Science in Antarctica: Problems and Opportunities "On the Ice"

McMurdo Station, Antarctica.—Antarctica is of little use to anyone, except as a base for scientific research. This vast land—the coldest, driest, and highest continent—is a one-industry kind of place; the only way a man can make a legitimate living on this ice cap is as a scientist or as a provider of logistic support to scientists.

The environment is a hazardous one; but, with increasingly sophisticated technological aids, the danger and inconvenience originally associated with Antarctica have greatly diminished. It could be easily argued that doing research here is less dangerous than the ordinary hazards of life in the United States or in any other developed country. As one scientist, J. Linsley Gressitt, has written: "The days of pulling one's own sled or eating the sled dogs are well in the past."

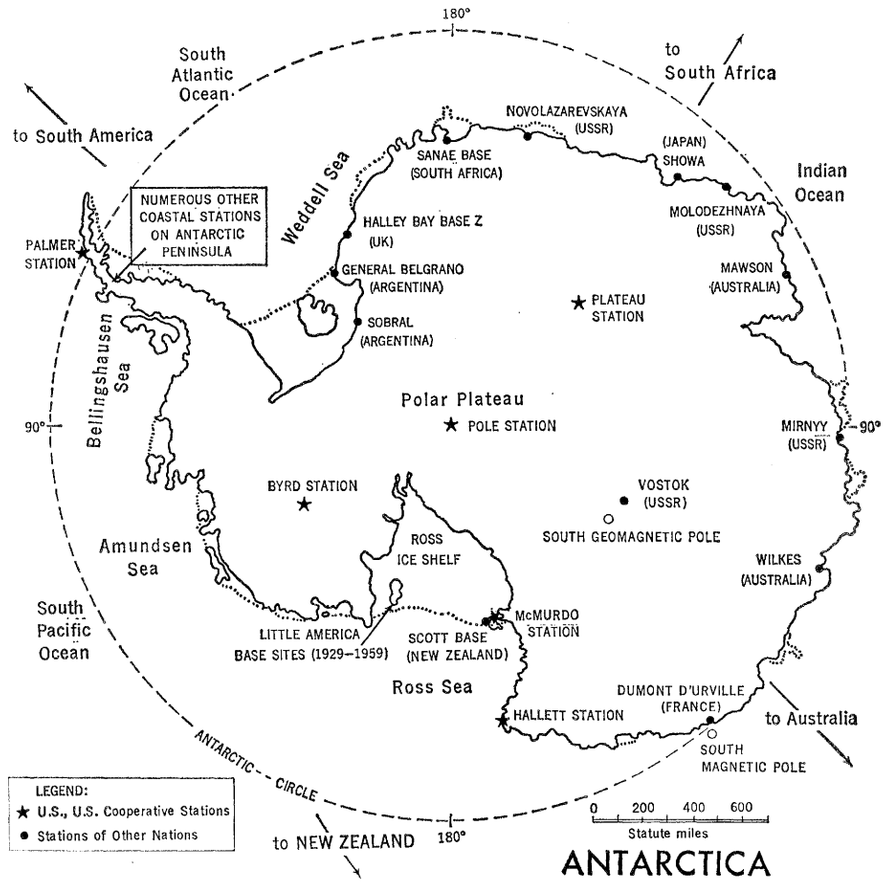
For the most part, mechanization has replaced those heroic physical efforts which gave Antarctica such a romantic allure in the annals of exploration and human achievement. Except for a New Zealand dog team which seems to be retained more for reasons of publicity and sentimental attachment than for real need, the sled dogs once imported to the Antarctic have been replaced by the motorized toboggan, the Snow-Cat, the helicopter, and the airplane. Scientists in Antarctica spend most of their time in adequately heated buildings or vehicles. They eat the finest delicacies that institutional cooking can provide; the U.S. Navy, which does most of the cooking at the American stations, provides a much more ample fare of steaks, lobster tails, and mountain trout than is customary in military cuisine.

Serving high-quality food is regarded as essential in maintaining "good morale," as is the provision of flush toilets at the more isolated stations such as Byrd and Pole. (Most of those stationed at McMurdo, the largest U.S. post, are still consigned to using less-sophisticated latrines. One researcher complained that the continued use of such facilities at McMurdo was "inexcusable"; he said that it would be difficult to get prestigious scientists to work in Antarctica if such primitive conditions were allowed to remain.) The New Zealanders pride themselves on having Antarctica's only bathtub, and the American stations are equipped with showers though people are told not to shower more than once a week because of the constant scarcity of water.

Through persistence, man has been able to adapt himself with some comfort to Antarctica. However, only constant caution prevents this continent from exacting a heavy toll in fatalities and serious injuries. At most places in Antarctica and at most times of the year, men must wear ample clothing to avoid frostbite. Antarctica is the coldest part of the world, far colder than the Arctic. The Soviets have recorded winter temperatures of more than −126°F at their interior stations, and the Ameri-

U.S. Navy Photograph

Three U.S. icebreakers push an iceberg away as they clear a channel through the Ross Sea to McMurdo station. Bulky items needed by scientists and logistics support personnel are shipped by sea during the Antarctic summer to McMurdo after the icebreakers have opened the way.



cans have logged a temperature of −113°F at the geographic South Pole and a reading of nearly −60°F at balmier McMurdo. At a temperature of −22°F, with a 22-mile-an-hour wind, inactive exposed human flesh is reported to freeze within 1 minute.

In these chilly and isolated conditions, the potential loss of shelter poses a most severe threat. As a sign prominently displayed at one station pronounces, "Fire is the great Antarctic monster." Fire is especially difficult to deal with because of the lack of water and the cold. Although U.S. stations have been fortunate in avoiding serious fire losses, it is remembered that eight Soviet scientists died in a fire at Mirnyy in East Antarctica in 1960.

The United States and the Soviet Union, respectively, are the nations with the largest scientific research programs in Antarctica. They are also the only two nations currently engaged in the strenuous and expensive activity of supplying stations in the interior of the continent. Most nations operate their permanent stations on the milder and more accessible coast of the continent.

The number of Americans "on the ice" ranges from somewhat more than 250 in the dark months of the austral winter (March through October) to a figure approaching 2000 in the perpetual sunlight of the Antarctic summer. The great majority of the American contingent is comprised of members of the U.S. Navy, the organization responsible for the logistics support for American scientists in Antarctica. By depending on a force of military personnel, the United States differs from most other nations in Antarctica which tend to have civilians performing logistics support.

The Antarctic Air Lift

More than other nations, the United States relies on transport and supply by air. (The Soviets conduct their major annual resupply trip to their inland Vostok station by tractor traverse.) McMurdo Station, which is located on the Ross Sea 2200 miles south of Christchurch, New Zealand, is the major staging area for the U.S. effort. Bulky supplies, such as the main import—fuel—are brought in by ship to McMurdo, then flown during the summer months to the U.S. stations at the South Pole, Byrd and Plateau. The vast quantities of fuel required to heat buildings, generate power, melt snow for water, and propel vehicles must be transported over great distances—more than 800 miles to Pole and to Byrd. The Navy says that it takes 1.3 gallons of fuel to deliver each gallon inland. The aerial mainstay of the support force is a group of four C-130 ski-equipped Hercules aircraft. This huge cargo carrier has served so well that the Navy plans to acquire an all-Hercules fleet for its Antarctic support force.

While the Navy spends $19.8 million annually on its logistics efforts here, the National Science Foundation (NSF), the sole U.S. funding agency for Antarctic research, spends $7.6 million annually to support the projects of about 200 scientists. Like many other government expenditures, the NSF's Antarctic program has been squeezed by the demands of the Vietnam war.

In the past few years NSF has put an increasing emphasis on sponsoring research in the biological sciences in Antarctica. In addition to examining the rich marine life of the oceans around Antarctica from shore stations and from the research vessel USNS *Eltanin*, biologists are engaged in a variety of studies on the major animals which spend part of their time on the Antarctic coast. Most of the projects concern the most conspicuous of these animals—the seals and penguins—which, fortunately, are fairly docile cooperators in scientific examination. McMurdo is the principal U.S. land station for biological research and is the site of a well-equipped biological laboratory.

Naturally enough, NSF is continuing large-scale funding of Antarctic research in other disciplines—in geology, glaciology, oceanography, meteorology, and upper-atmosphere physics. Byrd, the next largest U.S. station after McMurdo, is a major research center in upper-atmosphere work. Byrd is also a principal center of studies to explore the Antarctic ice cap, the major natural feature affecting the continent. At present, NSF is sponsoring a massive project to drill a 4½-inch hole through the 8000-foot-thick ice cap under the Byrd station. The core from the drilling is being brought to the surface where it will be kept in natural cold storage; sections will be sent back for detailed study to the Army's Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire, which is conducting the unusual project. The drillers

hope they will be finished by the end of February.

For the most part, scientific research in Antarctica has moved beyond the descriptive and survey phases which characterized its early years; more attention is now being devoted to exploring specific scientific problems. Another change noted by Antarctic observers is that there now seems to be less field work done by primary investigators; many in the U.S. scientific contingent are collecting material for senior scientists back in the United States. A similar tendency has been noticed in the work of other nations; for instance, Westerners visiting the Soviet stations have noted that their men are mostly involved in assembling data which will be written up by scientists in the Soviet Union.

A surprising deficiency in the U.S. program is the lack of research in the social and behavioral sciences. Recently, NSF gave a research grant for a study of sleep patterns of men wintering-over at the South Pole station. This study, currently in progress, is the first and only project in the behavioral sciences which NSF has sponsored in Antarctica. One leading NSF official concerned with Antarctic programs placed the blame squarely on the behavioral scientists: "We have never been able to get a first-rate psychiatrist, psychologist, or sociologist to winter-over in Antarctica; not one of them has been man enough to leave the comforts of his wife's bed."

Bedding difficulties aside, natural scientists often find that doing research in Antarctica has its compensations. The comment of J. Linsley Gressitt that "The facilities made available by the NSF, and the logistics provided by the U.S. Navy, are almost beyond the dreams of most entomologists" is echoed, if often in milder form, by scientists in other disciplines. One glaciologist interviewed by *Science* indicated that he thought that the aerial support and mobility that the scientist had in Antarctica was superior to that which he could find anywhere else, and he commented that it was far preferable to rely on the dependable pilots of the U.S. Navy than on the heavy-drinking, unpunctual private pilots that he had had to hire to help him with his research in Alaska. Other scientists like the idea of being able to work long hours on their research projects without the pressure of the distractions which would mark their activity at home.

U.S. Navy Photograph

Richard B. Weininger, scientific leader for the station at the South Pole in 1967. Half the scientists at Pole Station, including Weininger, wore a gold earring in a pierced left ear during the past winter season. Members of the group said that this practice was traditional among Antarctic wintering-over parties.

(Most nations engaged in Antarctic research, including the United States, exclude all women from assignment here.) Some men miss being with their families, but communication, by a combination of "ham" radio and telephone, with the United States is usually easy and inexpensive. Some call home regularly every week. Others find Antarctica a pleasant place to work socially; in this frontier-like existence there is a friendly, egalitarian atmosphere. The NSF provides many opportunities for graduate and even undergraduate students in science to study in Antarctica. Indeed, youth seems to be the dominant characteristic of the Antarctic population; most are under 40.

Of course, Antarctica has unique natural advantages for research. It provides unmatched sites for certain kinds of inquiries in ionospheric physics, meteorology, and cosmic-ray study. Those interested in polar studies can find permanent bases on this southern continent, unlike the more fragile posts on the ice of the Arctic Ocean in the north. Antarctica is also the area of the world least contaminated by man, a condition which makes it especially attractive to biologists.

As well as the advantages, there are obvious handicaps to researchers working in Antarctica. Some scientists complain about NSF being the sole source of research support and argue that NSF is too interested in the more "spectacular" projects. The long and complicated logistics system which serves Antarctica science requires scientists with bulky equipment to complete their planning many months and even years before they initially arrive "on the ice." Once they arrive, it is impossible to get large equipment delivered in a hurry that was not anticipated in the original specifications. And, if equipment breaks down, it must be repaired by the men on the scene; no manufacturer's representative is readily available for consul-

NSF Photo

A group from New Zealand's Scott Base prepares to kill a seal for food for its dog team, the only team left in the Antarctic. In addition to using seals killed for scientific study to feed their dogs, the New Zealanders also kill 30 to 40 Weddell seals each year for dog food. The unusual formation over the mountains of the Ross Island in the background is known as a lenticular cloud.

NEWS IN BRIEF

• **HARVARD DRAFT POLL:** On the basis of a poll, the Harvard *Crimson* reports, "One out of every four seniors at Harvard is looking forward to either fleeing the country or going to jail in order to avoid induction if his application for [a draft] deferment is turned down." The *Crimson* added that 59 percent of the seniors would "make a determined effort to avoid military service." Forty-three percent of Harvard's senior class, 529 students, answered questionnaires on their views. Details of the poll revealed that 61 percent of the students would "serve" in the military if all their applications for deferment were rejected, that 11 percent would leave the country if their applications for deferment were turned down, that 11 percent would go to jail if their applications for deferment were rejected, and that 6 percent would take their cases to court if their deferment requests failed.

• **HEALTH SCIENCE ETHICS:** Senator Walter F. Mondale (D–Minn.) plans to introduce a bill to create a Commission on the Ethical and Social Implications of Health Science Research and Development. Mondale stated that recent developments, such as heart transplants and the synthesis of DNA, raise a number of questions, including "what is life and what is death, who shall live and who shall die, whose genes shall be altered and for what purposes, how long and under what conditions shall we prolong life, how far shall we go in creating artificial life and what will be its status once it has been created?" The function of the commission would be to assess the ethical and moral questions raised by scientific breakthroughs.

• **EARTH SCIENCE EDITORS:** An association of Earth Science Editors (AESE) has been formed by some 35 editors of geological research publications. Among the projects under consideration by the new group are the compilation of a handbook for authors, publication of a style manual for earth science editors, and development of methods to obtain reports and documents not easily available. The association is accepting membership applications from editors, managing editors, and persons in similar positions on earth science publications. Information may be obtained from Thomas Rafter, Secretary-Treasurer, AESE, % American Geological Institute, 1444 N St., NW, Washington, D.C. 20005.

• **FIRE AT CEI:** A five-alarm fire destroyed the headquarters of the Committee for Environmental Information (CEI) in St. Louis on 6 January. CEI president Martin Schweig, Jr., and finance chairman Barry Commoner said that CEI would continue publication of *Scientist and Citizen* (*Science*, 25 Aug. 1967). CEI's temporary mailing address is Box 222, Clayton, Mo. 63105. Describing the $25,000 loss as "a tremendous sum for us," CEI has made an appeal for contributions to its members and subscribers. Only "a minimal part of the loss" is covered by insurance, CEI officers said.

• **SOVIET EDUCATION:** Between 1967 and 1985, the number of Soviets with higher education will double, a new U.S. Census Bureau report predicts. According to the report, the total number of living Russians with higher education will reach 15 million in 1985 compared with 20 million Americans who are expected to have completed higher education by that year. The report also forecasts that by 1985 nearly 11 percent of the Soviet population will have completed specialized secondary education compared with 4.8 percent in 1959. However, the report states, "If these growth rates are realized, Soviet planners will fall short of their goal for 1970 of a ratio of one specialist with higher education to three to four specialists with specialized secondary education in the industrial, construction, transport, communications, and agricultural sectors of the economy." According to the study, Soviet "plans for school construction and teacher training have not been fulfilled in recent years. In addition, there are signs of student reluctance to continue school after the eighth grade. . . . School dropouts are a problem at all levels of education" as well as under enrollment and incomplete registration. Copies of *Estimates and Projections of Educational Attainment in the U.S.S.R. 1950–1985*, at 25 cents each, are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

tation and assistance. Because of the cold, scientific tasks often take longer to complete than would be normal in a temperate climate. Scientists often find that they are able to get much more done during their second summer in Antarctica than during the first summer before they fully understand the demands and limitations imposed by the environment.

Although many U.S. scientists praise the Navy for rendering first-rate support, others wonder whether the large number of Navy personnel in proportion to scientists is necessary and healthy. Some are appalled by the urban sprawl of "metropolitan McMurdo" which reaches a summer population of 1100, mostly Navy; this is the largest settlement on the continent. While in Antarctica, it sometimes seems that the massive and admirable Navy logistics effort would carry on of its own momentum whether or not it was supporting scientists.

The summer headquarters for the U.S. Naval Support Force, Antarctica, are located in the more temperate New Zealand climate at Christchurch. The admirals who have commanded the Navy force, veteran Antarctic observers report, have tended to spend more time in New Zealand than "on the ice." The NSF officials praise most, but not all, of the admirals who have served here and speak highly of the present commander, Rear Admiral J. Lloyd Abbot, Jr., who assumed his post in February of last year.

Perhaps it is not so surprising that Navy people and those known as "USARP's" (civilians supported by the NSF's "United States Antarctic Research Program") often disagree, but, rather, that they get along as well as they do. Relationships between all kinds of men can become strained in the close living quarters of Antarctica, especially among those who winter-over at McMurdo, Plateau, Byrd, or the South Pole.

The Navy conducts psychological screening of both Navy personnel and scientists to eliminate those who are not suited for the demanding experience of wintering-over. Special care is taken to eliminate excessive drinkers and homosexuals from these groups. Navy doctors say that, to their knowledge, no homosexuality has ever been reported in the U.S. stations. (Also, there is no record of a murder at the Antarctic station of any nation.)

With its 5½-million square miles, Antarctica is a big place, and the rela-

tively small number of men here have enabled this continent so far to escape much change by man. This isolation has been further insured by the fact that Antarctica is not yet a commercially valuable piece of territory; no mineral deposits worth developing have been discovered, and the high costs which would be associated with extraction and transportation have served to discourage extensive mineral exploration.

But Antarctica may be in for new incursions. Tourist visits by sea have been made to the Antarctic Peninsula, and a tourist ship arrived at McMurdo on 21 January. The U.S. Navy, understandably, has said that all tourists must be self-sufficient and that the Navy will not render logistics support for the tourist transports. Also, Antarctica may well become more important militarily, even though all weapons and armed military installations are barred from the continent by the Antarctic Treaty. Weapons which can approach enemy targets over Antarctica have now been developed, and there may be an increasing cry for military observation points here.

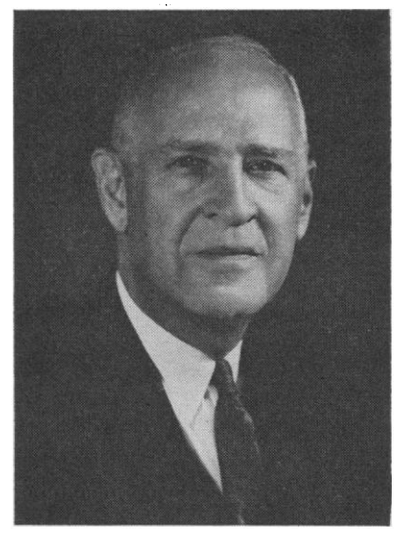
Despite the vastness of the continent, there has been some pollution of Antarctica. The air at McMurdo and around the nearby Williams landing strip is, at times, characterized by the disagreeable odor of fuel oil. Chimney smoke at U.S. stations sometimes causes camp fogs which make it difficult for airplanes to land. Untreated sewage emanates from many Antarctic camps, and mounds of garbage and other debris are thrown into the Ross Sea at McMurdo. Land vehicles and planes that break down in Antarctica are often left where they are; the Navy now has 17 nonoperative DC-3's lying around the continent. DDT, from sources originating elsewhere, has been found in Antarctic penguins.

There is concern among some Antarctic scientists that man may drastically disturb the status quo in Antarctica. A book published in cooperation with the Antarctic program of New Zealand's Department of Science and Industrial Research has warned that "the degree of man's contamination of Antarctica could become so great that it obscures the nature of the original life." In an interview, Jerry Huffman, the representative for NSF in Antarctica, indicated U.S. awareness of pollution problems and added that "we want to be careful to avoid polluting all the Dry Valleys."

Along with the risks of further pollution, technical change also brings the possibility of better service for scientists. Increasing employment of the more versatile turbine helicopter is greatly enhancing the mobility of Antarctic scientists. A flight of the larger and faster C-141 jet transport has been made from Christchurch to McMurdo, and the Navy now regularly schedules winter flights to McMurdo. These winter flights facilitate travel for scientists, especially biologists, who often want to come to McMurdo in June or July to do research after the conclusion of the regular aca-

Senator Lister Hill to Retire

Senator Lister Hill (D–Ala.), an influential champion of federal support for medical research, has announced that he will retire in January 1969, when his current term expires. The 73-year-old legislator, who has served almost 45 years in Congress, cited his age and long service in making the announcement last week.



Senator Lister Hill

Hill's departure will remove from active government service the last of the trio of men who have shaped the government's burgeoning effort in medical research during the postwar decades. Another member of the trio, Representative John E. Fogarty (D–R.I.), died a year ago. And the third member, James A. Shannon, director of the National Institutes of Health since 1955, is scheduled to retire in September.

Lister Hill, who is named after famed surgeon Joseph Lister, has held immense power over the nation's health establishment by virtue of two crucial committee posts. He is chairman of the Senate Labor and Public Welfare Committee, which writes legislation affecting the Public Health Service, and he is chairman of the appropriations subcommittee that dispenses money for the Department of Health, Education and Welfare. The senator is perhaps best known to the public as coauthor of the Hill-Burton Act, which provides funds for construction of hospitals and clinics. He has also been a fount of generosity to the nation's medical researchers. In postwar years, while Congress has resolutely ignored many other domestic welfare needs, it has been unfailingly kind to medical research—thanks largely to the Hill-Fogarty-Shannon combine. The typical pattern in determining the government's annual expenditures for medical research was that Shannon's NIH would request an increase in funds from the previous year, Fogarty's House appropriations subcommittee would recommend a boost above Shannon's request, and Hill's Senate appropriations subcommittee would recommend a still larger increase. NIH would generally end up with an appropriation close to what Hill recommended.

The spectacle of an agency actually getting more money from Congress than it had requested was so extraordinary that heads of other agencies enviously asked, "Where is our Lister Hill?" This is a question that may also arise in medical circles as a result of Hill's retirement announcement. At this point —due to the uncertainties of next fall's election and of senatorial preferences—it is not clear who will succeed to the chairmanship of either of Hill's committees, or whether the committees will continue their love affairs with medical research.—P.M.B.

demic year. Previously, scientists had to wait to fly to McMurdo in October or November at the beginning of the Antarctic summer.

With the building of many new facilities at McMurdo and plans to replace the under-ice station at the South Pole (which is gradually being crushed by the weight of the ice), it is obvious that the United States plans to continue its Antarctic research program for the indefinite future. In view of current international suspicion, it would seem impossible for either the United States or the Soviet Union to discontinue Antarctic research unilaterally while the other was doing it, even if the nations eventually concluded that it was of little scientific value.

Most research done in Antarctica is organized on a national basis, but there is some of the kind of international cooperation encouraged by the Antarctic Treaty. Individual scientists conduct research at the Antarctic stations of other nations. There is usually at least one American scientist at a Soviet station, and a Soviet doing research at a U.S. one. There is U.S. scientific instrumentation at Vostok, and the Americans make an annual flight to that Soviet station, which is marked by a great party and camaraderie. The United States occasionally inspects the stations of the Soviet Union and other countries, as permitted by the Antarctic Treaty. So far, the Soviets have cordially declined all invitations to inspect U.S. stations.

The Antarctic Treaty itself may be one of the greatest monuments of Antarctic scientific research. This treaty, which became effective in 1961, has already served as a model for the treaty providing for the peaceful uses of outer space. It is certainly conceivable that, at some future date, the provisions of the Antarctic Treaty could serve as guidelines for an agreement governing research in the Arctic. Fortunately for scientists, the Antarctic Treaty has helped thwart any sharp international disputes over territorial claims in the southernmost continent. Future generations may believe that the research done here was of great value, but they are just as likely to remember Antarctic science as an important causal agent in a process of political agreement and international accommodation.

—BRYCE NELSON

Federal Labs: White House Study Urges Closer University Ties

The government will soon issue a series of recommendations designed to promote closer relations between academic institutions and the hundreds of laboratories owned and operated by federal agencies.

In general, the recommendations do not call for anything that does not already exist in one way or another, such as joint or visiting appointments, cooperative research programs, special university courses for federal employees, and access to federal equipment by university researchers. The aim of the recommendations is simply to build upon and expand the patchwork of arrangements that have evolved between many universities and various federal in-house research centers. But the recommendations come from an especially influential source, the Federal Council for Science and Technology (FCST), an interagency, subcabinet body of federal R & D officials that is part of the White House science advisory apparatus. Because of the source of the recommendations and the apparent potential for further cooperative ties between universities and federal laboratories, the FCST designs could be of considerable importance for the nation's scientific and technical enterprise.

First of all, and probably most important, they could give many universities access to costly research and training facilities that are now far beyond their reach; such access could be of great value in a time of booming costs, competition for qualified faculty, and a slowdown in direct federal support for university research activities. And, second, it is widely felt that close academic ties might help to freshen the stuffy, regulation-bound atmosphere that is often associated with government laboratories, especially those tied to missions that have been bypassed by technological or political missions. The prevalence of these conditions, and the effect that a whiff of academe might have on them, is open to question, but a widely held view is that such exposure would be good, at least for the federal labs.

Having successfully passed through a round of agency review, the FCST recommendations are said to be scheduled for publication in the near future. Once this is done, they will stand, not as fiat, but rather as guidelines which federal agencies will be encouraged to follow in developing policies and practices. Thus, the full effects will probably be a long time in coming, but there is no doubt about the intended objective; it is, simply, to promote a great deal of human traffic, both ways, between the academic world and the government's own research centers.

Starting from the premise that academe and government can do a great deal for each other in research and training, an FCST "task group" conducted examinations of 75 federal research and development installations, plus one federal contract facility (the National Center for Atmospheric Research, at Boulder, Colorado). And the committee came to the conclusion that nothing short of scientific utopia prevails in the federal laboratories that have close ties with universities. In such places, it euphorically reported,

> . . . one senses a purpose, an alertness, an enthusiasm, a striving for excellence, a dedication, a feeling of accomplishment coupled with unlimited potential contribution, a vibrant participation at the advancing frontiers of science, an excitement, a sense of life and involvement. This atmosphere, fostered by close association with the academic world, highly desirable and not easily attained, was seldom transmitted to the task force in laboratories lacking close university relationships. It seems clear that a close working relationship with universities is a definite plus to a Federal R & D laboratory.

In a look at the reasons why some federal research centers send their employees to universities and bring uni-