Campus Computers: NAS Panel Calls for More Federal Aid

The rapid growth in computer capacity at colleges and universities must continue if the growing demands of research and education are to be satisfied, according to a report just issued by the National Academy of Sciences.

The report,* prepared by an NAS *ad hoc* committee under the chairmanship of J. Barkley Rosser of the Mathematics Research Center, University of Wisconsin, recommended that between fiscal 1964 and 1968 the annual budgets for campus computers and the total investment in computers should be more than doubled. Great as they are, the investment increases projected by the panel would be at a rate only about half the rate of investment increase in the past. The projections are considered quite conservative and should be viewed with caution.

In 1957 there were 40 computers on U.S. campuses. In 1964 the number had increased to 400, representing an investment estimated at $250 million and requiring an annual expenditure of about $130 million. The Rosser panel would have the investment grow to $528 million by 1968 and the budget to $300 million. The panel recommended that federal facilities grants and research funds to pay computer costs be increased from $65 million in fiscal 1964 to $180 million in 1968. (These funds were up to $87 million in 1965.)

The report's statistics and recommendations would be more valuable had there not been a lapse of more than 2 years between December 1963, when the main body of the study was completed, and publication of the report. An appendix updates some of the data to February 1965, however, and the report provides a useful review of some current and future computer applications in science and engineering.

The members of the panel, drawn from a variety of disciplines, were asked to examine the need for computers in their particular specialties. Accordingly, the report briefly discusses computer requirements for research in physics, chemistry, astronomy, space science, the earth sciences, medicine and the life sciences, the behavioral sciences, and engineering. In addition, separate chapters are devoted to the development of computer science and to the use of computers in education.

The nation-wide investment in computers, which had reached $700 million in 1958, soared to more than $7 billion by 1965 and—according to an early 1965 projection—will exceed $13 billion by 1968. Although only about 4 percent of the computers have been located on college and university campuses, the first computers were conceived and built at universities, and campus computing centers are developing programs to make the machines more accessible and useful to a variety of users. In order to hasten the stimulating effect of computers on the economy and on scientific and technical endeavor, the discovery and implementation of new uses for the machines should be deliberately fostered through education and research, the Rosser panel said.

Allocation of the increase in campus computer capacity proposed by the panel was recommended, rather vaguely, as follows: (i) the capacity for handling research needs of faculty and graduate students should be nearly doubled (about 85 percent of total capacity in 1964 was devoted to meeting research needs); (ii) the number of undergraduates trained annually to use computers in their later professional work should be more than doubled from 1964 to 1968 (such training represented about 10 percent of the 1964 campus computer effort); and (iii) the number of students trained annually as computer specialists and the support of computer science should be increased as rapidly as possible (these activities accounted for about 5 percent of the 1964 effort).

"Government agencies should cooperate in helping a number of strong campus research efforts in computer science to grow at an expanded rate and to develop into regional centers," the report said. "These centers may supply computing service for their own and for nearby institutions. . . . The research groups at these centers, with several directions of emphasis, would play major roles in originating and developing new programming systems and languages (software), new ideas for auxiliary and remote equipment (peripheral hardware), unified planning of hardware and software (coordinated design), and particularly the advanced education of computer specialists." The cost of strengthening and equipping about half a dozen regional centers would rise to at least $10 million a year by 1968, the panel said.

To strengthen campus computer programs it was also recommended (i) that general support be provided for novel, unforeseen research activities which, because they are not part of established programs, are unsponsored, and (ii) that the eight or more federal agencies contributing to the support of campus computer facilities should coordinate their support and join with the universities to work out satisfactory funding and auditing procedures. The report discusses funding procedures in detail.

In a letter accompanying the report, G. B. Kistiakowsky, chairman of the NAS Committee on Science and Public Policy, sounded a note of caution. He said his committee concurred with the report's central theme that computers have become an indispensable part of a wide range of scholarly activities and that their use must increase faster than the activities themselves if increasingly complex scientific and educational problems are to be solved. "We are concerned, however," he added, "that an ever-expanding use of computers for the solution of scientific problems might change the nature of problems that active scientists choose for study, and thus change the whole nature of scientific research.

"We are concerned lest this trend

* Entitled "Digital Computer Needs in Universities and Colleges," the report is available from the Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, D.C. 20418. Members of the committee, in addition to Rosser, were: Hendrik W. Bode, Bell Telephone Laboratories; Gerald M. Clemence, Yale University Observatory; W. J. Dixon, School of Medicine, University of California; Thomas A. Keenan, Computing Center, University of Rochester (executive director); F. A. Matsen, department of chemistry and physics, University of Texas; Philip M. Morse, department of physics, M.I.T.; Walter A. Rosenblith, department of electrical engineering, M.I.T.; Arthur H. Rosenfeld, department of physics, University of California; William R. Sears, Graduate School of Aeronautical Engineering, Cornell; Herbert A. Simon, Graduate School of Industrial Administration, Carnegie Institute of Technology; John W. Tukey. department of mathematics, Princeton; and James T. Wilson, Institute of Science and Technology, University of Michigan.

cause too many scientists to forget what a fabulously good computer the human brain is," Kistiakowsky continued. "We, therefore, strongly endorse the emphasis in the report on the need for better education of scientists in the use of computers. Only those who fully understand the limitations of computers as well as their potentialities can make good scientific use of them. The computer gives certain insights, and it is by no means correct to assume that these insights are identical with those given by the classical mathematical analysis. We believe that science would be much the poorer if, in the course of being computerized, the unique power of mathematical analysis to illuminate physical situations were seriously weakened. We, therefore, urge that, along with increased emphasis on computers in universities, there be an increased emphasis on education in classical applied mathematics."

Needs Underestimated

Kistiakowsky said there is increasing evidence that needs for computers for formal undergraduate and graduate instruction were underestimated by the Rosser panel. "Furthermore, computer education, especially at the undergraduate level, will have a heavy multiplying effect on the demand for computers in graduate education and basic research within a few years," he said.

A more intensive examination of the need for computers for education, as distinct from research, is being made by a panel of the President's Science Advisory Committee. The panel, chaired by John R. Pierce, research director for Bell Laboratories' communications sciences division, began work a few months ago and is expected to report to PSAC by fall.

One of the problems to which the panel is addressing itself is that of computer time going unused because universities lack the money to pay for it. The difficulty arises from a regulation of the U.S. Bureau of the Budget. A university with a computer used in government-sponsored research must charge all other users, including students doing class assignments, at the same rates it charges for time used in the sponsored research. In other words, charges must be nondiscriminatory and fixed on an average-cost basis. The resultant problem, though confined to institutions which do substantial amounts of government work, can be severe. As student use of the computer increases, the rates chargeable for computer time used in government-sponsored research decline; consequently, the institution must find more money from other sources in order to cover the costs of its computer facilities.

Edward A. Feigenbaum, director of the Stanford Computation Center, has become highly exercised about the matter. "It has become a national scandal," he told a recent meeting of Stanford deans and administrators. "The lost computer time is unrecoverable. It is gone forever."

The Stanford Computation Center's budget plan has been based on the expectation that unsponsored computer research will double every 2 years. But this year's demand for unsponsored use already is twice that of last year. The nearly $150,000 budgeted this year for unsponsored computer research by students and faculty was exhausted by mid-December. Of an additional $150,000 budgeted for homework and other instructional use. $65,000 had been spent. Two-thirds of the $300,000 total was made up of Stanford's own funds. The rest came largely from private gifts and from a National Science Foundation grant restricted to the support of unsponsored research.

"We've been asking everyone to hold their demands to a minimum, and they have done so," said Feigenbaum. "If they hadn't, the cost for the year could easily rise to $300,000 for instructional use alone."

The rapid growth in student use of computer time at Stanford is suggestive of what is happening at many major institutions. "During the fall quarter 1000 students used the computer to do homework in 44 different courses," Feigenbaum said. "These were standard problems, assigned by professors to be done on the computer. In many fields, civil engineering for example, you can't work with pencil and paper anymore." Stanford plans to provide almost $250,000 of its own funds for unsponsored computer use next year, but the need for additional funds will be great.

Several ways have been proposed for making computer time more abundant for unsponsored users without putting a financial strain on the universities. Feigenbaum has suggested charging sponsored users commercial rates, which are nearly twice as high as Stanford's. But this would be contrary to the Budget Bureau's "average cost" principle and would increase research costs. Another idea, also in conflict with the Budget Bureau principle but one not likely to affect research costs, is simply to provide "free time" for student use of the computer.

A third proposal, and the one perhaps most likely to be favored by the PSAC panel, is to retain the average cost concept while having the government initiate a program to provide money for student use of computers. In this way, rates would be reduced for everyone. To a good extent, such a solution would amount to a bookkeeping transaction, as the government would save on contract research much of what it paid for student computer time. There would be an increase in the cost of operating the computer facility, however, in that expenses would rise as more computer personnel and materials became needed for longer and more intensive use of the machines.

David Z. Robinson, of the White House Office of Science and Technology staff, said that the PSAC panel, which he is serving as technical assistant, has not decided what the government should do to help the universities provide more computer time for education. The present Budget Bureau policy of insisting on equal rates for users is logical and philosophically consistent, Robinson emphasized, however.

Computer Networks

The PSAC panel also is being urged to consider ways of reducing communications charges for colleges and universities which create computer networks. By pooling their resources, several institutions can enjoy the benefits of computers too costly for any one of them alone to purchase and operate. For example, last week it was announced that Duke University at Durham, the University of North Carolina at Chapel Hill, and North Carolina State University at Raleigh, the three points of the "Research Triangle," have received NSF grants totaling $1.5 million for the establishment of a large computer center. The center will be available for use by colleges and universities throughout North Carlolina.

If computers are not yet ubiquitous in higher education, their fast widening use is indicated by the fact that, even 4 years ago, 92 engineering schools with more than 130,000 undergraduates enrolled were requiring the use of computers in either all or some of their departments. As the NAS panel observed, though many people are aware that the computer will affect the nation's socio-

economic structure profoundly, even the well-educated often still think of the computer as a "magical box."

The recommendations of the NAS panel, as well as those likely to emerge from the PSAC panel's study, are intended to promote policies which will dispel the mystery and make the computer an instrument familiar to nearly all students and to most of their elders in the academic community.

—LUTHER J. CARTER

Announcements

The University of Minnesota has established a center for research in **human learning**, supported by the university's graduate school, NSF, and the National Institute of Child Health and Human Development. The center will be composed of staff from the departments of psychology, educational psychology, and child development and from the center for programmed instruction. NIH is offering fellowships for the training program at both pre- and postdoctoral levels. Additional information is available from James J. Jenkins, director of research, Human Learning Center, University of Minnesota, Minneapolis 55455.

Grants, Fellowships, and Awards

The American Microchemical Society is soliciting nominations for its recently established award for "outstanding contributions to the practice or teaching" of **microchemical techniques**. The recipient will deliver a lecture at a meeting of analytical chemists. Nominations should consist of letters, of up to 300 words, citing the nominee's work and giving his name and address. Deadline: *1 April*. (D. B. Sabine, U.S. Vitamin and Pharmaceutical Corporation, Yonkers, New York)

The National Institutes of Health is accepting applications for July 1968 appointments of clinical, research, or staff associates to work in **research and clinical investigation** programs in Bethesda, Maryland. Persons who will begin their internships this July and those who have had more advanced training will be accepted. The recipients of the appointments may be considered for PHS inactive reserve commissions, and for residency deferment under the Commissioned Officer Residency Deferment program, until the effective date of their NIH appointment. Deadline: *9 May*. (Roger Black, Clinical and Professional Education Branch, NIH, Bethesda, Maryland 20014)

The Atomic Energy Commission's division of biology and medicine is offering research contracts to scientists in the various aspects of **radiation biology** for preparing and publishing reviews of scientific areas related to its biomedical research program. Applicants should be prepared to take a 6- to 12-month leave of absence from their regular duties. The division conceives this type of review not as a condensation of existing literature, but as a work which, within its field, "defines the scientific objectives of the field, examines the prevailing concepts or hypotheses, and considers critically the state of existing knowledge." It also offers the opportunity to synthesize new concepts. The contracts pay full salary, travel, and secretarial costs. (Director, Division of Biology and Medicine, AEC, Washington, D.C. 20545)

Courses

Rose Polytechnic Institute will present a series of seminars in **relativity and cosmology**, 13–25 June, in Terre Haute, Indiana. The course is designed for college and university teaching and research staffs; a limited number of advanced graduate students will also be accepted. Financial support for participants may be available. (R. Llewellyn, Physics Department, Rose Polytechnic Institute, Terre Haute, Indiana 47803)

MIT is planning a course on "on-line **computation and simulation**," 22–26 August, in Cambridge. Work will include the on-line OPS system, which was developed in MIT's project MAC and covers a variety of information-processing activities. The program will also take in simulation strategy which becomes important when model construction and running interact. Enrollment is open to people in research and in computer system planning. (Director of the Summer Session, Room E19-356, MIT, Cambridge, 02139)

The Society of Photographic Scientists and Engineers will sponsor a seminar on **photographic systems** for engineers, 11–12 May, in San Francisco. The course is designed for nonphotographic enginers and senior technicians who use photo-optics in their jobs. Emphasis will be on photographic processes and techniques and their applications in measuring, data collection, and information storage methods. Attendance is limited, and advanced registration is required; registration, $30. (Society of Photographic Scientists and Engineers, 1330 Massachusetts Avenue N.W., Washington, D.C. 20005)

A **histochemistry** course for college and university zoology teachers will be offered by Vanderbilt University 31 July to 20 August. Applicants must teach at least one course in some area of zoology and must be interested in histochemistry teaching or research. There will be no tuition fee, and living and travel expenses for 20 participants will be paid from an NSF grant. Application deadline: *1 May*. (B. J. Bogitsh, Box 1733, Station B, Vanderbilt University, Nashville, Tennessee

A course in **cancer chemotherapy** will be held at the University of Texas, 9–21 May. It will review the antimetabolites, alkaloids, alkylating agents, antibiotic hormones, and several newer drugs; it will also include the current approaches in assessment of clinical drugs and management of the cancer patient. (Division of Continuing Education, University of Texas Graduate School of Biomedical Sciences, Texas Medical Center, Houston 77025)

Meeting Notes

An international symposium on **mathematical and computational methods in social sciences** will take place in Rome 4–8 July. The sponsors are the International Computation Center of Rome and the Centre de Calcul, Paris. The meeting will be organized in four sections: anthropology, archeology, psychology, and sociology. (P. Maranda, Department of Anthropology, Peabody Museum, Harvard University, Cambridge, Massachusetts 02138)

The Instrument Society of America is planning its national **analysis instrumentation** symposium 11–13 May in Houston, Texas. Papers are solicited in laboratory and process chromatography; radiation, optical electromechanical, chemical, or physical methods; and sample-handling techniques. Abstracts of 300 words are required.