerged from the FICHE analysis by Alderman. The need for "more terminals" or better access to computers (that also shows up in many phases of the questionnaire survey, the interviews, and the ECMI evaluation) is compatible with Alderman's conclusion in the FICHE analysis that students at minority institutions do not receive as much exposure to computers in their academic studies as do students at non-minority institutions. (17) Both Jaeger (questionnaire survey) and Alderman mention size as a factor, but Alderman feels that size alone does not account for the disparity, and he suggests that better software, staff, and hardware might be available on minority campuses if there were to be an increase in computer science programs. (18) Alderman finds the most severe disparity to be present in staffing, and he therefore recommends that attention should be focused on relevant curriculum programs and faculty members at minority colleges and universities. (19)

VIRTUAL NEEDS THE IDEAL AS SEEN BY AN EXPERT

In attempting to assess the needs of minority institutions in instructional computing, it was recognized that there are no formal yardsticks. No standards exist in the form of accreditation requirements (except in engineering education). No one has yet come forth with a mandate for all institutions. Certain indications of some standards have been appearing at pre-college levels here and there. Minnesota is developing a computer literacy program in its schools. Oregon has computer literacy curricula for teachers. But governing bodies for higher education have generally been silent except for budgetary restrictions. Thus there is nothing against which to measure instructional computing in minority institutions, other than what we can determine is the case in non-minority (or all) institutions.

On the other hand, journal articles are beginning to appear, and papers have been multiplying at national conferences over the past decade (CCUC, NECC, AEDS, ADCIS) (20) which suggest that there may be some unwritten standards for academic computing. Arthur Luehrmann, well known in these circles, has attempted, for the purposes of this study, to express his views on where he thinks colleges, and especially minority institutions, should be headed with respect to instructional computing. Luehrmann, whose article is presented in Appendix A (page 18ff), discusses and gives examples of computing as an intellectual tool, an "intellectual amplifier of the mental work of the student". He then sets forth the implications of this for students, faculty, and various administrators. Hardware alternatives, costs, the "bottom line and the public good" receive major attention in the article. Luehrmann also presents his views — which differ from those of the other evaluators — on computer science at minority institutions. (Evaluator Judith Edwards, on the other hand, while recognizing there is still wide disagreement on what is ideal in terms of computer operations, points to the Poynor objectives — presented below — and to certain characteristics of exemplary institutions as shown by the on-site interviews in presenting her proposed strategies in Appendix B, page 23ff).

OBJECTIVES DRAWN FROM THE CURRENT AND DESIRED STATUS

In developing objectives for instructional computing at minority institutions, evaluator Hugh Poynor (21) notes first that (a) both academic and administrative computing goals are expanding at the institutions, (b) computing applications are expanding generally, and (c) there is an explosion of the computer's price/performance curve, with hardware becoming less expensive and more powerful at a staggering rate. He also notes that with this cost effectiveness comes potential diversification of use in tandem with other burgeoning technologies such as telecommunications, videodisc, satellites, and cable television. The general picture which emerges, he says, is one of a generally favorable climate for the expansion and broadening of academic computing at minority institutions. He then goes on to develop broadly stated objectives to fit institutions with diverse capabilities and curricular emphases, which he feels would serve an orderly and thoughtful progression toward increased academic computing capability and activity in minority institutions. These objectives are outlined below.

(a) **Establish Institutional Computing Goals and Departmental Objectives.** Not only should goals and objectives be stated, but they should be updated annually and officially sanctioned at the highest administrative levels. Colleges must establish their positions with respect to all computing, and in so doing must centralize the decision-making process which surrounds apportionment of computing resources. Annual review and updating of institutional goals should follow from measurable objectives as stated, monitored, reviewed, and updated by the departments. The administration should become involved in a productive dialogue regarding the apportionment of the institution's computing future.

(b) **Gather Baseline Data and Routinely Collect Standardized Reports.** Routinely gathered data on utilization, as well as user evaluations, can be used to inform decisions regarding questions of software acquisition, equipment relocation, or scheduling, or services, and can be used to evaluate equipment or sevice configurations. Such data gathering can also inform decisions about institutional goals and progress made toward them.

(c) **Hire Computer Science Faculty and Train Other Faculty.** Since realistically it is difficult to recruit faculty skilled in computer applications, the focal point for improving faculty computer literacy logically falls to in-service training, or continuing education for the faculty. Faculty training priorities, and their corresponding budget, should be stated vis-a-vis other faculty responsibilities to ensure that they are not in competition. Training should include dissemination of news about software, documentation, use of the hardware, courseware, etc.; and responsibilty for this should be assumed by the central computing facility or its corresponding unit. The limits of the computer must also be taught.

(d) **Train Students.** Of equal importance with the coming increase in course offerings and majors in computer science is the need to improve the computer literacy of all students. In addition to requiring computer-based instruction or requiring computer use in connection with coursework in other disciplines, the institutions should have specific plans for providing all students, in whatever majors, with a perspective on the current and future role of computers in both life and work settings.

(e) **Enhance computer service.** Hardware, software, and staff cannot work in isolation but must work together to result in improvement. Rather than think only in terms of hardware, particularly where non-computer science applications are concerned, it is more useful to think and talk in terms of service requirements when specifying institutional computing objectives. Computer librarianship can learn much from the historical development of traditional library practices. Computer service levels should be locally defined and developed by a widespread process, including faculty and students (and even the administrative users of computer services if instructional computing activities must compete with them).

Poynor, who sets down the five objectives above in perceived order of priority, says also that the questionnaire survey and on-site interviews are especially pertinent to these objectives, showing that successful instructional computing depends heavily on the availability of computers with suitable software, and also upon the expertise, dedication, and enthusiasm of key faculty on campus.

(17) Alderman, *op. cit.*, pp. 17-20.

(18) Alderman, *op. cit.*, p. 20.

(19) Alderman, *op. cit.*, p. 26.

(20) CCUC: Conference on Computers in the Undergraduate Curriculum (annual, 1970-1978)
NECC: National Educational Computing Conference (annual since 1979)
AEDS: Association for Educational Data Systems (annual since 1962)
ADCIS: Association for Development of Computer-Based Instructional Systems (annual)

(21) Hugh Poynor, *Objectives for Educational Computing at Minority Institutions* (Santa Monica: Poynor Computer Applications, 1980).

SUMMARY OF PRIORITIES AND ALTERNATIVE STRATEGIES

PLANNING: Poynor, in drawing up objectives for instructional computing, has placed top priority on planning. Planning (ongoing and including evaluation) has also emerged as a primary ingredient in successful academic computing from the on-site interviews. Jaeger found that most presidents reporting to the questionnaire survey had institutional plans in place for academic computing. There seems to be no disagreement on the prime necessity of planning for those who would either establish or improve an instructional computing capability. Both Poynor and Edwards deal with the specifics of planning.

PERSONNEL AND SERVICES: Obviously computing hardware is a necessity, but with price/performance improving as dramatically as it recently has, equipment no longer takes center stage. Rather, computer services assume great importance; and they actually encompass the other ingredients (staff, software, hardware).

But before services can be rendered, someone has to be recruited and/or trained to render them and to disseminate the information and expertise. One evaluator — Luehrmann — is pessimistic as to whether computer science faculty can be a solution to this problem in minority institutions, which have more severe staffing problems than most schools. However, there is no disagreement as to the need for more computer science degrees among minorities, and most of the evaluators feel that a computer science program at an institution can enhance computer services for all disciplines in the institution.

TRAINING OF FACULTY AND STUDENTS: It seems clear that an institution must assume responsibility, after setting its goals, for the growth of academic computing, and that this involves training of faculty in various disciplines, as well as students. Poynor makes a point of this, and it emerges as a perceived need by the ECMI evaluation respondents. Edwards suggests ways of doing it.

HARDWARE ACQUISITION: Although hardware acquisition, as a priority, may tend to disappear into computing services in terms of primacy, at least one evaluator, Arthur Luehrmann, treats this subject in some detail (Appendix A), contrasting the advantages of time-sharing *versus* local microcomputer networks or "clusters" with central storage and printing. He does not dwell on brand names and other misleading details. Edwards also mentions some hardware considerations under planning strategies. Hardware, although it is a necessary ingredient, is by no means the only consideration in developing instructional computing.

STRATEGIES: To deal effectively with the instructional computing objectives described by Poynor, says Judith Edwards (Appendix B), it is necessary to choose strategies that are affordable, that will improve the quality of education, and that are efficient. Edwards also made a strong case for planning from the perspective of the institution's own goals. An externally imposed ideal, she says, can provide a balance in perspective, but is should not be the driving force in structuring an institution's strategies.

Edwards proposes strategies for each of Poynor's five objectives. In outlining planning techniques, she pays special attention to goal setting with respect to academic computing. For the gathering of baseline data and reports, she makes several practical suggestions. On hiring computer science faculty, she takes a more optimistic view than Leuhrmann and makes some practical suggestions for hiring, as well as training other faculty. To train students, she recommends using computer science courses, embedding the use of the computer in the general curriculum, and using courseware developed elsewhere (rather than developing it on site). To enhance computer services, Edwards suggests establishing the library, rather than a computer center, as a dissemination point.

FUNDING: Funding of anything in the typical minority college or university (as well as in many other small schools) tends to loom up as a priority. The reader may have noticed that it has not been mentioned as such. Its relative absence from most of the foregoing discussions does not minimize its importance, but it does put funding into perspective as one of the things administrators must think about, once the educational goals of instructional computing are established at an institution. It is entirely possible that the approximate thirty percent of all colleges and universities which did not have computer hardware by 1977 (22) had actually done some planning and goal setting but found that despite plummeting prices and rising performance of computing hardware, the needed staffing (and/or other) resources were not affordable at the time. Hardware constitutes mostly a start-up cost (which, even today, can necessitate development efforts to acquire external funding), but staffing is the major on-going cost, once an initial training effort has taken root.

A FINAL WORD ON STRATEGIES: We know now what the needs are for instructional computing in minority institutions (staff, courseware, more appropriate hardware) generally; where the gaps exist between them and the non-minority institutions (staff, services); and where there are deficiencies for all colleges and universities (type of hardware). Two ways of choosing strategies exist: local (institutional), and national. While local institutions must do their own planning and take their own initiative, some national approaches toward improving academic computing would be consistent with initiatives the federal government has been urged to take. (23) In view of the general clamor from the educational grass roots at all levels (evident in national conferences previously mentioned and in the April 2 and 3 hearings in 1980 before the combined Subcommittee on Science, Research and Technology of the Committee on Science and Technology, and the Subcommittee on Select Education of the Committee on Education and Labor, both of the House of Representatives, in Washington, DC), it appears that a ground swell to generate both coherent public policy and widespread federal support for integrating new technologies into all levels of education is underway. Congressmen are seriously listening to the problems and the potential such action holds for the nation. Concerns were raised several times during the grass-roots workshops held in connection with the hearings of April 2 and 3, 1980, about assuring that the nation's less-advantaged citizens would have equal opportunity to participate in the use of the new technologies. It is worth noting here that a resource does exist which can help that to happen: the minority colleges and universities.

APPENDIX A

COMPUTER EDUCATION GOALS AT MINORITY INSTITUTIONS OF HIGHER EDUCATION

Arthur Luehrmann
Director of Computer Research
Lawrence Hall of Science
University of California
Berkeley, California 94720

PREAMBLE

What follows is an essay on computer education goals for minority institutions of higher education. The findings here are based less on objective analysis of actual surveys of needs expressed by key individuals at those institutions and more on a study of successful computer education programs and also of the hardware and software trends leading into the next decade. As such, nearly all of these remarks have to be understood as one person's opinion.

Such an approach may be of value, however, for the following reasons. First, other consultants to this project will report in elaborate detail the findings of interviews and surveys of students, faculty and administrators of minority institutions. Second, stated needs tend to be strongly influenced by two factors: one's prior experience and one's belief as to what the future realistically holds. Stated needs, therefore, can be misleading in a field where innovation is rife. At the time he decided to create the assembly line to build the Model T, Henry Ford knew more about the public's need for transportation than the public did. Within a few years, of course, the public would have a stated need for the automobile but only after experiencing cheap cars and believing that they would get better and cheaper. A pre-Model T market survey would have turned up little more than stated needs for incremental improvements in trolley service and passenger trains. Needs in the field of computer education may be like that. If so, then surveys and interviews can usefully be supplemented by analysis based on a credible assessment of the near-term future of computer technology.

UNDERLYING PREMISE

The following analysis is based fundamentally on the premise that the health and viability of an institution depends critically on its capacity to provide students with new abilities that are desirable and rewarding, both personally and occupationally. While adminstration will reduce costs of operation and good public relations will attract interest, the institution is in critical danger if its graduates discover that they lack important concepts, methods and tools they need in the years ahead.

The ability to use computers constructively for the purpose of solving problems and carrying out tasks in many fields of work is now in great demand both by individual students and by the society as a whole, which offers a vocational advantage to people with those abilities. Any institution that now fails to provide its students with computer problem-solving skills is at risk.

EDUCATIONAL COMPUTING AND ADMINISTRATIVE COMPUTING

I will not in this paper discuss needs for administrative data processing at minority institutions; not because they are non-existent nor unimportant, but because they are entirely distinct from educational needs. An expenditure for administrative computing should be justified entirely on a cost-saving basis. Educational computing, on the other hand, has to be justified by improvement in the quality and content of the educational program. In the past these two separate needs were best satisfied, coincidentally, by the same type of computer system: a central computer with a number of remote terminals. As a result, many institutions rationalized the acquisition of their computers on the grounds that the same system would both save money and improve students' education. I know of rare instances in which this marriage of purposes has continued to be a happy one for both partners. In most cases the concrete need to reduce cost has taken priority over educational improvement, which is harder to measure. It is well documented that education's share has become smaller over the years.

Fortunately, the hardware situation in the 'eighties will avoid that conflict of purposes. It is extremely unlikely that any institution starting out today would choose the same computer system for both administrative use, which depends on multiple access to large amounts of centralized and secure data, and educational use, which can most often be carried out by students who work independently of one another at separate machines. As a result, I will not address administrative needs here, except to point out the fact that many institutions with a computer education program still do not budget separately for administrative and academic computing and still try to provide central computer services for both. It will take time for this situation to change, as it should.

COMPUTER-ASSISTED INSTRUCTION

Neither will I have much to say about computer-assisted instruction (CAI), in which the computer is cast in the role of teacher, giver of instruction, or drill master in some existing college-level subject. Evidently, such a use needs to be justified by evidence of improvement in quality or reduction of cost when compared with conventional means of instruction in those subjects. While research in CAI is active at several universities, there is little evaluative evidence today that would justify acquisition of computers at the college level for that purpose alone.

Furthermore, one must recognize that the only way that CAI could reduce educational cost is by saving educational labor. At colleges and universities educational labor is the faculty, which, as the U.S. Supreme Court recently ruled, is also a large part of university management. CAI, therefore, is unlikely to find a happy home in higher education, even if effective — especially during a decade of declining college-age population and teacher immobility.

There is a single exception to this negative situation, and that is in the area of remedial instruction, which is often a significant problem at minority institutions. Considering the broad range of preparation of their entering freshmen, one must recognize that an effective program of remediation is simply not economically feasible without some kind of automated individualized instruction. CAI has a useful role here.

VOCATIONAL SKILLS

Finally, I will not say much about the vocational aspects of learning computer skills, although they are quite significant for graduates who decide to specialize in computer science or who merely want to pick up a part-time job as a programmer. Today and for many years to come, it appears, the demand for computer skills will greatly exceed the supply. Since graduates with those skills have a sufficient salary advantage in their first year to recover the cost of their computer education, colleges and universities are being sent a clear message to create strong educational programs that will produce such graduates. They should pay attention to the message.

I do not stress this obvious point any further here, however, because the need for computer education at colleges and universities derives not only from short-term vocational payoffs but also from the traditional intellectual values appealed to by other subjects included in a liberal education.

COMPUTING AS INTELLECTUAL TOOL

Computers belong in colleges and universities so that students may learn to use them in the course of studying and solving problems in most of their other subjects. The student who expresses his or her understanding of some topic in the form of a computer program has a new way of thinking about and representing that knowledge. The student who carries out experiments on a computer model of a river basin or of the solar system has a new method of analysis and investigation. The student who uses a computer-based editing and word processing system has a new way to write, revise, and type papers. The student who turns to the computer as an aid in composing music or drawing pictures has found a new creative tool.

In each instance of this kind the computer acts not as teacher but rather as *intellectual amplifier* of the mental work of the student, who instructs the computer to carry out procedures he or she decides to be appropriate to the task at hand. *The chief goal of computer education, therefore, is to give each student (1) the specific skills needed to interact with the computer and (2) examples of significant computer use in a variety of academic disciplines.*

IMPLICATIONS FOR STUDENTS

To achieve the first part of this goal, each student needs an opportunity to learn to program a computer in a higher-level language, such as BASIC or PASCAL. In terms of student readiness, this can be accomplished best in the early years of high school, or perhaps even earlier. I know of very effective courses with broadly based enrollments of seventh and eighth graders. As the decade ahead progresses, more and more college freshmen will arrive with good basic skills in computing.

Nevertheless, it will probably continue to be true that for most students in the eighties, and especially those in minority institutions, college will be the place to learn to use a computer. Entering freshmen should expect to be offered or perhaps even required to enroll in a course in computer use. They should expect to spend four to six hours per week in the computer lab then, so as to test their understanding of programming and to carry out several larger software projects. In addition to the syntax rules of the programming language, they should learn a variety of fundamental algorithms, data representations, and the principles of structured design, transparency, and readability. Grammar, in short, should be embedded in the rhetorical purpose, just as it is in the English class.

Students should expect the computer lab to be equipped with enough computers or terminals so that each enrolled student can normally work alone. A knowledgeable student aide should be available for technical assistance. Manuals should be on hand. The collection of equipment needs to be sufficiently robust that it never becomes necessary to cancel and reschedule an entire time slot.

Having acquired a basic literacy in computing during their early college years, students should find increasingly that courses in other departments presume such competency and routinely include a number of relevant computer applications without taking time out to give instruction in computer basics. Furthermore, for all of their writing courses, students should expect to be able to type and edit their papers via word processing software and printers (especially important for students in minority institutions). Again, students should expect to be able to depend on access to appropriate hardware, manuals and assistance for these tasks.

Finally, a substantial minority of all college students, namely those with major or minor academic interest in the field of computer science, should find sufficient advanced course offerings to satisfy their professional needs. I shall return to this point later.

IMPLICATIONS FOR FACULTY

During the next decade college and university faculty should expect to count among their number several colleagues who spend most or all of their teaching efforts on computer education. At first they will appear in one or two traditional departments, but in due course they will associate into a computer science department or group. Other faculty members will increasingly introduce computer applications into their teaching as they discover student readiness and interest. In fact, it will often happen that inventive students lead faculty members into novel uses. Nevertheless, experience at computer-mature institutions with few restraints on use indicates that only 40 to 50% of the faculty will use the computer in their teaching. Most of them will need additional training in computer methods and uses in their disciplines.

Faculty members who develop their computer skills will often find new excitement in their teaching. They will also find that they are tugged away from their teaching by professional and market pressures. Faculty at other similar institutions will want advice and assistance from teachers who have effectively introduced computers into their classes, and that will lead to writing, consulting and travel. Some of the latter will also discover that society offers greater monetary rewards to computer specialists than to college teachers, and they will find it difficult to remain totally dependent on an academic salary.

IMPLICATIONS FOR ADMINISTRATION

Computer education touches aspects of college and university administration beginning with admissions and ending with alumni affairs.

Applicants to colleges have heard about computers and may have some experience already. The admissions office can expect more and more applicants to ask specific questions about facilities for and courses in computer use. Unsatisfactory or vague responses may mean the loss of high-potential students to better prepared institutions.

To the development office will fall the responsibility for generating the financial support necessary to acquire, maintain and supervise the computer equipment needed. As I will indicate in a later section of this paper, that cost today is considerably lower than one might suppose and is falling precipitously fast. Even so, the start-up costs will undoubtedly be large enough to require a significant development effort.

The dean of faculty will need to work on the development of faculty skills required to initiate computer education as a respectable discipline, protect and reward individual teachers who undertake the program, and help extend it to other departments by offering travel assistance, sabbatical leave, and the like to faculty who are willing and able to lead the way. The dean will have to cope with the problems of an emerging discipline over the next decade and also with the fact that the best faculty in this field will be tempted away by lucrative jobs in industry. It may be more effective to play the game in reverse and recruit good temporary teachers from among computer professionals who and/or whose companies feel a social responsibility for providing computer education in minority institutions.

To the office responsible for classroom space and equipment will fall the need to allocate space for one or more supervised clusters of computer equipment, to negotiate maintenance arrangements and to plan a depreciation and obsolescence cycle of replacement.

Finally, the alumni office should be prepared to seize an opportunity to develop specialized continuing education programs for graduates of past years who now feel a personal or professional need to know about computers and their use. Such programs can both provide a timely and warmly received service and also bring a substantial net revenue.

HARDWARE ALTERNATIVES AND COSTS

What kind of computer system is best for satisfying the educational needs itemized above? Until about five years ago the answer was universally agreed to be a centralized computer with numerous remote terminals. Pioneers developed their own educational time-sharing systems. The computer industry quickly followed suit, and until recently nearly all college-level educational computing has used such time-sharing systems. Three years ago the first so-called "personal" computer was announced for less than a thousand dollars, and several others quickly followed. Ever since that time it has been true that one could buy a complete computer, including keyboard, display screen, and tape recorder for less money than the simplest time-sharing terminal costs. Furthermore, the speed, memory size and programming capabilities of the personal computers are competitive with time-sharing systems. Naturally enough, there has been a great deal of interest among educators in the pros and cons of personal computers in school settings.

Close experience in teaching computer use with both systems makes it clear to me that neither system is ideal for that purpose. Yet each has essential components of an ideal system. Furthermore, at least two companies have produced "first drafts" of that ideal.

The personal computer wins out over time-sharing along several dimensions. It costs much less: $1,000-$3,000 per computer vs. $5,000-$15,000 per terminal for all time-sharing hardware, plus additional telephone charges. The personal computer is more responsive on the average and faster in most applications. It offers better graphic capabilities and even a music synthesizer in some models. The dialect of BASIC is often better than that on some time-sharing systems. One personal computer also offers PASCAL, FORTRAN and assembly language, and others are rumored to follow that lead.

Best of all for the teaching lab is the robustness of a cluster of personal computers. This may seem strange, since the basic reliability of both types of computers is about the same. The effect of failure on users, however, is strikingly different. A time-sharing system is generally judged to be very reliable if it is available 97% of the time. On the other hand, that means that for one day of every month the computer is out of service and all scheduled use of all terminals has to be rearranged. Now, consider an equally reliable cluster of ten personal computers. Ninety-seven per cent availability again means that the ten computers lose a day each during a month — *but almost never on the same day*. Thus the teacher can depend confidently on having nine computers available every day and all ten on most days. The personal computer lab never needs rescheduling.

A collection of personal computers also is easier to grow with. One needs to acquire only the number of computers one needs at the moment, and one can easily add to the collection one computer at a time. With time-sharing systems, one is always faced with initial excess capacity (and low revenue if computer time is charged for) followed by excess demand and poor responsiveness, which can only be solved by a large new hardware purchase.

On the other side of the scale, time-sharing has certain outstanding benefits to confer on educators, not the least of which is its centralized storage of programs and data and the quick and easy access to the same. To realize this advantage fully, a teacher has only once to ask a roomfull of students each to load from cassette tape a copy of the same program into their personal computers. First, there has to be a physical copy in the possession of each student, and that presents an enormous inventory management problem for everyone. Second, the tape-loading time is about three minutes and quite unreliable, requiring rewinding and starting over. The whole operation for the class would typically take ten minutes.

Floppy disks are faster and more reliable, but each disk drive costs about $500 and does nothing to diminish the inventory management problem.

In addition to the central disks, time-sharing systems generally have a centralized printer to which users have access for listing programs, text and data. Even cheap printers cost as much as a personal computer, however, making it impractical to add one to each student system.

What is needed, evidently, is a new sort of cluster computer system with centralized storage of programs and data, a central printer and a small network of personal computers connected to the center with short high-speed lines so that individuals may quickly get programs in and out of their computer and may each make use of the printer. Such systems are beginning to appear at incremental prices close to the total cost of adding a set of floppy disk drives to each computer in the cluster. They are clearly the systems of choice for educational computer use.

HOW MUCH CAPACITY?

A concentrated one-semester laboratory course in computer programming and problem solving should be staffed and equipped to enroll every student at the institution. While taking that course the student should use a computer six hours per week. If each computer is available for use a total of 60 hours per week, then it can accommodate ten students in the course. That is to say, the number of computers needed to support that course is equal to one-tenth of the enrollment in one semester. On average the enrollment would equal one-eighth of the total college population if all students are to take the course once during their eight semesters at the institution. We conclude that the total number of computers needed for this course is 1/80 of the total college population, or 12.5 computers per thousand students at the school.

With such a laboratory course providing all students base-level skills in computer problem solving, one can be certain that other courses will begin to require smaller amounts of student computer use. Taken together these uses could, over eight semesters, easily consume as much computer time as the basic course. *Hence a more realistic assessment of hardware need would be 25 computers per thousand students at the school.*

As pointed out above, these computers should be organized into clusters of from ten to twenty computers. The computers in a given cluster should be complemented by a printer and linked together to a central disk drive with enough capacity to give each user account at least 100,000 bytes of private storage.

Several such cluster systems are beginning to appear now and they add perhaps 10-20% to the hardware cost of the computers alone. At today's prices, the resulting average cost per computer for the whole cluster system is between $2,000 and $3,000. Therefore the equipment cost per thousand of student population is between $50,000 and $75,000.

OTHER COSTS

Maintenance costs will come to about ten per cent of the purchase price per year — $5,000 to $7,500 per thousand students.

There will certainly also be costs associated with the faculty who teach the computer courses or begin to incorporate computer uses into other teaching. It is difficult, however, to know how to treat those costs since the addition of new academic programs is usually balanced by reductions in older ones.

THE BOTTOM LINE AND THE PUBLIC GOOD

The total cost of such a computer education program, per thousand student population, is about $60,000 in capital outlay and less than $20,000 per year in ongoing expense. The supplementary cost of computer education, therefore, amounts to about $40 per student per year.

It should be noted that this figure, in constant dollars, is only about a third of the amount recommended for computer education fifteen years ago by the Pierce Report. The reduction relects mainly the decline in hardware prices in this field of technology.

This is evidently good news for an institution faced with declining enrollment and increasing costs. Nevertheless, the total dollar amount is great enough to cause deferral or even dismissal of a proposed computer education program. Such an action would not be in the public interest. Individuals who acquire computer skills have marked vocational and professional advantages over those who lack such skills. Without public intervention, it is inevitable that a young person growing up in a family for which the purchase of a home computer is not abnormal will have significant predictable advantages over another who never sees a computer at home nor at school. Equality of educational opportunity requires public intervention so as to develop broadly based programs of computer education.

COMPUTER SCIENCE AT MINORITY INSTITUTIONS

Throughout this paper I have carefully avoided using the term "computer science" and instead talked about "computer education." I have done this for two reasons. First, I believe that more individual and social good will be accomplished by assuring *all or nearly all* minority institution students that they will acquire more broadly applicable computer skills than would be achieved by a narrow program aimed at producing a few computer science majors at the same institutions. Second, I believe that it is extremely costly and difficult to create a stable, good-quality computer science program.

I am sympathetic with the expression of need for more minority group representation within the computer science profession, but I believe that only a few minority institutions will succeed in building and maintaining the qualified faculty required for an acceptable computer science degree program. Computer scientists, and especially minority computer scientists, are targets of very active industry recruiting programs, which are pushing starting salaries to heights that even leading universities cannot come near matching. At ACM annual meetings it is not unusual for there to be twenty university positions available for every applicant who shows up for interviews.

In such a situation there is serious danger that the determination to build a computer science department at any cost will lead to hiring fifth-rate people and then being left with them for many years to come, when, in fact, the availability of qualified people may be far better than it is today.

For these reasons I believe that top priority should go to establishing broad-based programs, aimed potentially at teaching computer skills to all students, and taught largely by existing teachers with primary loyalty to the institution or the teaching profession.

APPENDIX B

STRATEGIES FOR IMPROVEMENT OF EDUCATIONAL COMPUTING IN MINORITY INSTITUTIONS

Judith B. Edwards
Northwest Regional Educational Laboratory
Portland, Oregon 97204

INTRODUCTION

The status of educational computing in minority institutions has been extensively documented and reported in the past year (Alderman, 1980; Jaeger, 1979; McAlpine and Mason, 1980). These studies reveal the actual status of minority institutions, the desired status, and the gap between. *Needs* for improvement in educational computing in these institutions have thereby been identified. These needs then led to the development of a set of objectives (Poynor, 1980):

1. Establish institutional computing goals and departmental objectives.
2. Gather baseline data and routinely collect standardized reports.
3. Hire computer science faculty and train other faculty.
4. Train students.
5. Enhance computer service.

GUIDING ASSUMPTIONS

A given set of objectives can be met through a nearly infinite set of alternative strategies. The following strategic constraints and assumptions can make it possible to deal effectively with the educational computing objectives described by Poynor.

1. Strategies proposed must be affordable.

It is obvious that no institution, least of all a minority one, has unlimited internal resources to devote to the improvement of academic computing. Nor are unlimited resources likely to be available for this purpose from outside sources. Therefore, strategies for the improvement of educational computing in minority institutions must be within reasonable financial limits; they must be affordable. One alternative, for example, might be to make a well-developed, sophisticated system such as PLATO available without limit to all faculty and students of all minority institutions. But this strategy is assumed not to be affordable, even in the wealthiest institutions. However, a strategy that involved making such a well-developed, exemplary system available on a limited basis to some faculty and students could be affordable.

2. Strategies proposed must be educationally sound.

In developing strategies for improvement of educational computing, there is danger in assuming that more is necessarily better, that more use of computers is better use of computers. It should be remembered that although the immediate goal of this study is to improve educational computing in minority institutions, the underlying goal is to improve their quality of education. Educational institutions have more than two decades of experience in the use of computers; some uses have proven effective and some have not. Whatever strategies are proposed should result in computer uses that are effective and educationally sound. Strategies and their uses should be grounded on experience, baseline data and/or logic which demonstrates educational effectiveness.

3. Strategies proposed must be efficient.

Efficiency in the development and use of computer facilities is particularly important, especially in minority institutions where resources are limited. Wealthy, well-funded institutions can afford costly experiments, false starts, and expensive haphazard approaches. Minority institutions cannot. They must cost-effectively utilize available resources based on a carefully planned approach. Minority institutions, for example, will not be able to release faculty to develop CAI materials or their own financial accounting software. They will need to rely instead on materials developed elsewhere.

PERSPECTIVES FOR STRUCTURING STRATEGIES

Minority institutions may argue for improvements in the status of educational computing from a number of perspectives:

1. The current status needs to improve relative to non-minority institutions — the "parity" argument.
2. Status needs to improve relative to "virtual needs" or the *ideal* (discussed by Luehrmann in Appendix A).
3. Status needs to improve relative to the institution's own educational goals.

4. Status needs to improve relative to a comparable minority institution considered to have successfully implemented educational computing — an exemplary institution.

Any or all of these arguments may be convincingly used, with one possible exception: the parity argument, when applied in the area of "access to computing hardware." Parity is a valid rationale, however, if we are comparing "number of computer science faculty" available at minority and non-minority institutions.

Using an "ideal" situation as the standard for improvement assumes that it can be identified — and agreed upon — by everyone. Expert opinion and decades of experience can serve to validate perceptions of the ideal to a large extent. Those who teach in minority institutions, however, bring their own perspective to the picture of the ideal.

A possible weakness in the "virtual needs" (or ideal) approach to strategy development can be illustrated by the following analogy.

> Soon after Henry Ford started mass production of automobiles, owning one became an ideal of the American public. However, what need did the automobile really fulfill? The need for efficient transportation? If that was indeed the need and the ideal became the automobile, then the American public was grossly misguided by Henry Ford and the other automobile manufacturers. There are many today who feel that the automobile — inefficient, gas-guzzling, polluting and dangerous — is not the ideal means of transportation. If a needs assessment had been carried out at the time the automobile industry was getting started, if goals had been established, and strategies developed, we would probably not have such an inefficient method of primary transportation. The automobile was an ideal for Henry Ford and other auto manufacturers, but not necessarily for the American public.

In education, we have the opportunity to base our goals and strategies for computer application on the needs of our institutions. Rather than being a driving force, an externally-imposed ideal can provide a balanced perspective for these needs.

Another possible perspective on which to structure strategies is an institution's own mission and goals. Parity with other (non-minority) institutions may be a useful argument when seeking internal or external funding for computer operations, but such parity may not fit the mission or goals of a paticular institution. Parity may, in fact, be contrary to established goals. Attempting to bring an institution to an "ideal" computer operation may also be undesirable. There is currently little or no agreement on what is ideal in terms of computer operations; and so even if desirable, an ideal standard may not be identified. Perhaps the goals for computer utilization would be better based on the educational needs of the particular institution.

According to the survey conducted by ECMI in 1979, minority institutions vary widely in the degree to which educational computing has been successfully implemented. Should the "exemplary institution" be used as the standard for improvement, the survey can inform us as to the characteristics of a minority institution which is exemplary in its use of computers in education. The five objectives stated above and the strategies proposed in the following pages acknowledge and incorporate those characteristics, which are summarized here:

> The exemplary institution has developed a clear and evolving statement of its goals relative to educational computing.
>
> The exemplary institution enjoys visible and continuing support at the highest administrative levels for the goals of educational computing.
>
> The institutional goals for educational computing are furthered by at least one — and often several — faculty member(s) with the imagination, stamina, tenacity, charisma and dedication to write the proposals, work with faculty, establish a computer facility, acquire or develop software and courseware and upgrade personal computing skills as needed.
>
> The exemplary institution places a high priority on student access to computing resources.
>
> Federal or other external funding has been sought and obtained to support early capitalization costs.

In this discussion of perspectives which may be used in arguments for improving the staus of educational computing, it is clear that any of the above characteristics may be used. Furthermore, it is more important to note that the strategies proposed here to accomplish the five objectives for educational computing all serve as well to improve parity, approach the ideal, achieve the educational goals of the institution, and achieve exemplary status.

STRATEGIES

The specific strategies proposed for improving the status of educational computing in minority institutions are organized according to the five objectives. The alternatives presented have been effectively implemented in successful minority and non-minority institutions, although some strategies may be more appropriate for minority institutions where educational computing is already well established. Each institution will need to interpret the recommendations based on the *actual status* of the institution and the *desired status*. For some, the continuum from actual to desired may be a very wide one; for others, the gap may be quite small. Appropriate strategies should be selected accordingly.

STRATEGIES FOR OBJECTIVE 1:

ESTABLISH INSTITUTIONAL COMPUTING GOALS AND DEPARTMENTAL OBJECTIVES

The first objective is perhaps the easiest of the five to accomplish. It need not take a great deal of time or require a large amount of resources. The strategies proposed for accomplishing this objective are those that have served well in institutions with exemplary computer usage. Besides assisting the accomplishment of this objective, the following strategies will provide direction and an environment for accomplishing the others.

Strategy 1.1 Organize goal and objective setting effort.
This involves primarily deciding who is to be responsible for the establishment of the institutional goals and objectives. It is suggested that this responsibility be assumed by a task force with administration, faculty and student representatives. The president of the institution (or a very high-level administrator who can speak for the president) should serve. The task force should have a specific charge, a budget, and a deadline for realizing their goals.

Strategy 1.2 Education of the task force.
This strategy is particularly important for institutions with limited computer experience. Task force members will need to learn about (or become familiar with) educational computing before goals are established. Education can be accomplished through study, on- or off-campus workshops, and visits to exemplary institutions.

Strategy 1.3 Use an outside consultant to work with the task force.
This strategy is also particularly helpful for institutions with limited computer experience. Even for institutions with extensive experience, however, an outside consultant can be helpful by providing an objective point of view. Those on the ECMI Steering Committee could provide particularly insightful and useful assistance in the planning stage.

Strategy 1.4 Consider goals from other institutions.
As a starting point, it will be helpful to the task force to consider educational computing goals developed at exemplary institutions.

Strategy 1.5 Consider all educational computing uses.
In the establishment of the institutional goals, all possible uses for educational computing should be considered. Educational computing can be categorized as follows:

> Administrative computing encompasses all uses of the computer for the administration of the institution. Included would be financial accounting, payroll, staff accounting, student records, grade reporting, alumni records, admissions, etc.

Academic computing can be broken down as follows:

> COMPUTER SCIENCE: teaching of vocational computer skills to students.
>
> THE COMPUTER AS A TOOL: teaching students to use the computer as a tool in disciplines other than computer science; teaching, for example, business or engineering students to use the computer as a tool in their fields.
>
> THE COMPUTER FOR TEACHING: use of the computer to teach concepts or skills in any subject area. Rather than a student's tool, the computer is used as a teacher's aide. This a usually called computer-assisted instruction (CAI) and is sometimes further categorized into types or modes of CAI such as simulation, drill and practice, tutorial, etc.
>
> THE COMPUTER FOR INSTRUCTIONAL MANAGEMENT: management of instruction, particularly where individual student progress is involved. This is usually called computer-managed instruction (CMI).
>
> THE COMPUTER AS A RESEARCH TOOL: use of the computer to store and process research data.
>
> COMPUTER LITERACY: familiarizing students with the computer — its uses, how it functions, and its effect on society.

Strategy 1.6 Establish educational computing goals in congruence with the overall institutional goals.
Computing goals should be consistent with the overall mission, goals and needs of the institution; they can be established from a number of different perspectives and at various levels. For academic computing, it is suggested that goals first be established in terms of instruction. Examples of such goals are:

> Students shall have the opportunity to major in computer science.
>
> All students needing remedial work in basic skills shall have the opportunity to learn those skills through CAI.
>
> All majors in accounting shall learn to use the computer as an accounting tool.
>
> All graduates shall have learned at least one programming language.

All faculty shall have the opportunity to use the computer to enhance instruction.

Strategy 1.7 Prioritize goals.

Resources for computer facilities are unfortunately limited in minority institutions. Priorities will therefore need to be established to most efficiently use resources for the most effective computer applications. In the area of administration, for example, a higher priority may be placed on institutional financial accounting than on student accounting. Financial accounting utilizes fewer computer facilities and is thus more cost-effective. In the academic area, some applications consume much more computer resources than others. Word (text) processing, for example, consumes a very large amount; and hardware is tied up while text then requires a great amount of computer storage. Therefore, in assigning priorities to academic applications, an institution would probably assign a low priority to word processing by students. The benefits could be quite low for the high cost involved if a time-sharing system is used. On the other hand, an exception might be made for students in secretarial programs for whom word processing is an essential part of their training.

Strategy 1.8 Establish time frames for accomplishment of goals.

Goals are more likely to be accomplished if specific target dates for their accomplishment are developed.

Strategy 1.9 Secure financial support.

Accomplishment of goals will require internal and/or external financial support. It is usually easier to secure this support for *specific* computing goals. The possibility of outside funding should not be overlooked. Both public and private agencies provide grants for educational computing.

Strategy 1.10 Show administrative support.

Perhaps the single most effective (and least expensive) strategy for improving educational computing, is to show that the top administration of an institution believes in and supports the program. Top administrators should make it clear to all employees that they believe in the goals established for educational computing, and that they expect all employees to work toward those goals.

STRATEGY FOR OBJECTIVE 2:

GATHER BASELINE DATA AND ROUTINELY COLLECT STANDARDIZED REPORTS

It is important to collect baseline data and reports on educational computing. This information can be used in a variety of ways: monitoring utilization; support for decisions regarding software and additional hardware acquisitions; tracking the attainment of goals; etc. If the computer system is fairly sophisticated, the computer itself will provide the data. Otherwise a logging system may be established. In some cases surveys of students, faculty and other employees will be used. Whatever the method of recording, the data should relate to the educational goals and objectives established, and should show progress toward those goals.

STRATEGIES FOR OBJECTIVE 3:

HIRE COMPUTER SCIENCE FACULTY AND TRAIN OTHER FACULTY

Strategies 3.1 through 3.4 deal with hiring computer science faculty, while 3.5 through 3.9 address the training of other faculty.

Strategy 3.1 Actively recruit computer science faculty.

All universities are currently experiencing a serious personnel shortage in the computer sciences. Faculty salaries simply cannot compete with those offered by business and industry, particularly at a time when computer scientists are in short supply. Minority computer scientists are in even greater demand. For the present, then, "active recruitment" may yield inadequate return for the effort expended. As minority institution computer science programs improve and respond, however, recruitment will be a more productive strategy. In the meantime, computer scientists without Ph.D.'s should be easier to find, and would be acceptable for two-year colleges and perhaps some four-year colleges as a short-term solution.

During the period of short supply and high demand, additional strategies may need to be employed to expand the computer science faculty.

Strategy 3.2 Obtain computer science faculty from industry.

Corportations such as IBM and Control Data have been known to provide assistance for small colleges and minority institutions in the form of a short-term "loan" of a staff computer scientist. Some institutions have used this strategy to establish a computer science program and facililty. If this strategy is used, however, there should be a clear recognition of the problem of maintaining the program once the borrowed scientist leaves.

The responsibilities of the temporary person should include establishing procedures, recruiting staff and faculty, training existing faculty, as well as beginning to establish a computer science curriculum. Although certainly less than ideal, the "borrowed scientist" strategy can be repeated every year with a new person, if a willing corportaton can be found.

One difficulty that has been experienced by minority institutions using this strategy is that the temporary person does not understand the context, constraints or goals in which he or she has been placed. To help alleviate this problem and to assist in providing appropriate role models, the institution may wish to specificallly request the loan of a minority scientist. Any such temporary faculty should receive initial orientation to the minority institution, and periodic re-orientation as needed.

Strategy 3.3 Hire computer scientists on sabbatical or short-term leave from larger institutions.

Again, this strategy is a short-term expedient and not the ideal solution. It has an advantage over the industry loan strategy, however, in that the person will be a teacher, with an understanding of the role and responsibilities of a faculty member in an institution of higher education.

Strategy 3.4 Hire part-time computer science faculty.

If the minority institution is located in a community which employs computer professionals, a computer science program and facilities can be staffed by part-time personnel whose primary job is external to the institution.

Strategy 3.5 Educate administrators through shared-cost seminars.

The ECMI orientation sessions for college presidents was a particularly successful strategy in gaining informed support for educational computing in minority institutions. Such sessions can be planned on a regional basis, for example, or for a consortia of Indian college presidents. Sharing the planning and cost of the orientation seminars would make it feasible without federal assistance.

Strategy 3.6 Recruit faculty with computer skills.

If the effective use of computers in academic areas other than computer science is to increase, appropriate faculty must be trained and/or recruited. In recruiting, a desirable qualification may be computing skills, particularly in the sciences and engineering where such skills may well be requisite to future success in the field.

Strategy 3.7 Educate faculty through establishing networks.

Faculty from wealthier institutions have long depended on a network of other professions to learn new techniques, find resources, and stay abreast of the state of the art. With limited resources, however, it is difficult to fund travel to conferences and conventions where contacts are established and maintained. This may be a strategy that will require federal support to implement.

Strategy 3.8 Educate faculty through exchange visits.

An externally-funded exchange program, requiring a proposal by the institutions participating, would provide faculty with the opportunity to share expertise with other universities (not necessarily minority). Visits usually take place at different times; for example, a Morehouse physics professor visits Haskell, then the Haskell physics professor visits Morehouse. A temporary replacement for the absent teacher could perhaps be supplied through a staff loan from industry, as in Strategy 3.2. Crucial to the success of such an exchange program would be written commitments and agreements by both participating institutions.

Strategy 3.9 Educate faculty through ECMI-type training sessions.

A highly successful strategy named by all exemplary minority institutions for successful educational computing has been participation in ECMI summer programs. Programs of this magnitude would require continued federal funding, although regional faculty training sessions may be organized on a shared-cost basis.

STRATEGIES FOR OBJECTIVE 4:

TRAIN STUDENTS

Strategy 4.1 Improve computer science offerings.

Computer science course offerings and majors will improve as faculty in computer science are hired and as other strategies are implemented.

Strategy 4.2 Increase educational opportunity and computer literacy through CAI.

For those students needing remedial work as a prerequisite to enrolling in a college-level course, equal educational opportunity does not exist. When staff and resources are not available to teach remedial classes, they are simply not offered. CAI, however, can be used to teach remedial subjects without adding to the burden of the faculty. A degree of computer literacy is also achieved through this interaction with the computer.

Strategy 4.3 Embed use of the computer in the curriculum.

To achieve the goal of computer literacy while at the same time enhancing the productivity and effectiveness of coursework, use of the computer should be a requirement in some courses. Comprehensive use of the computer to achieve course goals is a characteristic feature in exemplary minority institutions which have achieved success in computer utilization and literacy.

Strategy 4.4 Secure CAI courseware.

CAI courseware developed at other institutions should be obtained, rather than attempting large-scale, in-house development. Faculty time is at a premium — even for incorporating already developed courseware into the curriculum — without the additional burden of CAI development. Existing "clearinghouses," such as the MISIP Project carried out by Carl Stucke at Atlanta Junior College, or the CONDUIT courseware exchange (University of Iowa), should be primary sources for courseware and information. An additional source of courseware for basic skills (both tutorial and drill and practice) is the MICROSIFT Clearinghouse at Northwest Regional Educational Laboratory in Portland, Oregon.

Strategy 4.5 Enhance career opportunities through computer-related course offerings.

By using the computer as a tool in those disciplines where it is appropriate, the student acquires a skill which will increase competitiveness in the job market.

STRATEGY FOR OBJECTIVE 5:

ENHANCE COMPUTER SERVICE BY ESTABLISHING THE LIBRARY AS A DISSEMINATION CENTER

The existing library or media center facility can and should provide a focus for collecting and disseminating computer-related information and resources. Faculty should have access to information about computer uses in education generally, and about their discipline specifically. Courseware should also be available through the library. This concept differs from that of the computer center as a focus for computer-related resources, information, and courseware, which is the traditional approach. The library is more acceptable to most faculty because they are already familiar with it. Librarians are beginning to see themselves as taking this responsibility, and this is a growing trend.

PARTICIPATING EVALUATORS

NEEDS ASSESSMENT

FICHE (FOURTH INVENTORY OF COMPUTERS IN HIGHER EDUCATION) ANALYSIS:

"Access to Computing Resources at Minority Colleges and Universities"

Donald L. Alderman
Educational Testing Service
Princeton, NJ 08540

QUESTIONNAIRE SURVEY:

"Academic Computing in Minority Colleges and Universities"

Richard M. Jaeger
Center for Educational Research and Evaluation
School of Education
University of North Carolina
Greensboro, NC 27412

ECMI CONFERENCE EVALUATION

"The Impact of Conferences on Educational Computing for Minority Colleges and Universities"

Thomas J. McAlpine
Director of Institutional Research
Alabama A&M University
Normal, AL 35762

and Donald L. Alderman (see above)

ON-SITE CAMPUS INTERVIEWS

"Interviews on Academic Computing Conducted at Selected Minority Campuses"

Hugh Poynor (designer)
Poynor Computer Applications
6372 West 82 Street
Los Angeles, CA 90045

Thomas W. Mason (summarizer)
Head, Data Processing Technology Department
Florida A&M University
Tallahassee, FL 32307

OBJECTIVES

"Objectives for Educational Computing at Minority Institutions"

Hugh Poynor (address above)

STRATEGY ASSESSMENT

"Strategies for Improvement of Educational Computing in Minority Institutions"

Judith B. Edwards
Northwest Regional Education Laboratory
400 Lindsay Building
710 S. W. 2nd Avenue
Portland, OR 97204

"Computer Education Goals at Minority Institutions of Higher Learning"

Arthur Luehrmann
Director of Computer Research
Lawrence Hall of Science
University of California
Berkeley, CA 94720

NOTE: All of the references listed above will be made available through ERIC. Except for the last two (under Strategy Assessment), they are not included with the Executive Summary because of their length. The Luehrmann and Edwards reports, however, are presented in their entirety in Appendices A and B respectively of the Executive Summary.

ECMI STEERING COMMITTEE MEMBERS AT THE TIME THIS STUDY WAS MADE

Raymond J. Barreras
Medical School
Morehouse College
830 Westview Drive, SW
Atlanta, GA 30314

Laurette Foster
Head, Mathematics Freshman Studies Lab Services
Box 2440
Prairie View A&M University
Prairie View, TX 77445

John W. Hamblen
Chairman of Computer Science Department
University of Missouri-Rolla
Rolla, MO 65401

Oscar V. Hinojosa
Manager of Instruction
Texas State Technical Institute-Rio Grande Campus
Harlingen, TX 78550

Clinton E. Jones
Director of Computer Center
Fisk University
Nashville, TN 37203

Jesse C. Lewis
Director of Computer Center
Jackson State University
Jackson, MS 39217

Sr. Patricia Marshall
Computer Science Department
Xavier University of Louisiana
New Orleans, LA 70125

Joseph Martin
Graduate Student in Education
University of North Colorado
Greeley, CO 80639

Thomas W. Mason
Head, Data Processing Technology Department
Florida A&M University
Tallahassee, FL 32307

Albert B. Miller
Chairman, Psychology Department
Delaware State College
Dover, DE 19901

Grover C. Simmons
Director, Atlanta University Center Comp. Center
Wheeler Hall, Room 127
360 Westview Drive
Atlanta, GA 30310

Nellouise D. Watkins
Director of Computer Center
Bennett College
Greensboro, NC 27420

Roger K. Williams
Chairman, Psychology Department
Jenkins Hall
Morgan State University
Baltimore, MD 21239