to yield 4000 watts of electrical power. After some delays, caused in welding the solar cells and fabricating the electronics, the arrays are now undergoing final tests by the builders, the European Space Agency. Another hitch involving ESA concerned the photon detector tube on the faint-object camera, which was unable to withstand vibrations in a stimulated launch test, and had to be redesigned and rebuilt.

Since testifying before Congress in June, Beggs is more confident that NASA and its contractors have gone a long way toward correcting the problems, especially the management troubles. At both Perkin-Elmer and Lockheed, top executives are now responsible for making sure everything comes in on time and within budget. "It will be embarrassing to have to ask Congress for more funds," says Keller.

Costs to science. All systems are not Go yet. A number of critical components need to be developed and integrated into Space Telescope. Among these are the high-gain antenna, in-flight and ground computers and mission operations system that will link Space Telescope with the Space Telescope Science Institute, officially dedicated on 15 June in a spacious brick building in a leafy corner of The Johns Hopkins University campus in Baltimore. The institute, which is administered by the 16-member Association of University for Research in Astronomy, is organized to process proposals by astronomers to use Space Telescope, allocate time for research on it and gather and analyze data beamed back from space (PHYSICS TODAY, March 1981, page 59). The institute already has attracted a few detractors who complain about its growth in staff and its tendency to take on more functions.

Space Telescope itself has been a source of criticism from astronomers. By its lateness, it will miss the voyage around the sun of Halley's Comet, which will begin approaching Earth in November 1985 for the first time in 76 years and come closest in February 1986. By its astronomical cost, Space Telescope has forced NASA to cut back on the Solar Optical Telescope (PHYSICS TODAY, September 1982, page 17) and to raise questions about the starting time of the Advanced X-ray Astronomical Facility. —IG

Will school reforms follow the reports?

What more can there be to say about the sorry state of US public education? Since April, when the government's National Commission on Excellence in Education warned of a "rising tide of mediocrity," the public has been deluged with schemes for reform from educators, politicians and business leaders. Rounding up the usual suspects in the learning crisis is easy enough: the shortage of competent and committed teachers, the decline and breakup of the family that once instilled respect for authority and learning, the distractions of television and pop culture, the conflicting demands on public school systems that are now expected not only to teach but to make up for past and present racial and economic injustice. Coming up with properly financed, acceptable solutions to the complex problems can be far more difficult indeed.

What has been proposed in two new reports issued within two days of each other in September underscores the situation. In *Educating Americans for the 21st Century*, the National Science Board Commission on Precollege Education in Mathematics, Science and Technology gets behind the National Commission on Excellence in Education to push in the direction of rigid prescriptions. Both urge that more classroom time be spent on mathematics and science—at least an hour of math and half hour of science each day for every child from first through sixth grades, says the NSB Commission, and as soon as 1985 the national requirement for high-school graduation should be a minimum of 3 years of math, including a year of algebra, and 3 years of science and technology, with a term of computer science.

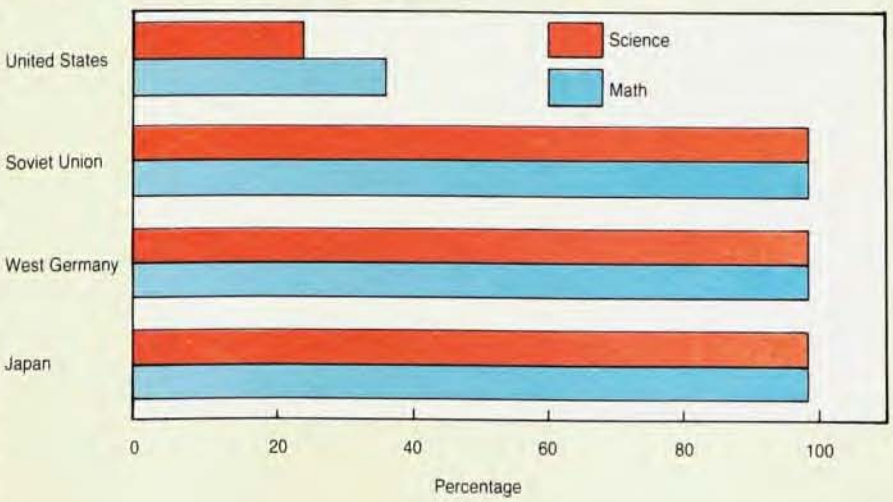
This is essential for updating the old "basics," the NSB Commission argues, because "the nation that dramatically and boldly led the world into the age of technology is failing to provide its own children with the intellectual tools needed for the 21st century." After a 17-month study of the situation, the commission, which was organized by NSB, the policy-making body of the National Science Foundation, put together an ambitious plan it claims is designed to make science and math education in US schools the best in the world by 1995.

In September's second examination of the problem, *High School: A Report on Secondary Education in America* (published by Harper & Row), Ernest L. Boyer, president of the Carnegie Foundation for the Advancement of Teaching, recommends a somewhat different strategy—a two-year science sequence that includes basic courses in the biological and physical sciences "taught in a way that gives students an understanding of the principles of science that transcends the disciplines." In addition, advanced science should be available as part of an elective cluster for students who want to prepare for college and careers. "Not all students are budding scientists," Boyer writes, "but becoming a responsible citizen in the last decade of the 20th century means that everyone must become scientifically literate. Having a substantial knowledge of scientific facts and processes, and understanding more about the interdependent world in which we live, are essential parts of the core of common learning."

Sad but true, a 1980 survey by the Carnegie Foundation found that 75% of public high-school seniors reported taking two years of science or less. For most this meant ninth-grade general science or environmental science and tenth-grade biology. Chemistry and physics attract only 37% and 22% of high-school students, respectively.

Better courses and teachers. The NSB Commission admits that promoting the

Percentage of high-school students taking 3 years of science and mathematics



study of math, science and technology requires "fundamental changes in both what is learned and how it is taught." The substance of math and science courses must be improved and updated, and more and better qualified teachers must be found, both reports emphasize. "The dearth of good math and science teachers has reached crisis proportions," Boyer declares in *High School*. "These shortages cannot be ignored. New patterns of employment must be explored. There is a vast reservoir of potential teaching talent outside the schools. . . ." Boyer advocates permitting highly competent professionals from business, government, universities and other centers of science and technology, retired or not, to teach, even part-time, and urges that teacher certification be modified to make this possible. Using virtually the same language, the NSB Commission recommends similar actions by state and local school boards and goes further by calling for additional training for most of the nation's 200 000 secondary math and science teachers "because of the rapid development of new knowledge."

Both reports also want to see calculators and computers introduced from kindergarten through high school—though both are equally cautious about their widespread applications. The history of technological innovation in classrooms is replete with failures. Boyer recalls that "virtually every new piece of hardware introduced into the schools in the past three decades has been oversold, misused and eventually discarded." The "teaching machines" of the 1950s gather dust in school storerooms. Educational television left little or no impact on schools and colleges. Language "labs" stood unused in schools from coast to coast while students recited lessons to their teachers. Computers may be no better, say the reports. Without thoughtfully designed instructional programs that are thoroughly understood and carefully applied by teachers and made a part of the routine curricula, computers are likely to be of no more enduring value to students than the latest arcade game.

Modernizing and strengthening the nation's schools will be both controversial and costly. The 20-member NSB Commission, headed by William T. Coleman Jr, former Transportation Secretary in the Ford Adminstration, and Cecily Cannan Selby, former dean of academic affairs and chairman of the board of North Carolina School of Science and Mathematics, calls on the Federal government to help finance 1000 "exemplary" elementary schools and the same number of secondary schools to emphasize math, science and technology. In a news conference, Coleman explained that exemplary schools do not mean "magnet" schools, which have been criticized as elitist, though both types, by their very nature, are considered powerful centers of academic change. The Federal cost for an exemplary schools program is projected at $276 million a year—for a total of $829 million in a three-year period. Like previous reports, the NSB Commission describes the shortage of good teachers as education's most critical problem—one that can only be solved by attracting better teachers with higher pay and status, while improving teacher training. As part of this proposal, the report recommends retraining teachers of math and science at summer and in-service institutes, at a cost of $698 million over five years, with the Federal government bearing half the cost.

The price tag on the NSB Commission's recommendations is $1.5 billion in the first year and as much as $4.6 billion over five years. Financing of such magnitude is unlikely to receive sympathetic reception by the Reagan administration, which insists that states and localities are responsible for public schools and once proposed to dismantle the US Department of Education altogether. The case against throwing Federal money at school problems was stated succinctly by the President's science adviser, George A. Keyworth II, on 30 September at a conference of the American Association of Physics Teachers at Arlington, Virginia.

Keyworth also claimed to detect in all the attention the reports on precollege education had received "something more important than new billion-dollar block-grant programs—a groundswell of public and political support for better education." One sign of this came last June when Congress restored the cuts the administration had inflicted the past two years on the National Science Foundation's education budget by authorizing $75 million for the agency's science-education programs in FY 1984. At the same conference, NSF director Edward A. Knapp announced that he was reestablishing the agency's directorate for science and engineering education, which had been abolished in March 1982. —IG

NAS physics survey picks up speed

At a simple ceremony near the Swiss border on 13 September when ground was broken for CERN's next electron–positron accelerator, LEP, French President François Mitterand boasted that the center now "holds a dominant place in the domain of high-energy physics." Mitterand's message does not escape members of the National Academy of Sciences physics survey committee, who are concerned about such matters as they examine the current health of US physics and seek to prescribe its directions for the next decade. Enormous progress has been made in physics since the last NAS survey, led by D. Allan Bromley of Yale in 1972.

Organized early this year under the chairmanship of William F. Brinkman of Bell Laboratories (PHYSICS TODAY, March, page 64), the committee and leaders of its seven panels gathered at the NAS building in Washington over the Columbus Day weekend in October to discuss drafts of panel reports and debate some sticky issues. Among the issues: the high proportion of foreign post-docs in US graduate schools, the absence of magnetospheric studies at universities and the recommendations by the Department of Energy's High Energy Physics Advisory Panel to kill the Colliding Beam Accelerator (once called Isabelle) at Brookhaven and to build a Superconducting Super Collider (often called Desertron), which is likely to recapture the lead in high-energy experiments that CERN now enjoys (PHYSICS TODAY, September, page 17). The committee does not necessarily have to endorse the conclusions of HEPAP, though it is likely to do so. It is certain to deal in its final report with such topics as new insights and projects that seem most promising (and, accordingly, should be high on the list for Federal funding), the need for cross-fertilization of different fields (to explore, say, many-body problems encountered, but only partially understood, in the liquid state, plasma and nuclear physics and even astronomy) and international cooperation in bold and costly frontier areas.

The seven panels and their chairmen are, in alphabetical order:

Atomic, molecular and optical—Daniel Kleppner, MIT

Condensed matter—Alexei A. Maradudin, University of California, Irvine

Elementary particles—Martin Perl, SLAC

Gravitational and cosmic—David T. Wilkinson, Princeton

Interfaces and applications—Watt W. Webb, Cornell

Nuclear—Joseph Cerny, Lawrence Berkeley Laboratory

Plasma and fluids—Ronald C. Davidson, MIT, and John M. Dawson, UCLA

Current plans call for publication of the committee's overview report in spring 1984 and the panel reports shortly thereafter. —IG □