

year, the technology is likely to be used "for at least the next 20 years," says d'Allest.

Still unknown is the impact that the effort required for the redesign of the ignition system will have on work that is already under way at SEP and elsewhere on the development of a much larger cryogenic engine, known as HM60. This is currently planned to be the main engine for the much larger single-stage Ariane V, which CNES hopes will be ready for launch by 1995 and will be man-rated, in order to carry the mini-shuttle Hermès.

The dangers that would be created by a similar malfunction in the HM60—recently renamed Vulcan—will be minimized by the fact that it will be ignited before the launcher leaves the ground. And Jean Sollier, the chairman of SEP, said last week that the new

work on the HM7 will provide useful knowledge for the development of the Vulcan engine.

However, he admitted that work on the Vulcan motor at SEP "will obviously be disturbed," and in particular that the skilled manpower and technical facilities available were likely to be stretched. "When you take a number of technical resources and dedicate them entirely to one project, then these resources are obviously not available to do anything else," he said.

The problem with the Ariane engines has come at a particularly critical time for ESA, which is still locked in an internal debate over the major directions of its space technology programs up to the end of the century. In particular, the prospects are growing for a heated battle for European-

level funding between the Ariane V/Hermès combination, and Britain's proposal for a horizontal takeoff launcher (HOTOL), whose engines would operate on very different principles (*Science*, 17 January, p. 209).

D'Allest of Arianespace is philosophical about the current problems with Ariane; "the technology in all these areas is such that we have to go slowly and envisage failures," he says, adding that "we are still signing launch contracts." D'Allest also denies the charge, made in an article in the *Los Angeles Times* last week, that the French government is taking seriously the hypothesis that Ariane might have been sabotaged. "All the tests which have been carried out so far have given no positive indication along these lines, and we see no reason to support such a hypothesis." ■ DAVID DICKSON

## Small Colleges Strong in Science

*But there is concern that the ability to produce talented students for science graduate schools may be diminished in the future*

A group of selective colleges that send more than their share of graduates into the sciences are worried about being able to do so in the future. At a recent conference on the future of science at liberal arts colleges, leaders of 50 private colleges and small universities met to discuss joint action to preserve their niche in science education.

Meeting at Oberlin College in Ohio, college presidents reviewed their recent science track records with satisfaction, noting that it puts them on an equal footing with the leading universities in turning out basic science majors. The colleges also rate well in the percentage of students completing doctoral degrees in science and going on to distinguished scientific careers. According to a background report\* released at the meeting, a subgroup of fewer than a dozen of the colleges "stand fully on a par with leading research universities" in the quantity and quality of their science graduates.

The colleges' partisans agree that the main

element in keeping them competitive is that they not only emphasize teaching but that their science faculties include practicing researchers. The report says that 60% of faculty at the 50 institutions averaged at least one article published in each of the past 5 years. It also notes that "students themselves are actively engaged in scientific research. Nearly 30% of all scientific articles produced at the colleges are jointly authored by undergraduate students and their faculty mentors."

The report notes that among its conclusions, "The most important is that over the next decade America's top liberal arts colleges must invest a total of one billion dollars above current commitments if they are to maintain and enhance their present strong position in basic science." The report was prepared by Oberlin provost Sam C. Carrier and director of institutional research David Davis-Van Atta.

Comparisons are made generally with selective universities with which the colleges traditionally compete for undergraduates and to which they send graduate students. The colleges continue to do well. Compared

to highly selective private universities, for example, the colleges have had a higher percentage of freshman majors in science and succeeded better in keeping the percentage up. The figures for a group of highly selective universities were 26.4% in 1976 and 15% in 1985. Comparable figures for the colleges based on a sample of 19 of the 50 were 31.8% in 1976 and 29.2% in 1985. Both sets of institutions far exceed the national average, which last year was between 5 and 6%.

The demographic outlook in the next decade is daunting. Not only will the size of the college-age cohort reach a low point in the mid-1990's, but the percentage of entering freshmen interested in science has been declining—nationally it fell from 9.9 to 5.5% between 1975 and 1985. The number of Ph.D.'s awarded in the sciences fell by some 11% in the same years.

Postbaccalaureate, the colleges rate favorably both in percentages of science students going on to graduate school and on qualitative grounds. Among the ten institutions with the highest per capita production of winners of the prestigious National Science Foundation Fellowships from 1976 to 1983, five were liberal arts colleges.†

Faculty demographics look even more dismal to the small colleges. Like the universities, the colleges have a bulge of faculty recruited in the period of major expansion in the 1960's and early 1970's. When these faculty members retire and have to be replaced starting in the 1990's, the colleges

\**Maintaining America's Scientific Productivity: The Necessity of the Liberal Arts Colleges*, Oberlin College, Ohio.

†The top ten institutions in order were Caltech, Swarthmore, Harvey Mudd, MIT, Harvard, Reed, Chicago, Yale, Pomona, and Bryn Mawr.

fear they will be at a disadvantage in competing for faculty from the smaller number of scientists entering the manpower pool. Industry and government as well as the research universities are seen as able to offer better salaries and other inducements.

In the face of the impending decline in numbers of students interested in science, recruitment from groups now underrepresented in science, such as women and minorities, is seen as necessary. A comparison of 20 top research universities and the 50 colleges shows that the percentage of women winning baccalaureate degrees in science at the colleges last year is almost half again that at the universities—15.2% for the colleges compared with 11.1% for the universities.

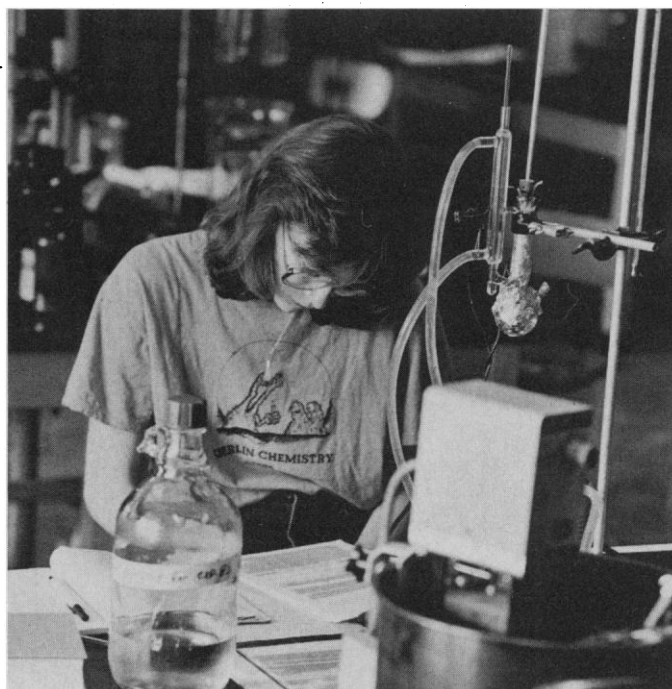
By and large, private liberal arts colleges have small endowments and are more dependent on tuition than the private research universities. They cannot rely on state funds as public institutions do. And the flow of research grants and contracts from federal science agencies has always been meager.

The report indicates that the colleges so far have managed to provide lab equipment adequate for instruction in science, but less satisfactory for research. A survey of anticipated needs for new and rehabilitated science facilities and for instrumentation shows serious future deficiencies.

The 50 institutions were selected from among colleges that have undergraduate enrollments of less than 3000 and award no more than 15% of their degrees to other than undergraduates. Invitations to join the group were given on the basis of three measures: percentage of students scoring over 600 in science on the Scholastic Aptitude Test, number of graduates earning doctorates in the natural and life sciences, and percentage of NSF graduate fellowships won. Some 120 institutions were surveyed

## A matter of concentration

*The report says that students from small colleges like Oberlin fare well in later science endeavors because these colleges emphasize teaching and offer participation in research.*



and rank-ordered to arrive at the list of 50.

The conference was convened by the presidents of seven of the colleges—Oberlin, Carleton, Franklin and Marshall, Mount Holyoke, Reed, Swarthmore, and Williams. The initiative to explore the subject, however, had come from Oberlin president Frederick Starr. A year ago Starr invited the presidents of the 50 colleges to a first meeting at Oberlin to discuss a preliminary version of the report prepared under Oberlin's auspices.

Finding the funds to maintain excellence will obviously be a major aim of the coalition. Starr notes that there "has been no approach to industry and foundations" for help and that those sources will be pursued. Attention at the meeting, however, clearly centered on Washington as the fount of research funds, particularly on the National

Science Foundation with its mandate to support science education. The presidents voted to establish a steering committee to explore how to formalize the group's activities and establish its own beachhead in Washington.

Opportunely, the keynote speaker at the Oberlin meeting was Roland Schmitt, senior vice president for research and development of General Electric and chairman of the National Science Board, NSF's policy-making body. Schmitt was laudatory about the colleges' record in science but he told those at the conference that they "must understand competition for funds is intense," citing what he called "contending crises" in science education. These include shortcomings in science and math instruction in the schools and deficiencies in instrumentation and shortages of science faculty in higher education institutions. He said that all these problems are serious and all might be solved by money from Washington but warned that NSF and other federal agencies lack the necessary funds. He added that industry is not a likely prospect for major support of undergraduate science education.

Schmitt urged the colleges to go beyond the effort to make policy-makers aware of the problem and to jointly devise a plan to attack it directly. He said that he had no "blueprint" to offer, but pointed to NSF's engineering research centers as an example of a successful program put forward by the community concerned. He suggested that the colleges create a partnership with state and local governments, saying he felt there would be "no lasting solution unless the states are heavily involved." ■

JOHN WALSH



John Seyfried, Oberlin College

**Oberlin campus.** One of the selective small colleges with a strong science program.