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ABSTRACT

Means by which traditionally minority institutions might obtain and utilize computer facilities are listed and examined. Sharing facilities between administration and classroom use are discussed, and guidelines suggested for establishing a cooperative utilization. Costs are analyzed, and methods described for stimulating faculty to employ facilties. Types of facilities are described, with recommendations, and a list of further readings included. (SK)

ADMINISTRATIVE AND INSTRUCTIONAL
COMPUTING IN MINORITY INSTITUTIONS

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A Symposium on Computers in Minority Institutions
Association for Educational Data Systems
1975 Annual Convention

Background

Many of the minority institutions are feeling the pressure to obtain computer facilities for instructional purposes. Because they are relative small (enrollments at most are less than 5,000), the immediate question which arises is "can we also make use of the computer for administrative, functions, such as registration grade reporting, accounting and alumni affairs," and, of course, the answer is "That depends--."

During the late fifties there were numerous opportunities for institutions (even large universities) just getting started to attend meetings and workshops to learn, share and discuss various alternatives, approaches, and techniques of using the computer for research, instruction and administrative data processing. This continued through the sixties for smaller institutions.

Administrative Computing

Such meetings as the Machine Records Conferences, the annual meetings of the Association for Educational Data Systems, CAUSE, COMMON, CUETUG, etc., became more sophisticated and in some cases equipment dependent (user groups). Many of the minority institutions have neither the equipment resources or experiences to participate in such meetings today. On the other hand a few have such resources and experiences which can and should be shared with their sister institutions. It has been proposed that the Association for Educational Data Systems be the catalyst for this exchange.

Conferences such as the Machine Records Conference and the annual meetings of AEDS attract primarily administrators from institutions having large and sophisticated equipment utilizing in most cases advanced computing technologies and concepts well beyond the experience and resource capabilities of most minority institutions.

The objective of the proposed workshops is to provide stimulation and assistance to four hundred college administrators from minority institutions. The most likely offices to be represented are registrar, admissions, accounting, alumni, development and purchasing. The proposer feels that the introduction of the administrators to computers and their uses in administration would greatly strengthen their ability to consider alternatives in computer selection and participate in information system analysis and design.

Instructional Computing

During the past six years, the National Science Foundation has partially supported six annual conferences on Computers in Undergraduate Curricula (Iowa, 1970; Dartmouth, 1971; SREB, 1972; Claremont, 1973; Washington State, 1974; and Texas Christian, 1975).

From the start, the Conferences on Computers in Undergraduate Curricula attracted primarily faculty from institutions having large and sophisticated equipment utilizing in most cases advanced computing technologies and concepts well beyond the experience and resource capabilities of most minority institutions.

In 1974 Lincoln University of Missouri received a $151,700 grant from the National Science Foundation's Minority Institution Science Improvement Program to provide for the First Conference on Educational Computing in Minority* Institutions (ECMI/1). The planning and conduct of the conference was contracted to the Computer Science Department of the University of Missouri-Rolla (UMR). Hamblen served as Conference Coordinator and was assisted by Joseph W. Trigg, Instructor of Mathematics, Lincoln University. Basic policy guidelines were

*"Minority" for purposes of the grant has been defined as "four-year traditionally black."

provided by a Steering Committee of representatives from nine minority institutions.

The members of the Steering Committee and their respective institutions are: Dr. James Frank, Chairman of the Committee and President of Lincoln University; Dr. James Kinard, Benedict College; Dr. Jesse C. Lewis, Jackson State University; Sister Patricia Marshall, Xavier University of Louisiana; Mr. Jesse J. Mayes, Federal City College; Dr. Albert Miller, Delaware State College; Mr. Grover Simmons, Atlanta University; Mr. Fred Stone, Tuskegee Institute; and Dr. Roger K. Williams, Morgan State College.

The Conference was held in the Sheraton-Biltmore Hotel of Atlanta, Georgia during March 23-27, 1975. It was directed at acquainting faculty of minority institutions on the use of the computer to assist them with the teaching and/or learning process, and to inform them of hardware and instructional techniques that may be employed in improving their science education programs.

Approximately one hundred, four-year, traditionally black institutions were invited to submit at least three applications. Two hundred participants were selected from the eighty-six institutions which responded. Each of these eighty-six institutions were represented by at least one faculty member. Selection was based on priorities assigned to the applicants by their institutions. A high priority was given to an applicant who could influence the promotion and/or development of computing at his/her institution, and to those who did not have extensive background in computing.

The major areas represented at the Conference were the mathematical, physical, natural, social and management sciences. These areas were represented by twelve disciplines. Each participant attended five group sessions with 5-15 faculty of the same discipline. At these sessions, faculty who had used the computer in their classes presented their materials to the attendees from their discipline. The group leader demonstrated what he has done and how he used the computer in his classes. In addition the four-day conference consisted of five general sessions and seven sessions of a programming short course in a language of the participants choice from FORTRAN, BASIC, and APL.

ACM Consulting Service [ENGEL]

History

The ACM has always regarded educational programs as one of its major missions. Educational activities within ACM led to the publication of curriculum recommendations in computer science in March, 1968, known internationally as "Curriculum '68" [17]. The publication of this document along with the report of the COSINE Committee of the Commission on Education of the National Academy of Engineering [9], and the Park City Conference on Computers in Undergraduate Education [29], all within a year went a long way to define the discipline of Computer Science and focus on key issues in computer uses in education.

The Curriculum Committee on Computer Science of ACM, who prepared "Curriculum '68", believed that it was necessary for the document to be interpreted to potential users. The initial vehicle for this was the ACM Visiting Scientist Program, supported by the National Science Foundation, which arranged for speakers to come to college campuses. In reviewing the accomplishments of this program, it was determined that a broader program was needed than one in which a computer scientist spent part of a day giving a lecture on computer science education.

Thus in June, 1969, a proposal was submitted to the National Science Foundation to provide funds for a more in-depth consulting visit to college campuses in which consultation would be offered in four basic areas:

1) Computer Science Curricula - ranging from the course content of an introductory course in computer science to a complete undergraduate curriculum.

2) Computer Facilities - emphasizing the alternatives available to the schools such as networks, batch systems, time-sharing systems, and commmercial services.

3) Computer Uses in Education - showing the activities that are going on in various subject areas where computers are being used and supplying information on where materials could be obtained.

4) Administrative and Budget Matters- dealing with questions such as where, in the school, computer science courses should be offered, who should control the computing facilities, how should faculty interested in computing be trained and recruited, and where are funds available to support computing on campus.[1]

This proposal was funded in October, 1969 by the National Science Foundation, and from that time until July, 1973, the College Consulting Service functioned as a service of ACM.

1 From the proposal

Procedures and Activities

The mechanics for the consulting visits were constructed to be quite flexible for the college visited:

> Visits are usually for two days, although travel requirements may cut into part of this time.
>
> The agenda for the visit is the responsibility of the school. It should be sent to the consultant before the visit. It may include a formal talk to students and faculty, but small group meetings and other informal activities have proven most effective. There should be some opportunity to visit with a few interested students.
>
> Topics such as various aspects of computer use, budget, problems, facilities and equipment, curriculum, faculty education, and administration can best be covered by scheduled meetings with small groups of appropriate faculty and administrators.
>
> A private talk toward the end of the visit with the president or senior academic dean is of considerable value.[2]

Notices of the existence of the program were sent by personal letter to the presidents of most four-year institutions in the country. In addition, announcements of the program were made in the trade literature and at selected professional meetings. Applications were submitted to the program director who made the selection of institutions to be visited and assigned the consultant. Eligibility was left somewhat open.

> The program is intended for undergraduate colleges and small universities where undergraduate education is the major objective. Institutions granting the bachelor's degree and accredited by a regional accrediting agency may apply.[3]

In the life of the program approximately 100 trips were made.

The distinction of "small' became quite difficult to make, in that in some cases state colleges with quite large enrollments were just getting started in computer work, and needed as much assistance as the under 2,000 student liberal arts college. Toward the end of the program, several two-year colleges were visited to assess the nature of the problems of computing at these institutions.

The relative emphasis over the years of the lifetime of the Consulting Service showed some changes. Perhaps the most dramatic change was from relatively little discussion of computer science curriculum early in the program to a point where it was the main purpose of the visits near the end of the program.

The early visits dealt mainly with questions of equipment and staff. Interestingly, the institutions in their applications generally stressed equipment selection as their main problem, and the visitor generally found the main problem to be staff.

In the early visits, few schools were even considering a computer science major. Such programs were considered only appropriate for large universities and engineering schools. Furthermore, staff for such programs was not available. With time the staffing problem became somewhat less difficult as graduate computer science programs produced more individuals with advanced degrees, and the schools found that the demand for computer science from entering students and the market place made it most desirable to introduce such programs.

Recommendations

Since the visits were not all alike, there can not be a single set of recommendations that apply to all schools. There were certain trends, however, that were clearly seen in reviewing the series of consultant reports.

Perhaps the single most common problem was the competition, either actual or potential, between administrative data processing and academic computing. Many schools had justified acquisition of their equipment on the savings it would give in administrative record keeping, and even where this was not the case, many administrators looked at the expensive array of equipment in the computer center, and were considering how it could be used for administrative work. The unfortunate part of this is that administrative data processing often became the "tail wagging the dog", and with little, if any cost savings. More information was generally produced by the computerization of administrative activities, but there was seldom any reduction in cost. What usually did happen, however, was that the personnel assigned to the computer center were required to devote a great deal of their time to the implementation of administrative programs, and often much of the available computer time was devoted to this purpose.

2 from the brochure describing the ACM College Consulting Service

3 *Ibid.*

In those institutions with enrollments of under 1,500 students, Hamblen suggested in the Proceedings of the Rand Conference [23] that there is a question as to whether any administrative computing should be done. He goes on to observe that for schools of under 2,500 students, it is difficult to justify a separate machine for administrative use.

Noting these observations, it does appear that the approach of separate machines for academic and administrative computing is the most desirable thing to do. In this way, conflicts over use should not arise. In many cases this is impractical, and there are some other possibilities. Most schools operate in such a way that students have little opportunity to use the computing equipment in the morning hours, while having needs for computer time in the afternoons and evenings. This could then suggest a firm scheduling scheme which would allow both groups uninterrupted time. Such a schedule should be under the control of the computer center director who would insure fair treatment of everyone.

As important as the problem of scheduling machine time is for administrative and academic work, staff scheduling may be more critical. All too often schools have been in a position where all of the computer staff time is devoted to the development and maintenance of administrative computing. In this case, it appears desirable to assign a separate group within the center, reportable to the director, to handle administrative computing. In this way, there will be a minimum of competition, and the true cost of the administrative operation will be determined.

The position of the computer center in the institutional organization is a recurring source of discussion. Here again, almost every possible combination from part of an academic department to an independent agency working under contract to the school was seen. It is clear that local circumstances come into play here, but as a general rule for those centers serving all aspects of the campus, the director of the center should be relatively independent, and report to an administrative officer above those he serves. This generally would imply a line to the president of the college or a senior academic vice president. In this way, the center should not become dominated by any single user.

In the life of the Consulting Service it was determined that the recommendation of specific hardware was impossible. As a general rule of thumb, it was determined that a school should anticipate a minimum expense of $50,000 per year to run a computer center and this would be approximately equally divided between equipment and staff. As the center grows this 50-50 split is likely to remain and it was found that the institutions were less likely to anticipate the staff costs than the equipment cost.

The other common recommendation regarding equipment involved the careful analysis of the uses of the system. In particular it is often the case that the equipment necessary for administrative data processing is quite different from that needed for academic computing. This becomes especially important when dealing with small machines, and again points out the importance of justifying and specifying equipment on what its use will be.

The problems of finding adequate staff seems to have improved in recent years. Computer science students, though still not plentiful, are certainly more available, and individuals with experience and backgrounds in the applications of computing are also available. A factor that is working against this, however, is that financial problems have caused many institutions to put a freeze on new appointments, and there has been a tendency to reassign people into the computer area rather than recruiting individuals trained in this field.

The position of director of the computer center calls for coordinating and developing all aspects of computing on campus. It also involves a key role in the selection of equipment, staff and services. There are no specific training programs for such individuals, though some courses in management of computer centers are appearing in university curricula. Where possible the person selected for this position should have experience in management of a computer installation, and in implications of computer applications. This position should be distinct from a position in teaching computer science, or any other department since the center should be independent of other organizational units of the campus; a courtesy faculty appointment, however, and occasional teaching is not inappropriate. There is little practical reason for the computer center director to hold a doctorate, though, it must be recognized that this individual will have a great deal of interaction with the faculty, and it may be necessary for him to hold this credential to achieve the proper respect of the faculty.

The rest of the staff of the center is closely tied to the nature of the work, and cannot be generally specified. It should, however, be recognized that if an organization wants quality programming and operations, it is necessary to have a staff of professionals, and not operate as many schools do, by leaving the problems of program development and implementation to part time help and amateurs.

Computer Science educational programs should be staffed separately from the computer center, and indeed the computer science department or group should be regarded as just another user of the computer facility. In the case of the academic program it appears critical that the positions be filled with computer scientists. The field has developed to the position of a field of study in its own right, and it is difficult to see how someone not primarily engaged in the field can keep up with the developments necessary to teach at the college level. How large a staff in computer science is necessary depends on the level of activity, but it is difficult to see how there can be less than one full-time person in this capacity.

The necessary ingredient to the development of innovative uses of computers in education appears to be administrative support and encouragement. This can come in many forms and in some ways the easiest is in the recruitment of new faculty members. Many students completing their work are actively engaged in the uses of computing, and are anxious to continue this in their professional life. Another approach is to institute an active program of bringing visitors to the campus who are involved in computer uses in education. In a two or three day period, such a visitor can present several lectures, and at the same time push the faculty into such activities on their own.

Other activities that have proved successful have been specially funded training and orientation programs for the faculty, and support of innovative educational computer uses through summer developmental grants. In all such cases it is necessary that the administration of the school be committed to such activities and insure that the faculty member so involved receives the proper academic credit for what is a time consuming and demanding task. It should be noted that in many ways the smaller schools, without the emphasis on "classical publication", have a better chance to have faculty members devote their time to innovative computer use.

In considering instruction in computer science the first point to observe is that such instruction has a rightful place in a college of arts and sciences. Many arguments have been presented on this point and it will serve little purpose to repeat them here. Granted that such instruction has a place in the curriculum the question then is how much how soon. Here again local conditions affect the decision, but nearly all schools with active computing activities have some form of computer science instruction. This is what keeps the students excited and active in computing, and in fact it is often the students that insist that such instruction be offered.

In all too many cases, however, schools have looked at computer science and determined that this is an active field, offering job potential for the students, and perhaps even serving to attract students at a time when many colleges are suffering from declining enrollments. They will often then select a computer user on campus and put him in charge of a "program" that does little more than offer several courses in different programming languages. The fact that computer science is a vital active field that should be represented at most colleges does not excuse such a procedure. It must be recognized that to institute a computer science program is both expensive and time consuming, and requires a commitment by the school at a time that limited resources may demand cutting back in some other areas.

LaFrance and Roth in reporting on a Workshop on Computer Science for Liberal Arts Colleges [22] give some indications as to how the development of a department should proceed. Recognizing that few liberal arts schools would be able to introduce a major, they called first for a strong development of a first course similar to course B1 of "Curriculum '68" [17] or Course 1 of Austing and Engel's report [4], and then as interest and staff develop, offer courses involving things like machine organization and programming, information structures and a survey of computer applications; courses 3. 4 and 2 respectively of Austing and Engel [4]. At such a time as these courses are under control, further work could be added as faculty and student interest dictates. Offering this kind of program would provide a firm base of knowledgeable students, would supply necessary service courses for a variety of students, and combined with an adequate selection of courses from other departments would meet minimum entrance requirements for admissions to graduate programs in computer science for interested students, or for direct entrance into the computing profession.

It should be noted that offering this much of a program requires a full time faculty member, and clearly, to expand these offerings would require more. It is also clear that such courses should be offered as computer science and not in some other department. To serve the service need of the program, a selection of one or more of these courses could be taken with no other prerequisites, and, to offer them in a mathematics department, for example, would only serve to drive away students who are not mathematically oriented.

Such a program then is within the reach of any school willing to commit itself to one staff member in computer science, it will serve to form a basis for future development of a more advanced program, it will serve a multi-track service need, and it will offer enough background for further work in computing.

The library resource is often neglected in considerations of the development of computer science and computer uses in education. Often the expenses of obtaining equipment are so great that little time is given to think out this pressing need. Most of the references at the end of this paper contain extensive bibliographies of materials appropriate to computer science education and computer uses in education. The selection of such items would provide a start at a good working collection.

It is often easy in addressing questions of educational computing, to overlook the obvious in the specification of details. The obvious needed ingredient to allow for excellence of either computer science instruction, or computer uses in education, is free and easy access to the computing equipment, preferably utilizing one of the user oriented systems that provide fast turnaround and clear diagnostics. This must be the first order of business.

Sources of Information

One of the major functions of the consultants in this program, was to direct interested people at the institutions visited to sources of additional information. No listing of such materials could be complete, however, a few items will be noted which have proved valuable.

Certainly any reading into educational computing should begin with the Pierce Committee Report [24]. Though, by and large, these recommendations for the proper level of support of educational computing have not been followed, they still serve as an excellent goal. In terms of additional documents in the full range of computing and computer services, three conference proceedings, the World Conference on Computer Education, 1970 [25], the Rand Conference, 1970 [23], and the Park City Conference, 1968 [29] are excellent. Computer Surveys,[4] published by ACM provides a good introduction to various aspects of computing and should be in most libraries. Computing Reviews also published by ACM provides up to date information on available books, articles, and other materials.

4 Information regarding this journal and other ACM activities, such as the Special Interest Groups, may be obtained by writing ACM Headquarters, 1133 Avenue of the Americas, New York, New York 10036.

ACM has a Special Interest Group on University Computer Centers (SIGUCC). This group publishes a quarterly newsletter dealing with various aspects of computer center administration. In June, 1972 SIGUCC sponsored a symposium on the administration and management of small college computer center, and proceedings are available which cover many of the problems associated with small centers [6].

A number of sessions have been held dealing with the uses of computers in various disciplines. Among these the Iowa Conference [30], the Dartmouth Conference [21], the Atlanta Conference [19], the Claremont Conference [32], and the IIT Conference [5] provide sources of valuable information and programs for computer applications. Sedelow [26] has prepared an outstanding survey on computer uses in the humanities. The Human Resources Research Organization (HumRRO) is engaged in an overall study of computer-based curriculum and has prepared a preliminary report [27].

In the area of applications, ACM has several Special Interest Groups dealing with computer uses in education (SIGCUE), social and behavioral sciences (SIGSOC), language analysis and studies in the humanities (SIGLASH), and computers and society (SIGCAS). All of these groups publish periodic bulletins and sponsor occasional meetings, usually with proceedings available.

To begin reading on computer science education "Curriculum '68" [17] is a good start. Work reported by LaFrance and Roth [22] and Austing and Engel [4] have attempted to put computer science programs into the perspective of the small colleges. Reports by Wegner [31] and the Committee on the Undergraduate Program in Mathematics [7] present some additional ideas regarding computer science programs. The ACM Curriculum Committee on Computer Education for Management [3, 28] presents outlines of work in information systems. The COSINE Committee of the Commission on Education National Academy of Engineering specifies the role of computer science in electrical engineering [9], and in subsequent reports outlines specific courses; computer organization [11], a computer-oriented first course in electrical engineering [10], digital subsystems [12], digital systems laboratory course [15], and operating systems principles [14].

ACM has a Special Interest Group on Computer Science Education (SIGCSE) which publishes a quarterly bulletin, and this group has held three technical symposia for which proceedings are available [1, 2, 18].

Future

ACM is currently seeking support foi a similar consulting program for minority institutions.

References

[1] Robert M. Aiken (ed.), Papers Presented at the ACM SIGCSE Technical Symposium on Academic Education in Computing Science, November 16, 1970, Houston, Texas, Association for Computing Machinery, New York, 1970.

[2] ______________, Papers Presented at the ACM SIGCSE Second Symposium on Education in Computer Science, St. Louis, Missouri, March, 1972, Association for Computing Machinery, New York, 1972.

[3] R.L. Ashenhurst (ed.), Curriculm Recommendations for Graduate Professional Programs in Information Systems, A Report of the ACM Curriculum Committee on Computer Education for Management, Communication of the ACM, Vol. 15, No. 5, May, 1972, 364-398.

[4] Richard H. Austing and Gerald L. Engel, A Computer Science Course Program for Small Colleges, Communications of the ACM, Vol. 16, No. 3, March, 1973, 139-147.

[5] Ronald Blum (ed.), Computers in Undergraduate Science Education, Conference Proceedings, Chicago, Illinois, August 17-21, 1970, Commission on College Physics, College Park, Maryland, 1971.

[6] Harris Burns, Gerald L. Engel, and John H. Esbin (eds.), The Administration and Management of Small College Computer Centers, Proceedings of a SIGUCC Symposium June 9-10, 1972, Atlanta, Georgia, University Computer Center, Iowa City, Iowa, 1973.

[7] Committee on the Undergraduate Program in Mathematics (CUPM), Recommendations for an Undergraduate Program in Computational Mathematics, CUPM, Berkeley, California May, 1971.

[8] Conference Board of the Mathematical Sciences, Recommendations Regarding Computers in High School Education, Conference Board of the Mathematical Sciences, Washington, D.C., 1972.

[9] COSINE Committee, Computer Science in Electrical Engineering, National Academy of Engineering, Washington, D.C., September, 1967.

[10] ______________, Some Specifications for a Computer-Oriented First Course in Electrical Engineering, National Academy of Engineering, Washington, D.C., September, 1968.

[11] ______________, An Undergraduate Electrical Engineering Course on Computer Organization, National Academy of Engineering, Washington, D.C., October, 1968.

[12] ______________, Some Specifications for an Undergraduate Course in Digital Subsystems, National Academy of Engineering, Washington, D.C., November, 1968.

[13] ______________, Impact of Computers on Electrical Engineering Education - A View from Industry, National Academy of Engineering, Washington, D.C., September, 1969.

[14] ______________, An Undergraduate Course on Operating Systems Principles, National Academy of Engineering, Washington, D.C., June, 1971.

[15] ______________, Digital Systems Laboratory Courses and Laboratory Developments, National Academy of Engineering, Washington, D.C., March, 1971.

[16] ______________, Minicomputers in the Digital Laboratory Program, National Academy of Engineering, Washington, D.C., April, 1972.

[17] Curriculum Committee on Computer Science, "Curriculum '68, Recommendations for Academic Programs in Computer Science", Communications of the ACM, Vol. 11, No. 3, March, 1968, 152-197.

[18] Gerald L. Engel and Robert M. Aiken (eds.), The Papers of the ACM SIGCSE Third Technical Symposium on Computer Science Education, Columbus, Ohio, February 22-23, 1973, Association for Computing Machinery, New York, 1973.

[19] John W. Hamblen (ed.), Proceedings of the 1972 Conference on Computers in the Undergraduate Curricula, June 12-14, 1972, Atlanta, Georgia, Southern Regional Education Board, Atlanta, Georgia, 1972.

[20] IFIP Technical Committee for Education, Computing Education in Secondary Schools, an Outline Guide, AFIPS, Montvale, New Jersey, September, 1971.

[21] Thomas E. Kurtz (ed.), Proceedings of the Second Annual Conference on Computers in the Undergraduate Curricula, Dartmouth College, June 23-25, 1971, The University Press of New England, Hanover, New Hampshire, 1971.

[22] Jacques LaFrance and R. Waldo Roth Computer Science for Liberal Arts Colleges, A Report of a Workshop held at Wheaton College, Wheaton, Illinois, July 12-24, 1972, SIGCSE Bulletin, Vol. 5, No. 1, February, 1973, 70-76.

[23] R.E. Levien (ed.), Computers in Instruction, their future for Higher Education, Proceedings of a Conference held in October, 1970, Los Angeles, California, The Rand Corporation, Santa Monica, California, July, 1971.

[24] President's Science Advisory Committee, Computers in Higher Education, U.S. Government Printing Office, Washington, D.C., February, 1967.

[25] B. Scheepmaker and K.L. Zinn (eds.), World Conference on Computer Education 1970, Papers of the First International Federation of Information Processing World Conference on Computer Education. August 24-28, 1970, Amsterdam, The Netherlands, Science Associates/International, New York, 1970.

[26] Sally Yeates Sedelow, The Computer in the Humanities and Fine Arts, Computing Surveys, Vol. 2, No. 2, June, 1970, 89-110.

[27] Robert J. Seidel, Beverly Hunter and Martin L. Rubin, A Study of Computer-Based Curricula: The Process of Change, Human Resources Research Organization, Alexandria, Virginia, November, 1971.

[28] Daniel Teichroew (ed.), Education Related to the Use of Computers in Organizations, Communications of the ACM, Vol. 14, No. 9, September, 1971, 573-588.

[29] William Viavant (ed.), Proceedings of the Park City Conference on Computers in Undergraduate Education, Park City, Utah, September 8-13, 1968, University of Utah, Salt Lake City, Utah, 1969.

[30] Gerard Weeg (ed.), Proceedings of a Conference on Computers in the Undergraduate Curricula, Iowa City, Iowa, June 16-18, 1970, University Computer Center, Iowa City, 1970.

[31] Peter Wegner, A View of Computer Science Education, The American Mathematical Monthly, Vol. 79, No. 2, February, 1971, 168-179.

[32] Fred Weingarten (ed.), Proceedings of a Fourth Conference on Computers in the Undergraduate Curricula, Claremont, California, June 18-20, 1973, The Claremont Colleges, Claremont, California, 1973.

Minicomputers [SWOYER]

[An experiment was funded by NSF in August, 1970, which assisted ten colleges' acquisition of mini-computers with coordinating supervision by the Southern Regional Education Board Computer Sciences Project.]

The ten colleges in the experiment exhibited a variety of computing needs and a diversity of preference in choice of computer vendor, configuration, and mode of operation. At the time of the start of the experiment, circa 1969, the purchase of a mini-computer by a small college posed an element of risk few felt they could afford. There was almost no experience based on which to rate the expected performance of a mini-computer in an educational environment, and although many faculty had previous experience in the use of computers, almost none were well versed in the elements of systems selection, software, hardware, or operational considerations. The grants from NSF were intended to partially off-set the risk, and the introduction of the SREB office of the Computer Science Project, plus support for a series of follow-on consultant visits, assisted with the establishment of reasonable initial computer operations on each campus. The experiment required institutional commitment to provide information about progress and use of the facilities through the three year project period.

The equipment selection process, and associated plans for operation, occurred in a tentative form in February, 1970. In many cases, revisions to original plans continued right up to a month or so prior to delivery. For most institutions, this was the first experience ordering a computer. The early 1970 time frame deserves some reflection. Most major minicomputer vendors were in the process of releasing new lines of equipment which are now considered commonplace. Data General had barely entered the market with its first Nova. Digital Equipment Corporation had just delivered the first of its PDP-11 series. Hewlett-Packard was just beginning to extend the popular HP2000 series computers. It was a time when much of the minicomputer equipment was new even to the sales representatives. To the uninitiated consumer, there was genuine cause for bewilderment. Several colleges planned a system in March of 1970, and by the time of the experiment's start in August discovered new equipment had come into the market with greater appeal. The case for Data General equipment, for example, found some attractively priced new minicomputers available which were completely unknown when the initial systems were evaluated five months earlier.

Some General Observations about Equipment Selection:

Although the ten colleges varied somewhat in the objectives to be satisfied by the minicomputer system, some initial generalizations were apparent.

1. Institutions primarily interested in economical use by fairly large numbers

of students opted for a batch mode of operation.

2. Three "least costly" systems, all batch or single-user oriented, were priced around $20,000 for a complete system. No single vendor was at the low-cost end of the scale, with a Data General Nova, a Digital Equipment PDP-8, and a Hewlett-Packard 2114 each contending for lowest price honors.

3. Irrespective of vendor, most institutions opted for a high-speed paper tape reader/punch.

4. Five institutions chose to operate multiple terminals in a time-shared mode. Of these, all but one had at least 12,000 words of memory. (The only college attempting time-sharing with 8,000 words of memory found it needed more during the experiment).

5. The common characteristic separating the "low-cost" $20,000 systems from the others (ranging upward from $40,000) was the exclusion or inclusion of a high-speed rotating secondary memory device (either a disk drive or a drum).

6. All time-shared systems had a disk or a drum.

7. The two "highest-priced" systems ($91-93,000) were both manufactured by Hewlett-Packard. One has batch oriented and the other time-shared.

8. Although equipment from General Electric, Wang Laboratories, Xerox and Honeywell was included in the evaluation, the "big three" minicomputer vendors (DEC, Data General, and Hewlett-Packard) ended up as the only manufacturers represented.

9. Every installation planned to use BASIC, nine as the primary language. About half felt at least some FORTRAN was important.

Some Conclusions and Suggestions

The major findings of the experiments are presented here with an aim to assist other institutions considering a minicomputer for instructional use. A basic conclusion, expressed unanimously by the ten somewhat varied types of undergraduate institutions, is that a mincomputer system is the best buy source of computing power for most instructional activities. The combination of low cost, constant availability, control, and the many advantages of an on-campus facility make the minicomputer a preferred choice over known off-campus alternatives.

Many conclusions have a financial basis. Cost statistics and equipment configurations are summarized here. Table I of [SWOYER] shows the minicomputer system purchased by each institution, its purchase price (in 1970, for most equipment), and average annual costs. The average annual costs are broken down as "equipment" "salaries and benefits," and "other" components, and include calculation of annual costs per enrolled student. The latter figure corresponds with a "rule of thumb" statistic calculated in a number of previous experiments and projects. It is useful as a rough guide. In this instance, it must be noted that the annual costs per student include all costs, not simply equipment costs. The figure ranges from $5.40 to $33.24 per student per year, of which equipment costs (often the sole basis for calculating cost per student) range from $2.80 to $17.10 per student per year. In all, it may be noted that 12,450 full-time students were enrolled collectively by the ten institutions, with a mean total annual cost per student of $17.52. (Of that total, $9.30 is the mean annual cost per student for equipment.) The institution which had prior experience using one or two interactive terminals to a remote time-sharing computer, felt the minicomputer source was unquestionably superior. In addition to cost savings (institutions here, and in previous NSF experiments had experienced average annual costs of about $19 per student), greater availability, and other obvious advantages cited above, there was an expressed academic advantage. This is hard to quantify, but includes the advantage of having a facility on which software changes, operating system experiments, and other developmental activities can take place which would not be possible on a large or non-institutional facility. In addition, the on-site system created an atmosphere or center of activity supportive of creative thinking about computing.

Prior to the experiment, the colleges established rough budget guidelines for the various levels of minicomputer systems. The mean estimated total annual cost was $28,130. The actual mean total annual cost turned out to be $21,810. The average annual cost per student was estimated in advance to be $21.42, which compared to the actual cost of $17.52. Thus is was observed that costs were actually somewhat lower over three years than projected.

Equipment costs were found to average 53% of the total expenses. This component of the costs ranged from $4,700 to $22,000 per year with a mean of $11,580. It would be expected that costs for comparable systems would be somewhat below these figures today, although one must not hastily apply a factor of, say, 50% (which may accurately reflect the comparable price of a processor unit today versus

1970) too broadly. Processors and memories have come down in cost drastically. However, most mechanical devices (such as disk drives, tape drives, card readers) have experienced less reduction. Maintenance costs, included here as equipment expense, have increased. Overall, the minicomputer system of today should probably cost about 80% of the comparable 1970 version.

Other costs, however, have increased. Salaries, benefits, publications, and travel expenses generally total about 25% more than in 1970. Supply costs are 100% higher for paper items than just two years ago. Since salaries and benefits constitute 27% of total annual costs, and "other" costs (largely supplies and institutional overhead) represent the remaining 20%, the end result of a new 1974-75 operation should have a price tag close to par with 1970 costs.

The institutions were queried, after the fact, about typical questions, which might be asked by prospective institutional minicomputer users, and what the answers to those questions should be. The following are some typical questions, with responses, which could be asked by institutions exploring minicomputers.

Question 1: What is the most common oversight when planning a college minicomputer operation?

Response: Underestimating the amount of time needed by the person (faculty member) responsible for the operation, especially during the first year. A minimum of 50% of full-time should be allocated, with more time available during the first year, if possible.

Question 2: What is the primary equipment difference that most colleges would opt for if they could redesign the system after several years experience?

Response: The most common change would be a computer with a larger memory. (Eight of the ten institutions gave this response.)

Question 3: What vendor would you choose if you were to "do it over?

Response: Curiously, the response to this question, in 1973, was a preference for the same vendor as previously used. Some qualifications were attached, indicating that perfect satisfaction was not always present.

Question 4: How many students may be adequately supported by one interactive BASIC terminal?

Response: (Answered by the five institutions with interactive minicomputers.) Two institutions responded with 22 to 25, with three institutions answering 10 to 15. The variability reflected the amount of computing required of the "typical" courses. The same question has been addressed by other institutions with interactive experience. A consensus indicates 22 to 25 students per terminal to be a maximum number in a course with modest assignments. More institutions prefer a terminal to serve no more than 15 students in a computing course.

Question 5: Is there a high risk of equipment failure with a minicomputer? Is a maintenance contract a necessity?

Response: Component failure in equipment other than teletypes, card readers, disk drives, and tape drives are almost non-existent. Following an initial shake-down period (three to six months), every institution that shifted to "on call" service, in place of a monthly contract, reduced its maintenance costs. In most cases, the reduction was more than 80%. The consensus favored maintenance contracts only for mechanical components (if at all) with maintenance of teletypes separate from vendor-supplied service contracts in any event.

Question 6: Was there any indicator that would tend to identify in advance whether an institution would have a successful minicomputer operation?

Response: All institutions achieved successful operations, within a variety of objectives. The quickest achievement of a satisfactory smooth operation (which would probably also tend to maximize successful instructional use) occurred at institutions where (1) prior faculty/staff experience with computing existed in some numbers (10% to 20% of faculty prior to arrival of the minicomputer, and (2) ample time was provided to allow at least half his time to develop the facility.

Question 7: What are recommended steps in computer selection to assure a reasonable choice of equipment?

Response: If satisfactory computing service is a primary objective, don't be a pioneer. One institution's hints were: (a) buy from an established vendor. (b) Select a time-tested mainframe and peripherals. (Personal visits and calls on customers with the same equipment are strongly advised.) (c) Stipulate in the contract that all hardware and software must be in full operation on-site before any payment is made. Another institution suggested asking vendors for sample systems to run experimentally for a test period. Still another suggested that primary attention should be paid to the availability of time-tested software in the areas of most interest.

Proposed New NSF Support Program

The National Science Foundation is currently considering a new program which has a catchy acronym,namely, MICAT. It stands for "Minority Institutions Computing and Technology.

The emphasis of MICAT is on the development of high quality, culturally specific, computer-based instructional programs. The program takes into consideration the fact that the learning processes for minority group members are different from Anglo-Americans. Thus, the primary thrust of MICAT is on the development of specialized courseware and instructional techniques tailored to specific educational needs and cultural characteristics of minorities. The minorities of concern are Native Americans, Blacks, Hispanics, Asians, geographically isolated Americans, and others which are under represented in scientific careers.

MICAT purports to provide support for the following activities:

1) faculty training programs in computer use technology to the extent that they can adequately select equipment, modify existing courseware, and develop new culturally revelant courseware;

2) dissemination activities which include the establishment of specialized courseware libraries for use by other similar minority institutions and a visiting scientist program to further support faculty courseware development activities;

3) development of well conceived programs of instructional computing on the campuses of Minority Institutions which include both science and non-science majors;

4) provide minimum but adequate computing capability for instructional computing and courseware development efforts;

5) conduct evaluation activities which will focus on the impact of integrating computer techniques into the instructional programs of each group of Minority Institutions independently.

The training and dissemination activities will be supported through lead institutions, or equivalence, which will serve as Centers for Technological Resources (CTR's) for the other similar minority institutions. The other activities will be supported through individual grants to Minority Institutions where appropriate.

Additional information on MICAT will be made available when, and if, the NSF makes it's decision in this regard.

References

ENGEL: Final Report on the College Consulting Service of the Association for Computing Machinery, National Science Foundation Grant GY-7052.

SWOYER: "Use of Minicomputer Facilities for Higher Education Instruction", Southern Regional Edcuation Board, Atlanta, 1975, NSF Grants GJ-1072, 1111, 1116-22, 1139-40.