Rx: For instrument senility, try creative financing

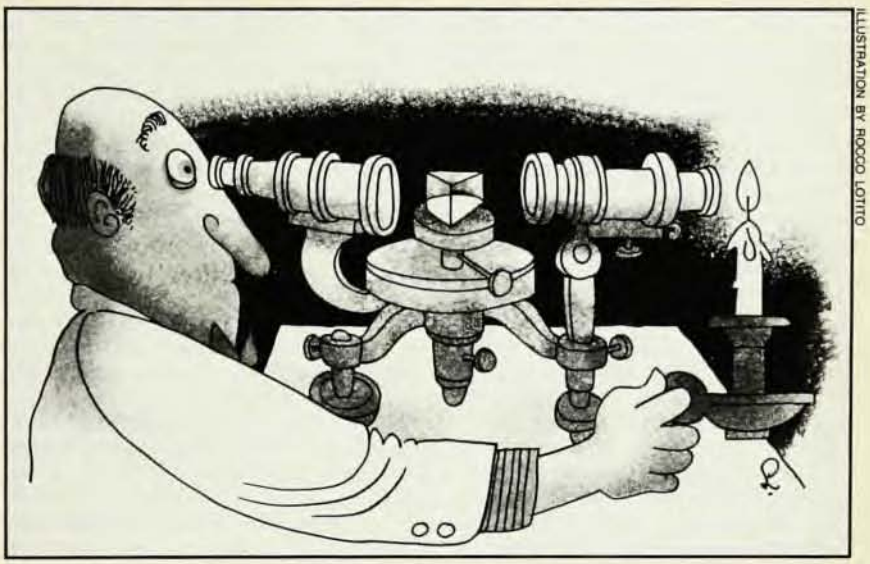

ILLUSTRATION BY ROCCO LOTITO

The condition of equipment in our university teaching laboratories was recently called "a national disgrace" by Mildred Dresselhaus (MIT). She said, "Our students would be privileged to use the labs they have in West Germany." Continuing inflation has made the problems of university administrators more acute, as they are asked to contend with an increase in competition for limited sources of funding and a decrease in available capital, combined with increases in both the acquisition costs for new equipment and the costs of maintaining them.

An ad hoc Working Group on Scientific Instrumentation, within the National Research Council, and an Interagency Working Group on University Research Instrumentation, led by NSF, are both addressing the question of how to meet the scientific instrumentation needs of university researchers. Both working groups have recognized the tight Federal budget situation and have used recent meetings to explore potential solutions for university equipment problems other than a large influx of Federal dollars. Included among the preliminary recommendations of the groups are suggestions for using new arrangements for financing equipment, increasing cooperation among users, more centralization, and seeking both tax and regulatory relief from the Federal government.

Last year, the Association of American Universities conducted a study for NSF that delineated the scientific instrumentation needs of research universities. The study, which examined the facilities at 16 of the major research universities, six national laboratories, and nine commercial laboratories, found that university equipment was twice as old as the equipment in industrial labs. Another way of quantifying the problem was used by Donald Langenberg, deputy director of NSF, in his testimony to Congress on 4 March. Langenberg stated that it would require an investment of $1–4 billion to make up the shortfall that has now accumulated in university research equipment. After this investment, action would still be needed to keep instrumentation at universities from once again slipping into obsolescence. But, says Robert Park, chairman of the Department of Physics and Astronomy at the University of Maryland, "It is unrealistic to suppose that either sum of money could be made available under present circumstances."

The interagency working group on scientific instrumentation, under the chairmanship of Langenberg, held its first meeting last August. The group is composed of the highest political appointee from each of the government agencies with a significant research budget (Richard DeLauer, Under Secretary of Defense for Research and Engineering, Alvin Trivelpiece, Director of the Office of Energy Research in DOE, Edward Brandt, Assistant Secretary for Health in the Department of Health and Human Services, Anson Bertrand, Director of Science and Education in the Department of Agriculture, and Hans Mark, Deputy Administrator of NASA); George Keyworth, the President's science adviser, attends the meetings as an observer.

This group supported and promoted some initiatives that already appear in the FY 1983 budgets of the agencies. The Department of Defense, for example, has requested an additional $30 million for scientific instrumentation in FY 1983. This money will be used to support instrumentation at universities for work in fields of interest to DOD; this is separate from and in addition to any funding for instruments derived from contract research.

At their most recent meeting on 24 May, the group decided that alleviating the scientific instrumentation problem would require a coherent national program. In formulating this program they suggested that certain policies be adopted, and they made specific recommendations about the implementation of these policies. They agreed that:

- Data about the status of scientific instrumentation needs continue to be acquired and maintained. NSF has funded a pilot project in its Science Resources Studies Division to determine something like a scientific price index, and it now plans to implement such a program.
- Agencies should take initiatives, within their constrained budgets, to help the scientific instrumentation situation.
- Some or all of the money that would be set aside from agency research budgets for small business R&D, if a recent

0031-9228 / 82 / 0700 55-04 / $01.00

bill passes Congress, should be used for small businesses that manufacture scientific equipment.

- The agencies should encourage corporations to donate equipment to universities. They suggested that the agencies provide leadership to maximize donations by making corporations and universities aware of their mutual interest, and they proposed establishing an exploratory project with the Scientific Apparatus Manufacturing Trade Association to this end.
- The government should stimulate the use of creative financing by universities.
- The universities should improve their management of research equipment.
- The Administration should provide incentives for universities to acquire equipment. They specifically recommended revising the Office of Management and Budget's Circular A-21 to allow interest on loans to be considered an allowable cost in figuring indirect costs.
- The agencies should stimulate additional use of government laboratories by university researchers. They suggested more publicity was needed about already existing programs to encourage university faculty to use these facilities.
- The government surplus property distribution system, whose present regulations restrain free distribution of technical equipment, should be improved to enable university research labs to benefit from these surpluses.

In addition to these recommended actions, Jack Talmadge, executive director of the interagency working group, told us they are looking for ways to get responses from university administrators and researchers concerning specific helpful policy changes and particulars about the problems that universities are facing. (Write to John Talmadge, NSF, 1800 G Street N.W., Room 416, Washington DC 20550.)

The NRC working group is organized under the leadership of an executive committee composed of three physicists—William Fowler, professor emeritus of Caltech; George Pake, Vice President of Research at Xerox Corp; and Park, University of Maryland. More than 50 research administrators from industry, universities and government met recently to evaluate the problems and advise the National Academy of Sciences and Engineering about what action they could take. Industrial, university and government agency caucuses were held, each of which tried to explore the reasons for the encroaching obsolescence of university scientific instrumentation as a jumping-off point for determining possible solutions. This meeting proved to be so fruitful that NRC prepared a report summarizing its conclusions, entitled "Revitalizing Laboratory Instrumentation." NRC will soon be distributing it to universities that perform research.

As part of the industrial caucus, led by Pake, Robert L. Melcher (IBM) defined what he termed a scientific price index: He explained that he had compared what it cost IBM to maintain state-of-the-art equipment in 1975 with what it cost in 1981. "What we found was that the inflation rate for scientific equipment was 16.4% per year," Melcher said. "The consumer price index over that period inflated at about 9.9% per year, and so what we are calling the scientific price index inflates on a per annum basis at a rate about 70% higher than the CPI."

The AAU study showed that there had been a leveling off, in constant dollars, of the Federal government's investment in university R&D throughout the 1970s. Meanwhile, capitalization costs were escalating rapidly, and in fact, doubled from 1975 to 1979 for equipment at major industrial research laboratories. John Vaughn, executive assistant to the president of AAU, told us that the tremendous increase in the sophistication of necessary instrumentation compounds this problem. In addition, because of continuing inflation, many researchers and administrators, forced by budget restrictions to choose between personnel and equipment, have repeatedly scrapped equipment from their grants to keep research teams together.

The equipment needed to advance frontline research has become more sophisticated and expensive. Inflation has eaten away at both the amount of money available and what each dollar will buy, and the Federal government, the major source of capital funds for university research equipment, has leveled off its investment in university R&D. These factors act in concert to constrain the money available for investment in research instrumentation at universities.

Trivelpiece, speaking to the Federal agency caucus of the NRC group, said that government agencies were willing to make changes in the percentages of their budgets invested in instrumentation, "but it is going to be a zero-sum game, to a first approximation." Trivelpiece was among many speakers to discuss the use of creative financing options open to universities, as a means of alleviating the limitations imposed by the lack of capital funds. He cited the purchases by Lawrence Livermore Laboratory (operated by the University of California) of two Cray-1 computers as an example of this type of financing. Livermore used a lease-to-ownership approach; this allowed DOE to use their operating funds instead of capital funds to finance the purchase of multi-million dollar equipment, through a bank, over several years, while taking tax advantages available to the University as a nonprofit corporation.

According to the NRC working group, employing some type of "risk management" policies to deal with debt financing would allow university administrators to become more flexible and more effective in their long-range financial planning. The group saw universities as having certain management traditions: thinking of equipment as belonging to one department or other, for example, not taking full advantage of their non-profit status, and allocating equipment purchases annually to specific projects, instead of thinking of the equipment as being for the university research enterprise as a whole. These traditions prevent the university from responding as flexibly and creatively as they could to the tightening budget situation.

Robert Scott, director of finanical systems at Harvard University, told us of some of the possible financial arrangements. Universities could acquire equipment and manage the financial accounting differently. For example:

- They could allocate costs among different uses or departments.
- They could lease equipment.
- Instruments could be acquired from others through cooperative ownership or partial donations.

Scott advocated using some combination of these arrangements. He said further that proposed revisions to the Office of Management and Budget's Circular A-21 (PHYSICS TODAY, February 1981, page 57) would permit universities to consider interest from loans as part of their indirect costs on a project, thus making debt financing more attractive to them. These financial arrangements do not "create" funds. Scott said, "You could get into a bad situation, however, if you borrowed too much and your income (the amount of your grants) is much less than you anticipated, then your ability to maintain the equipment could be threatened. This is the risk you take."

Other financial options available to universities include the use of revenue bonds, industrial development bonds, municipal leases and revolving lines of credit (where the interest is exempt from state and Federal taxes). George Olson (Colorado State University) explained how his institution had successfully employed some of these options to acquire Cray-1 computers for use by the National Center for Atmospheric Research in Boulder. Olson said that an industrial development bond (a bond issued by a city or county on behalf of someone else, in this case a Colorado State University research foundation), permitted CSU to buy the computer

with financing at 6.2% interest, and to lease it to NCAR, charging all interest and financing costs to the leasing contract. He estimated that this financing saved them about $2 million. CSU used a similar approach to acquire Cyber 205 computers for its own use, at a cost of approximately $12 million.

Donald Shapero (Office of Physical Sciences at NRC) told us that the NRC executive committee is now working with the AAU to set up three regional workshops to be held this fall. The workshops will inform the university research community about some of the financial planning options and will continue the dialogs, begun in these caucuses, between corporate, academic and government research planners.

Additional recommendations by NRC include increasing the use of block grants and centralizing large equipment. Block grants were viewed by the group as an effective mechanism for facilitating the long-range planning of equipment purchases. While there was a general consensus recommending increasing their use by universities, some people expressed concern that block grants had sometimes been used to support less successful researchers who would otherwise not have been given funds; on the other hand, block grants do provide the flexibility needed to initiate research in new areas. The lack of such flexibility induces excessive conservatism and encourages the tendency to support areas of research that have been supported in the past.

Sharing centralized research facilities is attractive financially. The cost of acquiring and maintaining the instrumentation is split among users, and travel to the facility is usually much cheaper than duplicating the equipment on campus. Fowler told us of his concern about going too far with centralizing facilities. He noted that in elementary-particle physics, in particular, groups of university researchers queue up for time on research equipment at national laboratories; this has been accompanied by reductions in funding for scientific instrumentation for on-campus equipment. Fowler said, "I strongly feel that we cannot let on-campus physics research be banished from scientific research in this country. I believe in the system we have, where there is a truly remarkable balance between experimental research conducted in universities, in corporate labs and in government labs." Others express the concern that going too far with centralization would pose additional problems for training scientists. Students are traditionally given low priorities on queues; many feel that graduate students also need interaction with each other in order to learn, and this would be largely unavailable at centralized facilities. —JC

SELBY

No Federal aid for precollege science

A new Sputnik is challenging scientific industry and education in the US. There is a shortage of engineers and technicians so severe and a decline in pre-college math and science education so ominous that President Ronald Reagan recently described the problem as "serious enough to compromise America's future ability to develop and advance our traditional industrial base...." The statement came in a message he sent to a National Convocation on Precollege Education in Mathematics and Science at the National Academy of Sciences in May.

In 1958, the year after the Soviet satellite was launched, the Eisenhower administration responded to inadequacy in science and math education by pushing Congress to pass the National Defense Education Act and to appropriate extensive funds for education to the National Science Foundation. The present administration eschews any parallel effort. Reagan has cut the dwindling NSF budget for education from $80 million to $15 million, none of which will go to precollege programs (see PHYSICS TODAY, May, page 77). His explanation was: "This administration has deliberately suspended what had become a proliferation of small Federal programs which—taken together—showed themselves to be ineffective in stemming the slide in science and math performance that has been evident for at least a decade."

Reagan and Secretary of Education Terrel H. Bell, who spoke at the convocation, maintained instead that effort must come from US industry and from local governments—the "grass roots"—because the US citizenry is dissatisfied with big government. After persistent questioning, Frank Press, NAS president and convocation host, said that that solution is "unrealistic" because the amounts industry can be expected to contribute fall far short of the billions needed.

Shortages. Paul DeHart Hurd (Stanford University) amplified on the continuing decline in the quantity and quality of science and math education over the last decade:

▶ Elementary-school children receive, on the average, one hour of science and four of arithmetic out of 25 weekly instructional hours.

▶ Only 34% of high-school graduates complete three years of math; only 8% finish a course in calculus. (In fact, only 31% of high schools offer calculus.) No more than 19% and possibly as few as 10% of high-school graduates take physics.

▶ Between 1963 and 1980, mean SAT scores in math declined from 502 to 466. Meanwhile, the portion of those tested receiving math scores lower than 300 rose 38%.

▶ During the 1970s the number of high-school math teachers being trained declined 77%.

▶ One-half of the nation's high-school math teachers hired in 1981–82 are "unqualified" and are teaching, with emergency certificates, subjects they were not trained to teach. Even so, 22% of math teaching jobs are unfilled.

By 1980, as higher salaries in industry were continuing to attract potential teachers, 30 states, Hurd told us, reported shortages of math teachers, and 16 reported serious shortages. By 1981, out of 45 reporting states, 41 indicated shortages of teachers in math and in physics, he said.

According to Robert P. Henderson (chairman of ITEK), each year industry is short an additional 17 000 engineers. He anticipates a shortage of hundreds of thousands by the end of the century.

Economist Edward F. Denison of the Brookings Institution emphasized the serious implications of the President's message. He finds the economy in trouble particularly because of the poor prospects it shows for long-term growth. He contrasted the past few years with the period of notable growth that occurred from 1948 to 1973. In the earlier period, he said, increases in education contributed importantly to prosperity.

The reasons. While other speakers laid the blame for the present decline on diminishing Federal funding during the last 20 years, Bell and Press attributed the problem, in Press's words, to the "Vietnam War and the supposed animus toward science that it raised" and to "requirements for bilingual education, for vocational education, for special education for the handicapped and the underprivileged." Bell added that "quality, excellence, and effi-