National and International Programs

Programs administered by the Directorate for National and International Programs cover a diversity of activities in support of science and science education. Some, the National and Special Research Programs, are major research efforts which relate to specific geographic areas or are of such a broad scope or magnitude that intensive efforts in planning, management, funding, and logistic support are essential to ensure maximum effectiveness and efficiency in program performance. Many of these programs involve extensive international cooperation in the planning for and the conduct of the research, as well as coordination and cooperation with other U.S. governmental agencies.

Other National and International Programs incorporate an international component or involve support of scientists from several institutions collaborating in research or sharing facilities. In some cases—in addition to a programmatic support function—organizational elements of the directorate fill a coordinating role with respect to related activities throughout the Foundation.

Following is a list of major program activities administered by the directorate* and discussed in greater detail in subsequent pages.

National and Special Research Programs

*International Biological Program*** (IBP). U.S. participation in IBP has taken the form of integrated research projects involving many investigators which include intensive studies of ecosystems in six distinct life zones or biomes. Intensive study of the grasslands biome is in full operation, and expanded field research in the desert biome is well under way. In addition to the biome studies, IBP includes a wide range of other environmental research such as biological control of insect pests and human adaptability to harsh climates.

International Decade of Ocean Exploration (IDOE). Fiscal year 1971 marked initial implementation of IDOE as a framework for research activity and data collection that will contribute eventually to preservation of the ocean environment, improvement of environmental forecasting, and establishment of a sound basis for seabed assessment.

Ocean Sediment Coring Program. The principal component activity of the Ocean Sediment Coring Program is the Deep Sea Drilling Project, which utilizes the drilling ship *Glomar Challenger* to acquire samples from the sedimentary layers of the deep-ocean basins for research in marine geology and related geological and geophysical sciences. Each 2-month cruise—planned by advisory groups of geologists and geophysicists—includes a scientific party of 10 or more scientists selected from U.S. and foreign institutions.

Oceanographic Facilities and Support. During fiscal year 1971, the staff and functions of the Oceanographic Facilities Program in the Research Directorate were transferred to the National and International Programs Directorate and integrated into a new Office for Oceanographic Facilities and Support. Besides continuing the support of 32 oceanographic ships operated by 18 academic institutions, the office was responsible for a grant for conversion of the 208-foot Navy ship R/V *Gilliss,* to be operated by the University of Miami. The new office is developing a systems approach to shared use of large oceanographic research facilities by the academic community.

U.S. Antarctic Research Program. The Foundation has been active in support of research in Antarctica since 1957. In fiscal year 1971, the President charged the Foundation,

*In October 1970, the National Sea Grant Program, originally assigned by statute to the Foundation, was transferred to the newly activated National Oceanic and Atmospheric Administration of the Department of Commerce.

**Although administered by the Research Directorate, IBP is included in this list because of its identification as one of the Foundation's National and Special Research Programs.

Leaving the harbor at Jacksonville, Fla., the renovated R/V *Gilliss* glides down to sea on a shakedown cruise to Bermuda. (Photo University of Miami)

effective in fiscal year 1972, with responsibility for planning and funding the total U.S. antarctic effort, including the logistic operations conducted by the Department of Defence. June 1971 marked the 10th anniversary of the Antarctic Treaty as scientists from 12 signatory nations continued to pursue a number of joint projects.

Arctic Research Program. The Foundation has been designated lead agency for the extension of scientific research in the Arctic and coordinates the arctic research efforts of all Federal agencies through the Interagency Arctic Research Coordinating Committee. Large-scale projects under development emphasize environmental problems and include elements of international cooperation.

*Global Atmospheric Research Program** (GARP). The Global Atmospheric Research Program is an international cooperative research effort aimed at increasing our understanding of the general circulation of the atmosphere and providing a mathematical and physical basis for long-range prediction, for determination of the feasibility of large-scale climatic modification, and for assessment of the consequences to global environmental quality of man's pollution of the atmosphere. Several GARP-related programs have been under way at the National Center for Atmospheric Research during the past several years, including development of a General Circulation Model of the Global Atmosphere. This mathematical model, a realistic representation of the earth's atmosphere, is now being used with real meteorological data to test its reliability as a tool for large-scale weather prediction.

*Although administered by the Research Directorate, GARP is included in this list because of its identification as one of the Foundation's National and Special Research Programs.

National Research Centers

Five National Research Centers funded by the Foundation were established to meet national needs for facilities, equipment, and operational support for research in astronomy and the atmospheric sciences. Each center is operated under contract by a single university or a university consortium which provides technical and administrative staff (see Appendix F). Both resident scientists and visitors using the advanced equipment and facilities contribute to the preeminence of the centers as research establishments.

Computing Activities in Education and Research

Administered by the Office of Computing Activities (OCA), the programs of Computing Activities in Education and Research are the focal point for Foundation support of activities designed to meet growing national computer requirements and to develop applications of computer technology for the classroom and laboratory. OCA also coordinates computer-related activities of other programmatic elements of the Foundation.

Science Information Service

The program of Science Information Service provides assistance to scientists and engineers by increasing the accessibility of information and assuring the adaptability of information services to the changing needs of the user community. Activities supported include development of information systems, support of selected publications and translations, and research on the science information process.

International Cooperative Scientific Activities

In addition to the international aspects of many other Foundation programs, direct support for cooperative and collaborative projects is provided through the program of International Cooperative Scientific Activities. The cognizant program office—Office of International Programs—along with the Office of Science Information Service (see above) administers the Foundation appropriation of excess foreign currencies (Public Law 480 funds).

Table 4
National and Special Research Programs Awards
Fiscal Years 1969, 1970, and 1971
(Dollars in millions)

	Fiscal Year 1969		Fiscal Year 1970		Fiscal Year 1971	
	Number	Amount	Number	Amount	Number	Amount
Arctic Research Program	0	0	0	0	32	$ 2.00
Ocean Sediment Coring Program	5	$2.43	25	$ 6.55	8	7.13
Global Atmospheric Research Program	9	.54	19	1.49	31	1.90
Research Applied to National Needs	24	2.43[1]	140	12.01[2]	213	33.96[2]
International Biological Program	16	1.22	24	4.00	37	7.50
U.S. Antarctic Research Program	145	6.86	128	7.41	121	7.76
Oceanographic Facilities and Support	0	0	31	7.60	21	8.57
International Decade for Ocean Exploration	0	0	0	0	44	15.00
Total	199	$13.48	367	$39.06	513	$83.82

[1] FY 1969 includes Weather Modification Program only.
[2] FY 1970 and FY 1971 include Weather Modification, Earthquake Engineering, and Interdisciplinary Research Relevant to Problems of Our Society. See pages 59–63 for details.

NATIONAL AND SPECIAL RESEARCH PROGRAMS

INTERNATIONAL BIOLOGICAL PROGRAM

The International Biological Program (IBP) in the United States, for which NSF has lead agency responsibility within the Federal Government and which is administered by the Research Directorate, is primarily directed towards understanding ecosystems. Studies of man in relation to his environment and of how he adapts to it are specifically included in this research. The ultimate objective of the program is to be able to predict the consequences of man-induced or natural perturbations of ecological systems and thereby to improve our capability for rational management of the ecosystems upon which man depends for food, fiber, water, and the amenities of life.

Ecosystems are complex, and their components are intimately interrelated in ways that are still largely unknown. Perturbations in remote and seemingly unimportant parts of a system can trigger a chain of cause-effect relations which multiply to produce profound consequences throughout the system. On the other hand, ecosystems often display extraordinary stability in the face of environmental stress. Because of their complexity, the most logical route to understanding the functioning of ecosystems is an integrated research program involving many scientists in which all aspects of the system are treated simultaneously.

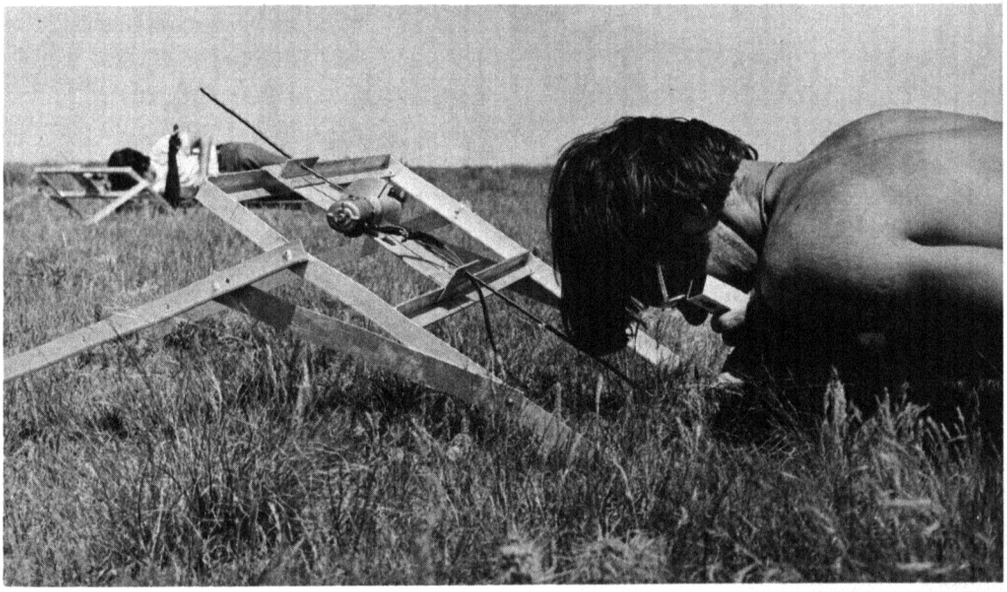
Integrated ecosystem studies of this sort are now in progress in the grasslands region, the deserts and coniferous forests of the western United States, the eastern deciduous forest region, the arctic tundra, and the upwelling regions in the marine environment. These research programs rely heavily on a systems analysis approach and the use of computer modeling. The new and essential aspect of the U.S. approach to the IBP is that as many as possible of the processes taking place in ecosystems are simultaneously evaluated in such a way that they can be linked into a single computer model which simulates the behavior of the entire system.

No operational computer model of a whole ecosystem, usable for testing hypotheses or making predictions, yet exists, although substantial progress toward this goal has been achieved in the past year. Two preliminary computer models of the grassland ecosystem have been developed. When they are operated, their output results indicate appreciable inadequacies in the present state of the models. However, their development and implementation has focused the researchers' attention on those mechanisms of the grassland to which the system as a whole is especially sensitive. The lessons learned in the development of these initial models will be applied during the coming year to provide more directly useful and realistic output. A high degree of linkage and communication among the various IBP studies prevents duplication of effort in model development and in other research, and facilitates exchange of concepts.

Other aspects of the U.S. IBP program are at various stages of development. Field research on isolated tribes of South American Indians has led to development of models of human genetic response and of gene flow within primitive populations. This information will be of significant value in providing a norm against which genetic changes in more urbanized populations can be assessed. Research is underway on human physiological responses to cold and high altitudes and to global nutritional variation. Studies of biosocial adaptations and responses to major migration trends were initiated during the past year. All these studies of human adaptability to the stresses of the physical environment are closely linked to similar research being conducted by scientists from other nations participating in IBP. Sharing of the data and the emerging concepts promotes research efficiency, and makes the progress of American research directly available to scientists elsewhere at an early date.

Research began during the past year on significant aspects of the origin and structure of ecosystems. This research is intended to delve into the processes by which organisms of diverse genetic composition organize themselves when confronted by similar climates. Parallel studies are being made of shrub communities in very similar Mediterranean-type climates in California and in Chile,

Lysimeter is large core of several tons of prairie soil and sod which can be weighed accurately to measure uptake and loss of water. In place, the core is not separated from surrounding plant life. (Photo Colorado State University)



IBP research technician observes motor-driven probe (running diagonally from upper left to lower right), and records all the plants that it touches in its journey to the ground. Resulting data, which reveal utilization of sunlight, are used in computer model of grasslands.

and in desert communities of equally similar climate in Argentina and Arizona. Scientists from both the Latin countries and from the United States are working collaboratively at all the sites, with each country's research funded from its own national sources. Although it is too early for this program yet to have achieved appreciable results, it has already emerged as a model of international cooperation in basic research on ecological processes. Research of this type could ultimately have significant implications for rational use of land and water resources.

INTERNATIONAL DECADE OF OCEAN EXPLORATION

Fiscal year 1971, the first year of the International Decade of Ocean Exploration (IDOE), was devoted to establishing the guiding philosophy for the program, generating research plans, and setting into motion efforts to meet the long-term goals.

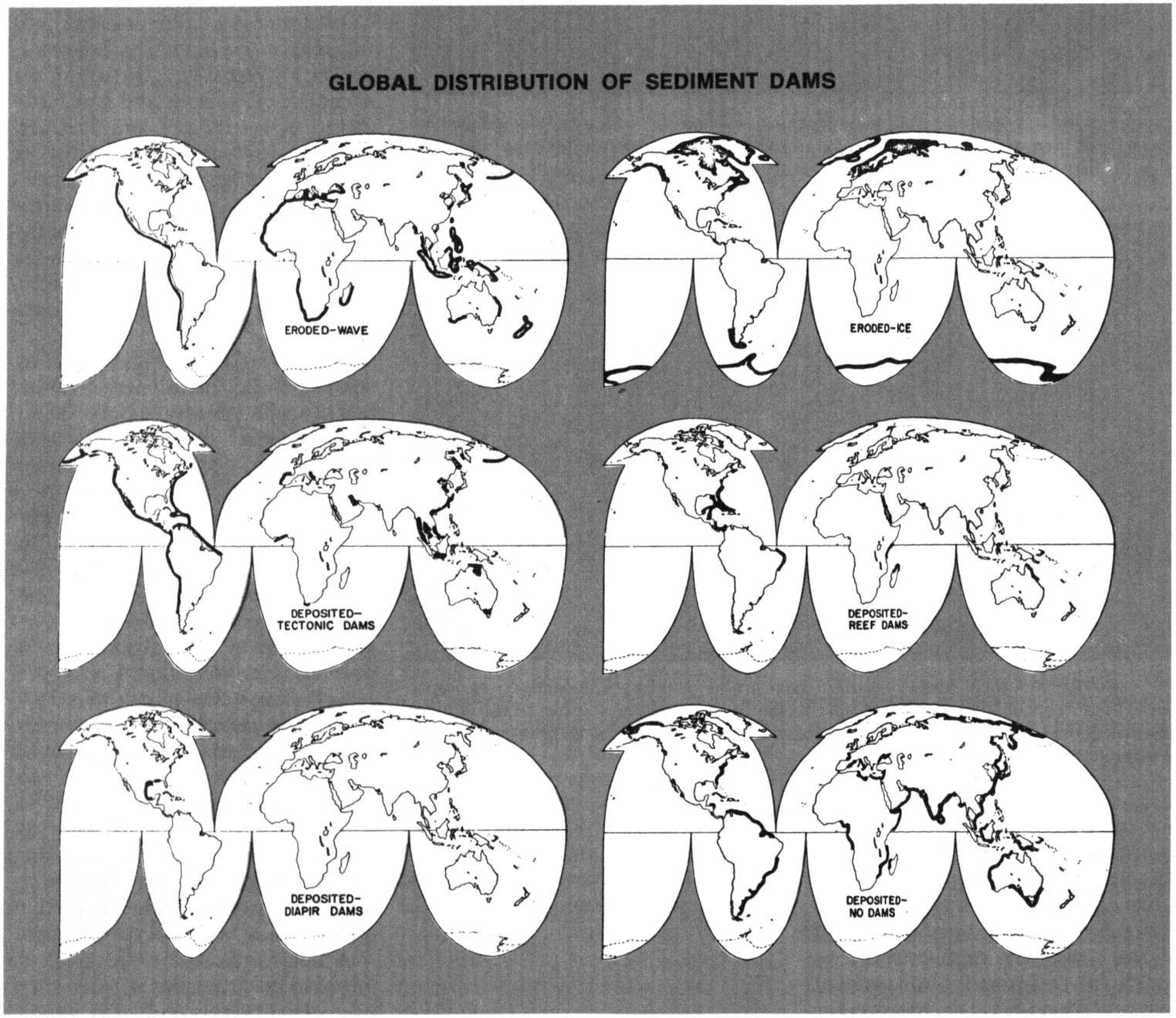
As a first step toward the goal of preserving the ocean environment, investigations were begun to determine the present concentrations (baselines) of pollutants in the North Atlantic, the northeastern Pacific, the Gulf of Mexico, and the Caribbean Sea. In each oceanic area the several participating laboratories are giving close attention to the exchange of samples and standardization of techniques and measurements to ensure comparability of results. Samples of biological materials, sediments, and water from areas adjacent to and remote from pollution sources are being analyzed for concentrations of pesticides, herbicides, heavy metals, and petroleum chemicals.

Special scientific workshops involving U.S. and foreign oceanographers will identify present knowledge, crucial scientific problems, and a set of priorities for a long-term research program on pollution in each of five major problem areas: sources and input rates of pollutants; dispersal by physical motions; transfer among chemical, biological, and geological phases; effects on organisms; and the ultimate fate of pollutants in the oceans. Envisioned benefits from these programs include establishment of safe rates of waste disposal into the oceans, techniques for monitoring the degree of oceanic pollution by man, identification of situations exceeding pollution tolerance levels, protection of living marine resources from deleterious manmade materials, and protection of man from toxic marine products.

A long-term research program to improve environmental forecasting has been formulated. It will emphasize studies in ocean-atmosphere coupling mechanisms in the North Pacific; the role of large-scale dynamic processes in ocean circulation

and global climate; the physical, chemical, and biological dynamics of upwelling processes; and the formation and circulation of water masses in the depths of the oceans. The program is expected to contribute to the improvement of extended weather forecasts, with attendant benefits to farming, construction, transportation, water resource management, and recreation; more accurate fisheries prediction; improved understanding of the oceans as a food source and as a heat sink for industrial activities; and enhanced ability to calculate water renewal rates in the deep ocean as they affect disposal of waste, dispersal of nutrients and pollutants, and improved global circulation forecasting models.

The environmental forecasting program was begun in 1971 with a study of medium-scale geostrophic eddies in the North Atlantic and their role in the general ocean circulation. This Mid-Ocean Dynamics Experiment, involving nine institutions—eight U.S. and one foreign—requires a melding of theory, numerical modeling, and field experiments. The schedule calls for 18 months of hardware development



The continental shelves are formed by a variety of processes throughout geologic time, including erosion by waves and ice, and deposition of sediments often behind "dams" caused by ancient coral reefs, protrusion of salt domes, and crustal folding. The generalized map shows the distribution of the types of shelves which are being studied as part of IDOE's program of seabed assessment to improve our understanding of the processes responsible for the occurrence of natural resources beneath the sea.

and testing, a 6-month field program, and a year of data analysis and interpretation.

The program for expanding seabed assessment activities emphasizes studies of the geophysical and geological structure of the major unsurveyed, wide continental shelves; correlation of onshore and offshore geology through the use of fine-grain surveys in selected areas; and geophysical, geological, and geochemical studies of mid-ocean rift valleys and deep-ocean trenches. It is expected that these studies will provide regional data for the assessment of seabed areas involved in future law-of-the-sea discussions, the determination of economic potentials of mineral deposits, and the evaluation of ocean trenches as possible sites for waste disposal.

One seabed assessment project initiated in the past year is a geophysical survey of the entire continental margin of the west coast of Africa. The project involves investigators from the Woods Hole Oceanographic Institution, the University of Rhode Island, and the University of Capetown (South Africa), and participants from France, the Federal Republic of Germany, the U.S.S.R., and countries along the African coast. The 4-year survey will require a year for hardware development, 2 years of field work, and a final year of data analysis and interpretation.

The data management and instrument development aspects of the IDOE program are receiving special emphasis. On behalf of IDOE, the Environmental Data Service and the National Oceanographic Instrumentation Center of the National Oceanic and Atmospheric Administration are working directly with the institutions and agencies responsible for conducting the scientific research. In addition, it is expected that the major IDOE programs will involve development of many new sensors and measurement techniques.

Cooperative arrangements are being pursued with institutions and scientists of other nations. The broader scale involvement of foreign governments is being developed through the Intergovernmental Oceanographic Commission of UNESCO.

The $15 million allocated to the IDOE program in fiscal year 1971 was distributed approximately as follows: 15 percent to studies of environmental quality, 50 percent to environmental forecasting, and 35 percent to seabed assessment. During this initial period, Government agencies are performing 40 percent of the research, and 60 percent is being carried out by academic and nonprofit institutions and industry.

POLAR PROGRAMS

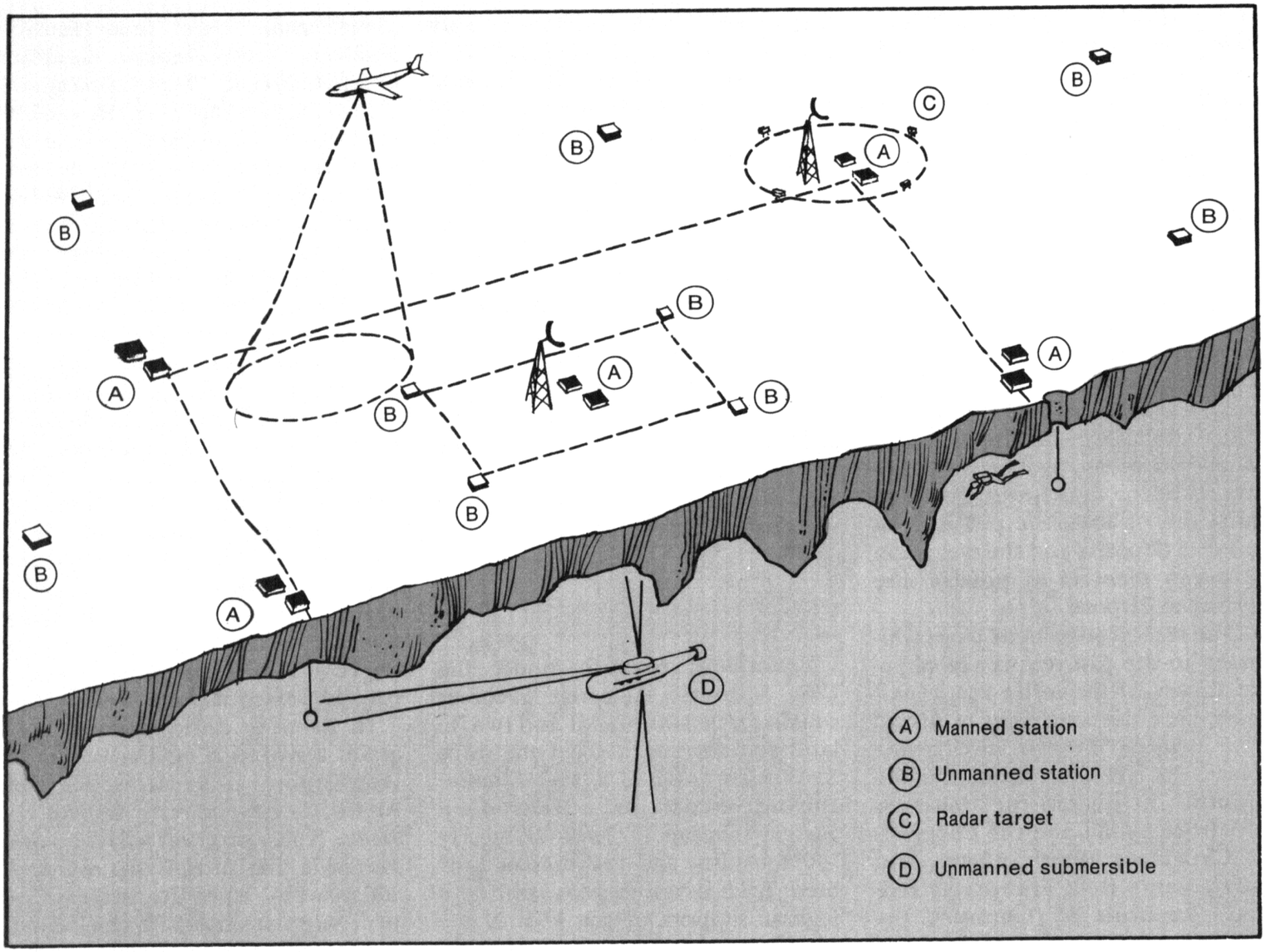
Year-round research under the U.S. Antarctic Research Program continued at two coastal and two inland stations and aboard the ships R/V *Hero* and U.S.N.S. *Eltanin*. During the increased activity of the austral summer of 1970–71, nearly 150 scientists and technicians pursued field investigations with the logistic support of the U.S. Naval Support Force, Antarctica, and icebreaker support by the U.S. Coast Guard. Research spanned many disciplines, with major participation by biologists, earth scientists, oceanographers, and atmospheric scientists.

One of these investigations was conducted by atmospheric physicists from the University of Maryland and Stanford University. Data collected earlier in Antarctica suggested that energy transfer takes place between atomic particles and electromagnetic waves in the plasmapause (the outer boundary of a densely ionized layer around the earth), much as is observed in cyclotrons. On January 2, 1971, this cyclotron resonance was confirmed by simultaneous air and ground measurements at Siple Station, which at 76°S. 84°W. is ideally located for observing magnetospheric phenomena. Using instrumented balloons, the scientists detected bremsstrahlung (the electromagnetic radiation produced by the sudden retardation of charged particles in an intense electric field) that showed remarkable correlation with X-ray bursts and very low frequency waves known as risers. This coincidence occurred several hundred times in a 1-hour period.

Following up on these investigations, the scientists intend to use an antenna array at Siple in February 1972 to create artificially stimulated risers in the ionosphere. If these experiments are successful, it would be the first known positive control of precipitation of trapped energetic electrons in the upper atmosphere. A potential application of the technique would be to modify the reflective properties of the ionosphere to improve radio communication capability along magnetic field lines.

In the new Arctic Research Program, a group at the University of Washington is preparing for the Arctic Ice Dynamics Joint Experiment. This program will be conducted in the Arctic Basin over several years by university and government scientists from both the United States and Canada, and will be funded by both nations. Measurements will be made at a grid of stations on sea ice to determine its influence on global atmospheric and oceanic circulation and to improve ice forecasting techniques.

A study of the tundra ecosystem, coordinated by scientists from the University of Alaska and the U.S. Army Cold Regions Research and Engineering Laboratory, began in the summer of 1970. In 1971, scientists from 43 institutions were engaged in projects supported by Federal agencies and industry. One group, comparing natural and disturbed tundra areas, is attempting to establish the sensitivity of the ecosystem to various types of stress and determine the potential mechanisms for aiding recovery of damaged areas.



Array of instrumentation for the Arctic Ice Dynamics joint Experiment.

United States and Danish scientists have joined forces to obtain depth profiles of the Greenland ice cap and to core the ice for information on major climatic cycles in the Arctic. Development of a special coring rig is well advanced in the United States, and Danish scientists are preparing the radiosounding apparatus to be flown for the study.

OCEAN SEDIMENT CORING PROGRAM

The Ocean Sediment Coring Program continued to conduct exploration of the floors of the deep-ocean basins by drilling and coring of underlying sedimentary layers and, to a limited extent, the igneous rock beneath. The operations are conducted from the drilling ship *Glomar Challenger*. In 1971 cores were taken at 65 sites on two crossings of the North Atlantic, in the Mediterranean and Caribbean Seas, and in the eastern North Pacific Ocean. The maximum penetration reached was 3,900 feet into the ocean floor, with a 100-foot penetration into basaltic rock beneath the sediment layer. In the Caribbean, for the first time a hole being drilled was successfully reentered, allowing a worn bit to be changed, and drilling resumed in 13,000 feet of water.

Earlier results of the program produced evidence substantiating the ideas of continental drift, seafloor spreading, and the general youthfulness of the oceanic basins. During the past year, crustal motions that were formerly expressed only as the movement of one sector of the earth's crust relative to another sector have been related to the rotational axis of the earth. In addition, these studies are leading to a better understanding of the large-scale motions of the crust of the earth with respect to the history and significance of deep-sea trenches, of the interaction between continents and ocean basins, of the origin of earthquake zones, and of the structure and composition of the oceanic

crust. Remarkable vertical motions of the oceanic floor have been detected.

The results of the program also include advances in the chemical history of the oceans, the history of ocean current systems and gross oceanic circulation, paleoclimatology, the origin of sediments and their changes after deposition, organic evolution and productivity, and changes in the continental portion of the earth.

Of immediate and practical significance is the continued broad evaluation of seafloor resource potentials and the acquisition of experience and technology for the effective exploration of the deep-ocean beds. In addition, understanding of the globe has been enhanced by the opportunity to interpret miles of geophysical surveys through direct correlation with physical samples.

The drilling and coring operations were conducted by Global Marine, Inc., under a subcontract with Scripps Institution of Oceanography. National and international scientific guidance to Scripps is coordinated through the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES). This consortium of five academic groups advises on drilling itineraries, site selection, initial core descriptions, and other aspects of the operations. Almost 200 scientists, including representatives from more than a dozen foreign nations, have served aboard the *Glomar Challenger* to conduct on-site analyses of samples fresh from the borehole.

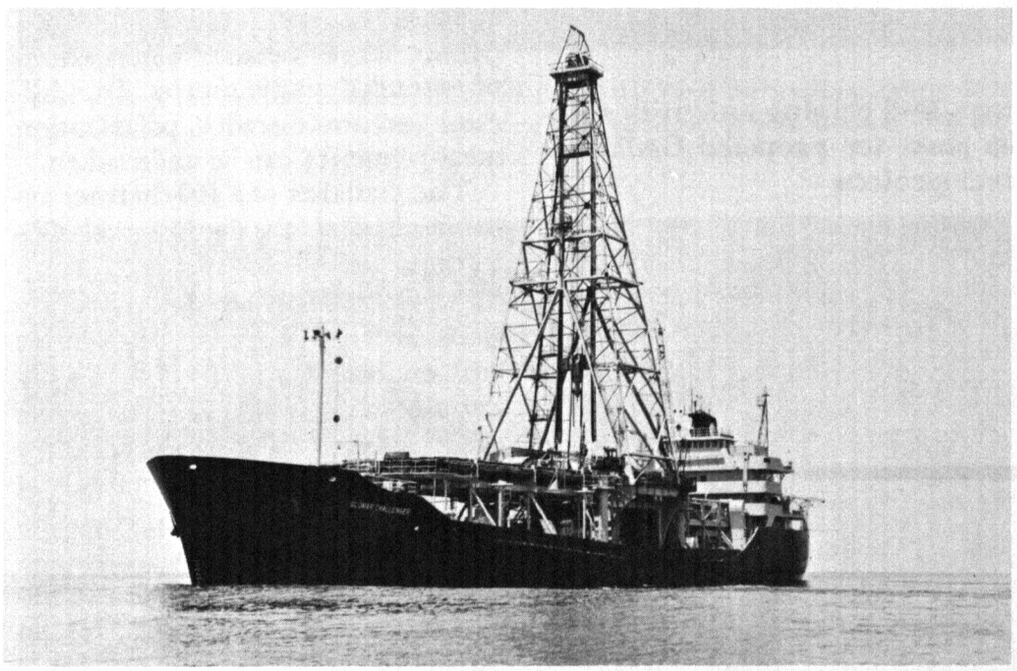
During the 1971 fiscal year, NSF published volumes IV, V, and VI of *Initial Reports of the Deep Sea Drilling Project*. Volume VII, a 1,750-page, two-part document, was prepared for printing, with distribution scheduled for August 1971.

GLOBAL ATMOSPHERIC RESEARCH PROGRAM

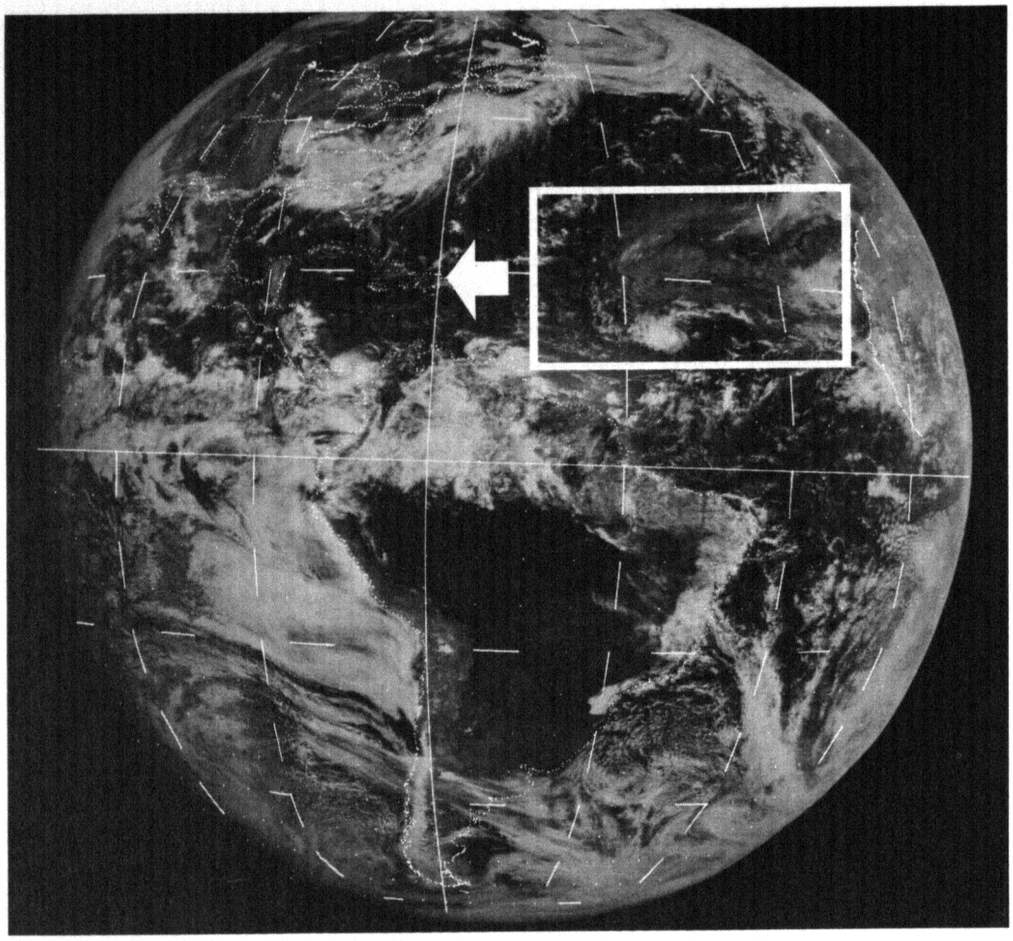
NSF's participation in the Global Atmospheric Research Program (GARP), under the Research Directorate, supports university research aimed at a better understanding of global atmospheric dynamics and numerical simulation studies related to global meteorological observations. Emphasis within GARP, nationally and internationally, in 1971 was concentrated on the planning and design of the GARP Atlantic Tropical Experiment (GATE) to be conducted in the summer of 1974. Using an array of ships, aircraft, and other observational platforms, including satellites, scientists expect to determine how the energy within the tropics plays an important role in global circulations. An international management structure has been established, and at least eight nations are expected to participate in GATE. Plans for U.S. participation have been issued by the U.S. GARP Committee of the National Academy of Sciences.

Experiments such as GATE and the Barbados Oceanographic and Meteorological Experiment (BOMEX) of 1969 provide opportunities for research leading to better understanding of the physical processes of the atmosphere and, eventually, for improving the numerical prediction models. BOMEX research on air-sea interaction showed that the tropical ocean reflects 3 percent of the radiation received from the atmosphere and has resulted in better values for the rates of transport of heat and moisture in the tropical ocean area. The research also revealed that there are great variations in day/night ocean surface temperatures, that wave-like formations exist at all ocean depths, and that great quantities of dust originating in the Sahara Desert are present over the South Atlantic BOMEX area. Additionally, the data from BOMEX have been used in numerical model studies of air-sea interaction and of the general circulation of the atmosphere, in a quantified description of solar energy distibution, and in the prediction of atmospheric currents.

The National Center for Atmospheric Research has been given responsibility for the coordination of all Observing Systems Simulation Experiments. Using global circula-



Port side view of the DSDP vessel *Glomar Challenger*. The vessel weighs 10,400 tons, is 400 feet long, and the million-pound hook-load capacity drilling derrick stands 194 feet above the waterline. The automatic pipe racker, just forward of the derrick, holds 24,000 feet of 5-inch drill pipe. (Photo Scripps Institution of Oceanography)



One of the findings of the Barbados Oceanographic and Meteorological Experiment was that dust over parts of the southwestern Atlantic had originated in the Sahara Desert. This photo, taken on August 11, 1970, shows a great mass of westward-moving dust as a gray area off the coast of Africa (upper right). (Photo NASA ATS-3, produced and gridded by NOAA)

tion models, NCAR along with the National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration is testing various configurations of observing systems to determine which combinations of conventional and satellite sensors will be most efficient for global observing networks.

The University Corporation for Atmospheric Research (UCAR), which operates NCAR, has formed a UCAR GARP Council to facilitate communications with universities for GARP plans and problems. NCAR's work on GARP is being coordinated by an NCAR GARP Task Group, which is identifying important problems and supplying staff support for the UCAR working groups and helping university scientists plan for proposed GARP research projects.

NATIONAL RESEARCH CENTERS

NATIONAL ASTRONOMY AND IONOSPHERE CENTER

The National Astronomy and Ionosphere Center (NAIC) is operated by Cornell University, Ithaca, N.Y., under contract to the National Science Foundation. Observing facilities are in Puerto Rico, at a site 12 miles south of the city of Arecibo. The principal instrument is a spherical antenna of 1,000-foot diameter—the world's largest radio telescope.

This spherical reflector is a major research instrument that functions both actively as a radar telescope and passively as a radio telescope. The capabilities of the instrument derive from its unique design, which includes a large fixed reflector, movable line feeds that correct for spherical aberrations, and high-performance transmitters, receivers, and computers.

A major project to upgrade the surface of the reflector was authorized in fiscal year 1971. This upgrading will provide the primary modification necessary to permit use of the reflector to wavelengths as low as 10 cm. Construction is scheduled to commence in fiscal year 1972 and will take 2 to 3 years to complete. A detailed engineering study is also under way to modify the feed support structure and install an S-band radar system.

A design study for a new high-power 430-MHz (million cycles per second) line feed was completed, with fabrication and installation of the feed planned for fiscal year 1972. The high gain of the main beam and the reduced side lobe level will permit more detailed observations of extended radio sources. In addition, accurate radio polarization measurements can be undertaken.

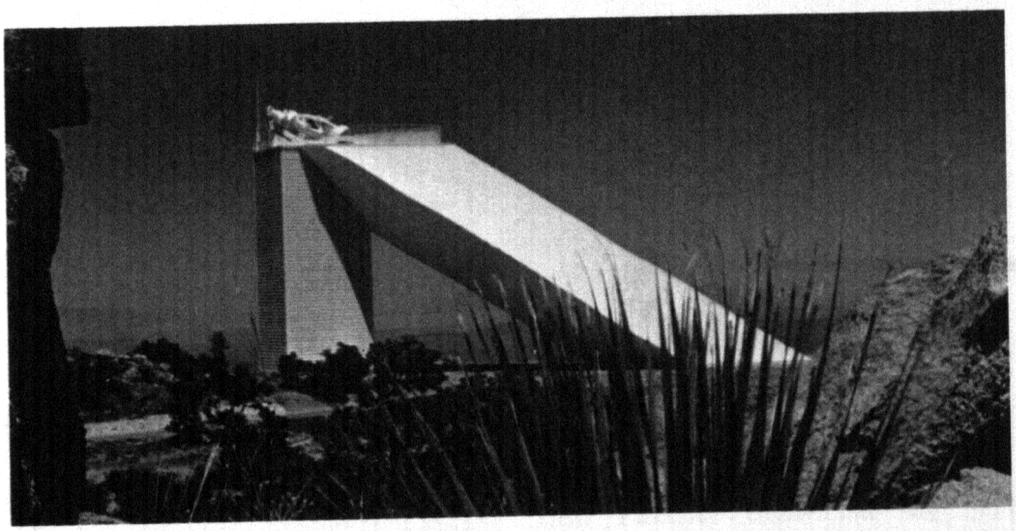
The transfer of a 100-channel autocorrelator from the Haystack Observatory in Massachusetts to Arecibo was accomplished and modifications are in progress. This device will enable the observatory to undertake more extensive spectral-line observations. The large reflector will then be used to study clouds of neutral hydrogen and the distribution of molecules in space.

As part of the ionospheric research program at NAIC, radio waves are transmitted into the ionosphere and the reflected signals analyzed to determine the electron densities and temperatures in the reflecting region. Particularly suc-

Table 5
National Research Centers
Fiscal Years 1969, 1970, and 1971

	Fiscal year 1969			Fiscal year 1970			Fiscal year 1971		
	Capital obligations	Research operations and support services	Total	Capital obligations	Research operations and support services	Total	Capital obligations	Research operations and support services	Total
Cerro Tololo Inter-American Observatory	$3,449,000	$1,101,000	$4,550,000	$365,000	$1,535,000	$1,900,000	$ 313,000	$ 1,967,000	$ 2,280,000
Kitt Peak National Observatory	1,137,700	4,561,810	5,699,510	46,000	6,419,000	6,465,000	127,000	7,092,600	7,219,600
National Radio Astronomy Observatory	483,212	6,795,002	7,278,214	675,000	5,180,000	5,855,000	- 0 -	6,897,400	6,897,400
National Astronomy and Ionosphere Center	.....	.....	.....	150,000	1,400,000	1,550,000	3,755,000	2,343,600	6,098,600
National Center for Atmospheric Research	425,000	10,611,737	11,036,737	212,840	11,228,960	11,441,800	484,280	14,194,626	14,678,906
Total	$5,494,912	$23,069,549	$28,564,461	$1,448,840	$25,762,960	$27,211,800	$4,679,280	$32,495,226	$37,174,506

This view of the Arecibo installation shows two of the three towers supporting the feed support structure 435 feet above the spherical mesh reflector. (Photo Cornell University)



The Robert R. McMath Solar Telescope at Kitt Peak National Observatory, Arizona. (Photo KPNO)

cessful have been the heating experiments where a 100 kilowatt transmitter operating at 40 MHz is used to locally heat the ionosphere. These experiments have yielded valuable information on physical processes and motions in the upper atmosphere.

KITT PEAK NATIONAL OBSERVATORY

Kitt Peak National Observatory (KPNO) is operated under contract to the Foundation by the Association of Universities for Research in Astronomy, Inc., a nonprofit consortium of nine U.S. universities. The observatory provides support facilities for a staff of 320 at its headquarters in Tucson, Ariz. Of these, 23 are scientists who carry out basic research in stellar and solar astronomy and in the planetary sciences.

Observing facilities, located atop Kitt Peak, 45 miles west of Tucson, include six stellar telescopes with apertures of 84, 50, 36 (two), and 16 (two) inches. The telescopes were used in fiscal year 1971 by 100 visiting astronomers and 51 graduate students from U.S. and foreign institutions. The two largest telescopes were assigned to visitors 65 percent of the available viewing time.

The Robert R. McMath Solar Telescope—the world's largest—is

also located on Kitt Peak. It was used by 33 visiting scientists from U.S. and foreign institutions in fiscal year 1971, accounting for 60 percent of the scheduled observing time. In addition, one scientist and 16 astronauts used the telescope as part of a NASA training program.

The building and rotating dome for the new 150-inch stellar telescope on Kitt Peak were completed, and installation of the telescope mounting was started. The primary mirror is nearly finished after 2½ years of grinding, polishing, and testing. The 158-inch-diameter mirror surface is accurate within a few millionths of an inch.

Public visitors to Kitt Peak during the year numbered over 52,300, with representation from all 50 States and five foreign countries.

Journey into Light, an informational film portraying the Kitt Peak facilities, functions, and programs, was produced by KPNO, and has been loaned to more than 100 organizations during the year.

CERRO TOLOLO INTER-AMERICAN OBSERVATORY

Cerro Tololo Inter-American Observatory (CTIO), operated under contract to the Foundation by the Association of Universities for Research in Astronomy, Inc., is located in Chile, with headquarters in the city of La Serena. Observing facilities are at Cerro Tololo, a superb site in the Chilean Andes 40 miles to the southeast of La Serena. The facilities include five stellar telescopes with apertures of 60, 36, 24, 16 (two) inches and a Schmidt-type instrument with a 24-inch aperture. These telescopes provide unique opportunities for American astronomers to study celestial objects visible only from the Southern Hemisphere. Excellent observing conditions prevail at both infrared and visible wavelengths.

During fiscal year 1971, 66 astronomers from 35 institutions made observations at CTIO. Visitors from the United States, including graduate students, were assigned 62 percent of the available observing time. Another 13 percent of the telescope time was divided nearly equally among astronomers from Argentina, Canada, Chile, and West Germany. The remaining time was used by the CTIO staff.

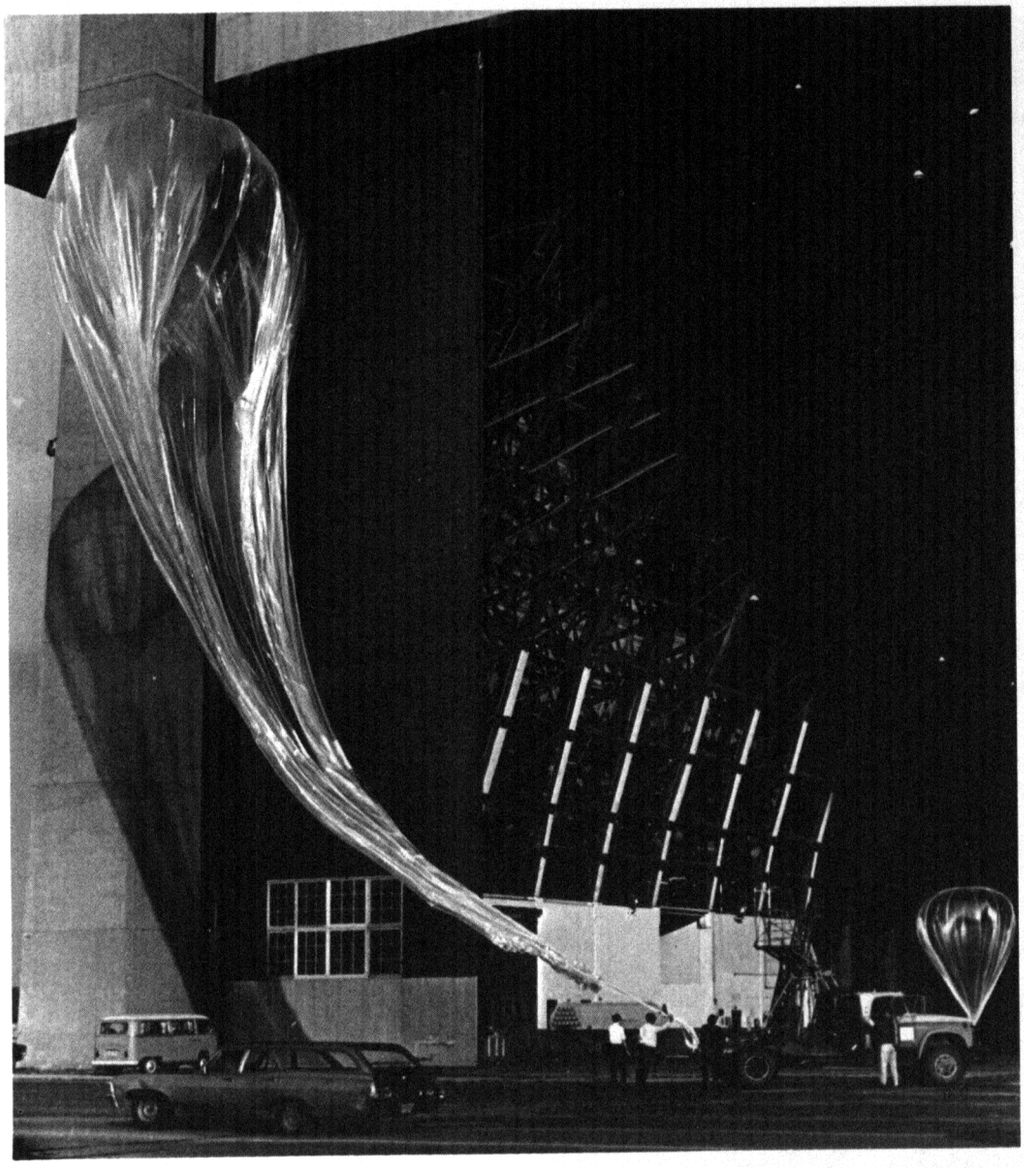
During the year, the coudé spectrograph of the 60-inch-diameter telescope became operational. This large spectrograph provides the means for accurate determination of many stellar parameters, including chemical composition, element abundances, and radial velocities. The telescope and pre-spectrograph optics are now being used in conjunction with a very high dispersion spectrometer for detailed topographic mapping of Mars during the current opposition. Improvements in image-tube techniques and computer-controlled data acquisition systems have increased telescope efficiency markedly.

Major construction work was concluded on a building to house the new 150-inch-diameter telescope. Two wings of a projected four-wing dormitory to house technicians were finished and occupied. In La Serena, an office addition to the headquarters building was completed. Also, an IBM 1130 computer was installed, enabling CTIO staff and visitors to reduce portions of their observational data while in Chile.

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

The National Center for Atmospheric Research (NCAR) is operated under a Foundation contract by the University Corporation for Atmospheric Research, a nonprofit consortium of 30 United States and one Canadian universities. NCAR facilities consist of the Mesa Laboratory and the High Altitude Observatory at Boulder, Colo.; the National Scientific Balloon Facility at Palestine, Tex.; and the Research Aviation Facility at the Jefferson County Airport near Boulder. A principal mission of NCAR is to support the work of university scientists by operating facilities for joint use and by providing leadership for large atmospheric research experiments. In calendar year 1970, NCAR served 150 visiting scientists.

Airborne photo of observatory site at Cerro Tololo illustrates majestic isolation of the Andean environment. (Photo KPNO)



A 22-meter GHOST balloon is inflated in preparation for launching. The small tow balloon will provide supplementary lift for the first few thousand feet. (Photo NCAR)

During fiscal year 1971, the NCAR staff of 570 included about 100 scientists at the doctoral level representing meteorology, physics, chemistry, mathematics, and other physical sciences. NCAR's programs place special emphasis on problems requiring interdisciplinary research.

In recent years, NCAR has played a significant role in organizing and managing cooperative efforts by scientists from universities, Federal laboratories, and other organizations conducting field studies that are beyond the scientific, technical, and logistical capabilities of a single institution. For example, the National Hail Research Experiment, which began preliminary operations under NCAR management in northeastern Colorado in the summer of 1971, unites atmospheric and social scientists and technicians from five universities, three Federal departments, and one State agency.

A major step toward increasing NCAR's capability in solving large, complex problems in fields such as atmospheric dynamics was the acquisition, in June 1971, of a Control Data Corporation 7600 computer system.

In February, the Research Aviation Facility dedicated its new hangar and operations base at the Jefferson County Airport. This 24,000-square-foot facility includes laboratories and shops as well as hangar space for NCAR's four research aircraft. A significant advance in facilities for atmospheric research was the sophisticated instrumentation developed and installed in the deHavilland Buffalo for dynamic studies of the atmosphere.

NATIONAL RADIO ASTRONOMY OBSERVATORY

The National Radio Astronomy Observatory (NRAO) is operated under contract to the Foundation by Associated Universities, Inc., a nonprofit consortium of nine U.S. universities. Observatory headquarters, located at Charlottesville, Va., provides support facilities, including a research library and computer, for a staff of 248. Thirty-seven scientists conduct basic research in radio astronomy using data gathered by radio telescopes located at Green Bank, W. Va., and Tucson, Ariz.

The major telescopes located at Green Bank include a 300-foot-diameter meridian transit instrument, a 140-foot-diameter fully steerable telescope, and an interferometer incorporating three 85-foot-diameter dishes and a portable 42-foot-diameter antenna for remote operations. The Tucson facility, located on Kitt Peak, includes a 36-foot millimeter-wave antenna. During the year, 140 visitors were allocated 67 percent of the available observing time on the telescopes.

Observing capacity at NRAO was enhanced by the development and installation on the Green Bank three-antenna interferometer system of a 1,420-MHz receiver system, designed to operate in conjunction with a new 384-channel autocorrelation receiver. Also, a new tunable receiver with a frequency range of 5 to 10 GHz (billion cycles per second) was constructed for the Green

NCAR technicians set up coherent cloud physics radar near Grover, Colo., for use in the National Hail Research Experiment. Radar is used to probe the growth, structure, and motions of thunderstorms. (Photo NCAR)

Bank 140-foot-diameter telescope for spectral-line studies. An additional receiver, operating in the 22 to 24 GHz range, was constructed for use on both the 140-foot telescope and the 36-foot telescope at Tucson.

At Tucson, the 36-foot telescope was placed in 24-hour operation for the first time. A new spectral-line receiver in the 67 to 101-GHz range and a computer processor also became operational. A capability for circular polarization observations at 31.4 GHz and 85 GHz was added during the year.

A new aluminum surface was installed on the 300-foot telescope, more than tripling the frequency coverage of the antenna. After the resurfacing, a four-channel, 2,700-MHz receiver was designed and installed for radio-source survey work. The variable-speed declination drive was computerized and modifications made near the focus to permit limited tracking of radio sources during meridional transit.

NRAO is collaborating with the following scientific research groups in the design, development and construction of terminal equipment for the very long baseline (VLB) interferometry of radio sources:

—Federal agencies

- Department of Defense (Naval Research Laboratory)
- Department of Commerce (National Oceanic and Atmospheric Administration)
- National Aeronautics and Space Administration (Jet Propulsion Laboratory)

—U.S. universities

- Cornell
- Harvard
- Massachusetts Institute of Technology

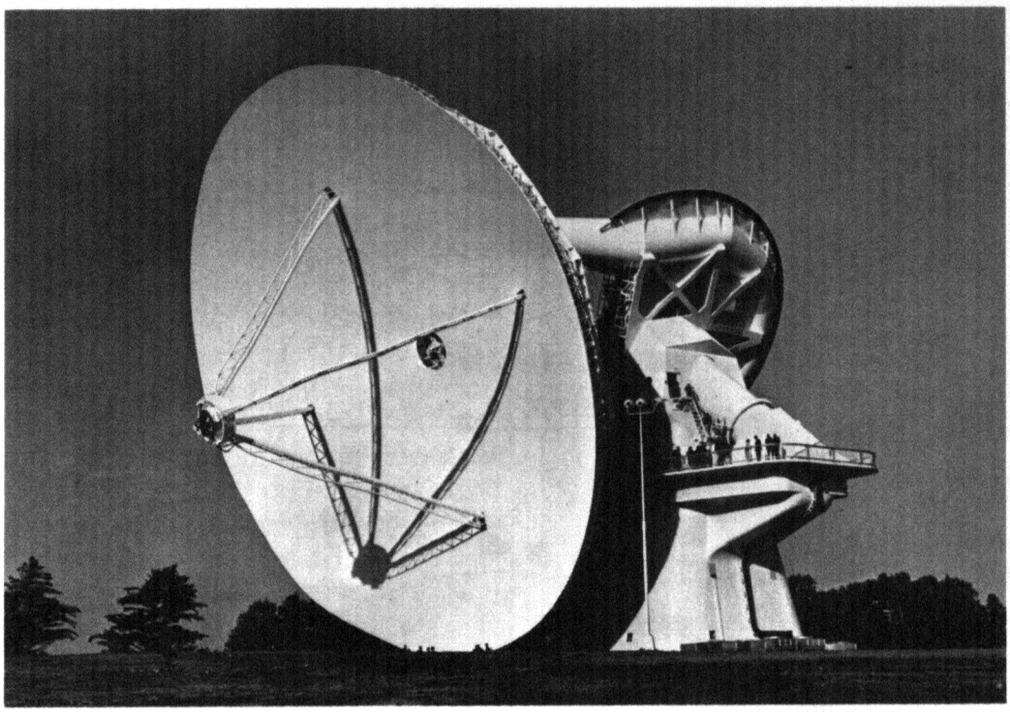
—Foreign research institutions

- Chalmers Institute of Technology (Sweden)
- Max Planck Institute (West Germany)

This collaboration has brought together the best in technical expertise from the radio astronomy community. These terminals, four of which are complete, incorporate special VLB signal processors to facilitate the first stage of data reductions.

COMPUTING ACTIVITIES IN EDUCATION AND RESEARCH

The objective of the Foundation's program of Computing Activities in Education and Research is to provide the nation with a base of computer science knowledge which will make possible innovative approaches for the use of computers in education and research. In addition, Government, industry, academic insti-



The 140-foot telescope at NRAO is the largest equatorially mounted radio telescope in the world. Seven years were required for design and construction of this high-precision instrument intended for use at shorter wavelengths. (Photo NRAO)

tutions, and other users will be able to evaluate better the capabilities and limitations of computers and to use their potential more effectively.

In fiscal year 1971, the Office of Computing Activities was reorganized into three new sections to reflect the changing nature of national requirements. The Computer Science and Engineering Section sponsors research in fundamental computer science, the Computer Innovation in Education Section helps bring the power of the computer to bear on the problems of education, while the Computer Applications in Research Section fosters the development of advanced computer techniques to increase science research capability.

COMPUTER SCIENCE AND ENGINEERING

The Foundation is supporting basic research in computer science and engineering to increase the fundamental knowledge available for continued progress in dealing with complex computational problems. During fiscal year 1971, attention was focused on three programs: Theoretical Computer Science, Software and Programming Systems, and Computer Systems Design.

Operating systems are computer programs which schedule and control a computer's activities, and their design is an area of special concern. Owing to their growing complexity through the decade of the 1960's, it has become increasingly difficult to design and implement such systems and virtually impossible to predict their performance using present knowledge and techniques. Research is being supported in computer science and engineering directed toward the discovery of principles that will enable the development of more manageable operating systems.

The principles for the design of more complex computer systems, the understanding of the effective means of implementing such systems, and the analysis of the limitations of complex systems need further development. During fiscal year 1971, these principles were investigated by researchers at many institutions, including the University of California (Los Angeles), the University of Texas, New York University, the University of Colorado, the State University of New York at Stony Brook, and the University of Washington. For example, at Stony Brook, Arthur J. Bernstein is studying the optimal scheduling of tasks for the different components comprising a computing system to minimize competition among computing jobs during simultaneous use of a single unit.

Another area of concern is that of system reliability. As the number of elements in computers and computer networks increases, the chance of individual failure resulting in breakdown increases. One principle of good design is to maximize the ability to detect and recover from error; another is to confine or localize the effects of each error. Edward J. McCluskey at Stanford University is studying one aspect of this problem—the effects of errors on networks of logical elements.

Automatic validation of input data assumes increased importance when data are received from automatic sensors or other sources without human scrutiny. This problem is being studied at Purdue University, Case Western Reserve University, and the University of California at Santa Cruz.

COMPUTER INNOVATION IN EDUCATION

In order to make effective use of the computer in education, there must be flexible hardware and software systems, a meaningful curriculum base, and related computer application programs which can be distributed through shared facilities. In fiscal year 1971, approximately $6 million was awarded to academic and nonprofit organizations towards the attainment of these goals.

Among the more dramatic prod-

ucts in the area of computer technology and systems is the home terminal developed by the MITRE Corporation. It consists of a slightly modified but otherwise standard home television receiver and video tape recorder together with some supplementary electronics. This combination is capable of furnishing 600 television sets simultaneously with individual and personalized picture sequences over a single coaxial cable and may help make economically feasible the home delivery of individualized instruction.

During fiscal year 1971, 23 grants were awarded for computer-oriented curriculum development at college and secondary school levels. The areas included engineering, mathematics, biology, chemistry, statistics, social sciences, and ecology.

The unit cost of computing continues to decrease as new equipment configurations, such as networks and minicomputers, offer a greater range of instructional alternatives. Research was carried out to determine how these developments might be used to increase instructional effectiveness.

The advent of lower cost pictorial displays spurred renewed interest in these devices for instructional purposes. The University of Oregon undertook a study of the use of graphics as an instructional aid in teaching physical sciences. Other experiments with instructional graphics are under way at the University of Michigan.

One of the most urgent needs in the instructional use of computers is the development of high quality instructional materials that can be adapted to several different systems. In this area, the Iowa Regional Computer Center is working with seven member institutions of a regional network to develop curricula in mathematics and biology. Dartmouth College will provide computer and staff support for six to 12 invited faculty members to develop course materials for use in teaching the environmental sciences.

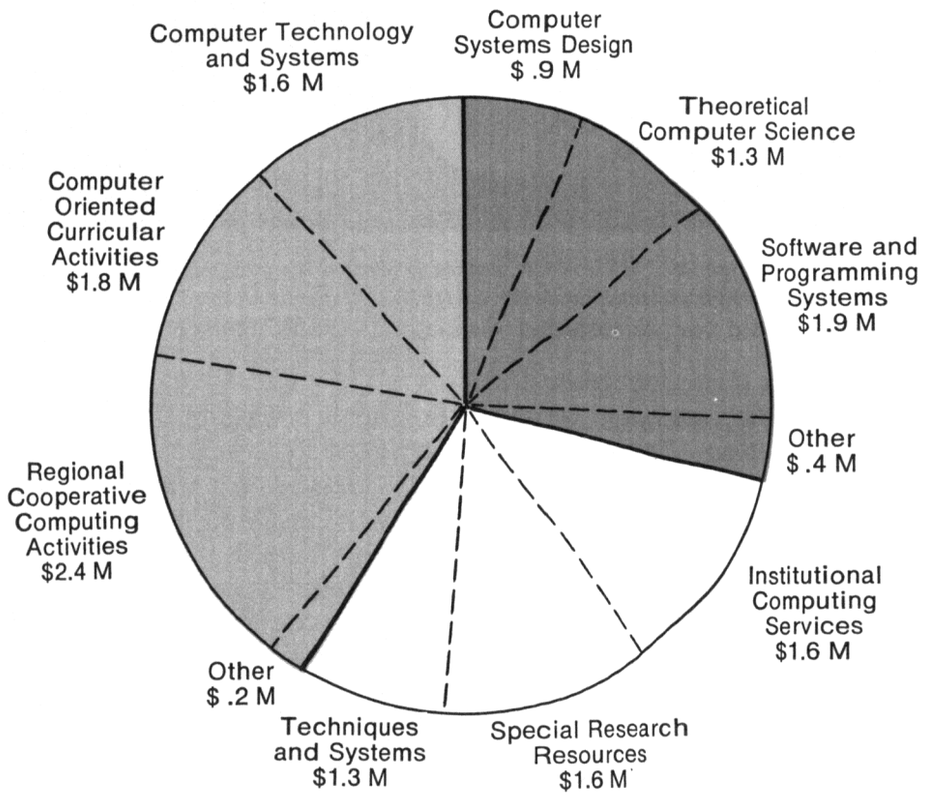
COMPUTING ACTIVITIES IN EDUCATION AND RESEARCH AWARDS BY PROGRAM CATEGORIES FISCAL YEAR 1971

Computer Innovation in Education Section.....$6.0 M

Computer Science and Engineering Section.....$4.5 M

Computer Applications in Research Section.....$4.5 M

TOTAL VALUE = $15.0 MILLION

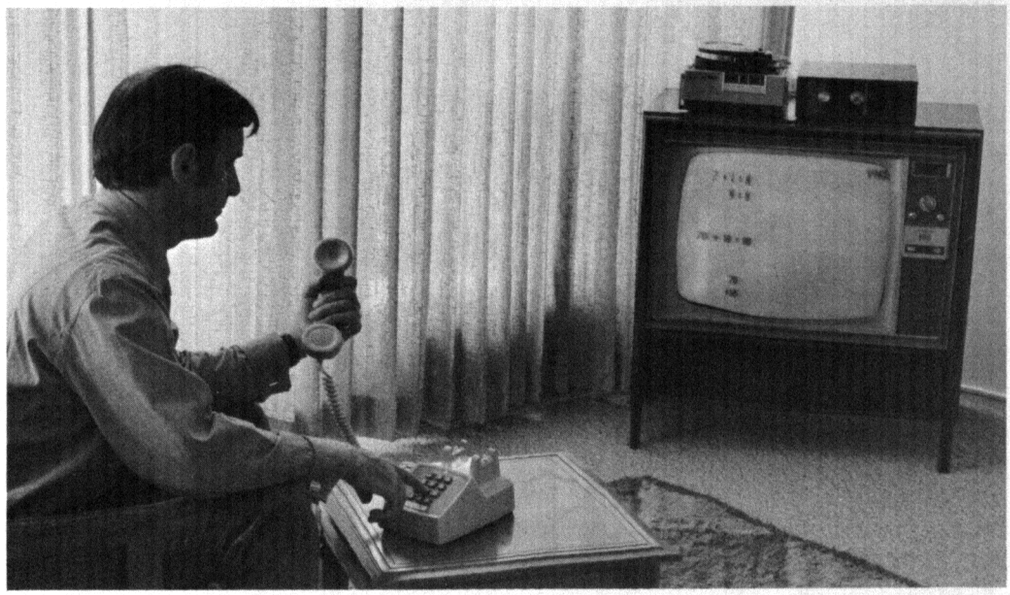


A second conference on "Computers in Undergraduate Curricula" was held at Dartmouth College in June of 1971 with NSF support. Partial support was also provided to the Illinois Institute of Technology and the Commission on College Physics to host a conference on "Computers in Undergraduate Science Education: Physics and Mathematics" in August of 1970. The growing attendance at these conferences and the marked increase in the quality of papers submitted are just two of the many indicators of a rapidly growing awareness of computer-based instruction.

The Foundation has been providing support for the establishment of educational computing networks through its Regional Cooperative Computing Activities Program since 1968. Typically, each network is organized around a major university which provides computer resources and assistance to a number of nearby institutions. The information and guidance offered enable participat-

ing faculties to discover discipline-oriented innovative techniques in computer usage and to develop computer applications which enhance the quality, depth, and breadth of their students' education. The regional activities also serve as a test bed for the computerized curricular products as well as for transfer and dissemination of new techniques.

In fiscal year 1971, 61 grants for regional activities, totaling approximately $2.4 million, included support for four major universities and 59 participating colleges in five States. Four new regional activities in New Jersey, Colorado, Washington, and California were added to the 18 established between 1968 and 1970. The wide variety of cooperative approaches is currently being analyzed, and the data will be presented in a forthcoming report.



A home computer terminal, utilizing conventional television technology and rapidly growing cable television systems, might allow computer-assisted instruction (CAI) and other graphic computational, data retrieval, and commercial computer services to be made available to mass populations at relatively low cost. (Photo MITRE Corp.)

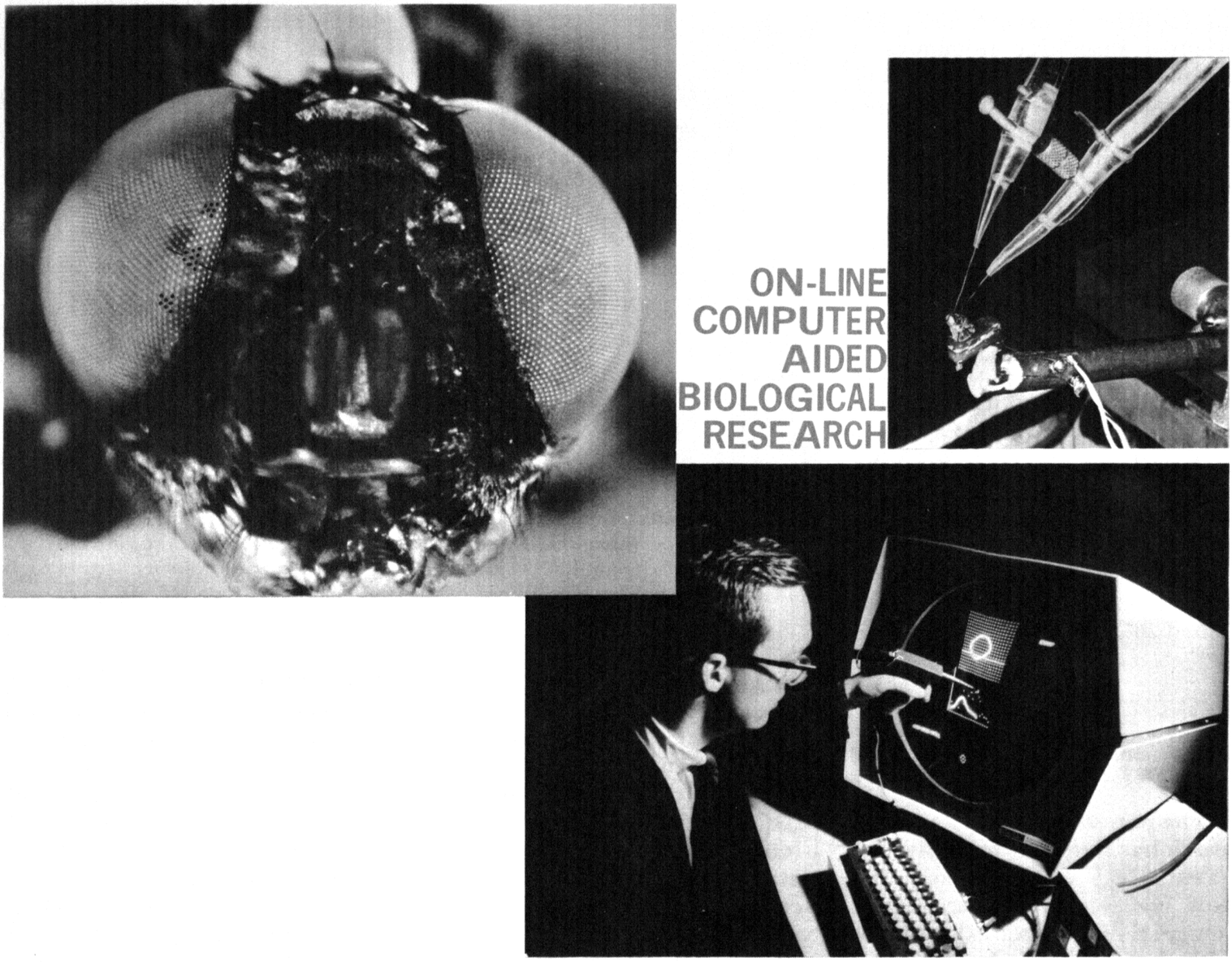
COMPUTER APPLICATIONS IN RESEARCH

The potential of computers in research has increased markedly with recent advances in technology. It is now possible for researchers to achieve a high degree of interaction with the computer via a variety of remotely located terminals. In many instances a computer is an integral part of a complex laboratory setting. The Foundation started specific programs in fiscal year 1971 to advance science research capability through the development of sophisticated computer-based techniques and systems. Three projects are described which illustrate this new activity:

- Researchers in the life sciences and computer science at the California Institute of Technology are developing a computing system for direct interaction between the researcher and the experiment. The computer permits the researcher to evaluate and redirect his experiment while the experiment is in process. The researcher can apply strategies that range between the methodology of formal modeling and the current procedures for data acquisition and analysis. This system concept has already been applied in intensive study of the complete nervous system of insects, most notably the housefly, *Musca domestica*. The system has enabled the detection and study of 108 distinct classes of interneurons representing a population of 300,000 interneurons, or about one-third of the interneurons of the fly. Before the system was developed, only a very few interneurons could be studied. Foundation support will permit further development of this advanced computational system applicable to a wide range of interdisciplinary research activities.

- A major research center in computational technology for economics and management science has been established by the National Bureau of Economic Research in collaboration with leading scientists at academic institutions. Attention is being given to the development of more comprehensive analytical approaches to cope with modeling of interdependencies, nonlinearities, and other complications which arise when different economic groups and institutions adjust to changes in their external circumstances and policy environments. Particular emphasis is placed on distribution of the new techniques to the research community. The center is designed to attract leading researchers in these fields and in computer science from universities and colleges, Government, nonprofit institutions, industry, and commerce.

- The Architecture Machine group at the Massachusetts Institute of Technology has developed a computer system capable of recognizing rough handwritten drawings, e.g., architectural sketches, to a considerable psychological depth. The computer monitors a sketch drawn on an electronic tablet with a light pen, and infers information about not only the shapes and locations of lines and corners, parallelism, perpendicularity, coplanarism, etc., but also the degree of certainty or interest felt by the artist in each section as might be suggested, for instance, by the rate at which the section was



Scientist at California Institute of Technology in action at the console of a highly interactive computer-based system created to further research in insect vision. (Photo California Institute of Technology)

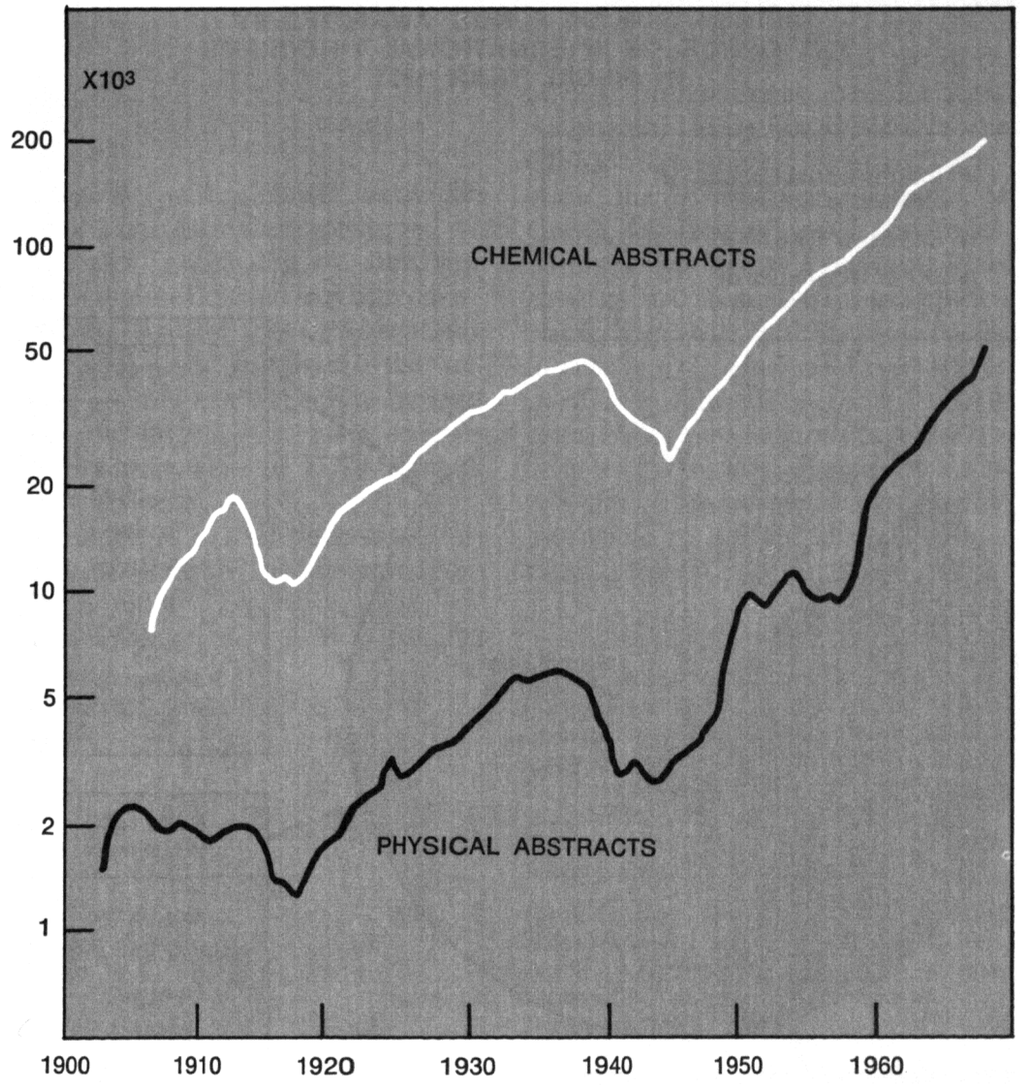
drawn. Projects such as this one provide the basis for more direct person/computer communication in the future, not only for architectural applications but for many other areas as well.

SCIENCE INFORMATION ACTIVITIES

Scientific research relies upon the information generated by prior investigations and yields results which, when disseminated within the scientific community, form the basis for continuing research and applications. In pursuing its legislative mandate to provide for information services "leading to a more effective dissemination of scientific information," the Office of Science Information Service in fiscal year 1971 made 78 awards totaling approximately $11 million and negotiated nine contracts for an additional $1 million in equivalent excess foreign currencies.

SYSTEM DEVELOPMENT AND IMPROVEMENT

Like research itself, investment in the improvement of the science communication system is cumulative in its effect. NSF assists professional societies in their development of information systems for their particular scientific disciplines, and it also assists universities in the development of information systems for the university community. The major focus in system development has been on the application of computer



Abstracts published in *Chemical Abstracts* and *Physics Abstracts,* doubling every 8.1 years except in wartime. (Photo ACS)

technology to information processing in order to reduce processing costs and to provide a variety of computer-produced services tailored to individual needs. The conversion to computerized systems hastens the time when the major information systems can be connected electronically through the use of standard telecommunication equipment.

Discipline-Oriented Science Information Activities

The discipline-oriented information systems funded by NSF are in various stages of development, with the American Chemical Society's Chemical Information System the most advanced. The Foundation expects that the demand for information from these systems will be sufficient to ensure that they can be operated without Federal support once they become fully operational.

The Chemical Abstracts Service (CAS) completed the conversion of its indexes to computer-based production this year and continued development of its computer-controlled composition and publishing operations. There are now 10 organizations in the United States as well as groups in Canada, the Netherlands, Sweden, the United Kingdom, and West Germany that are licensed to provide public services from the CAS machine-readable files. In response to requests from potential customer groups, CAS initiated a series of user seminars for orientation in the use of its new computerized data bases.

The American Institute of Physics (AIP) continued development of its computerized information system. Achievements during the year include: (1) a monthly series of magnetic tapes, each containing bibliographic records of articles published in AIP journals; (2) an announcement journal and (3) specialized bibliographies in selected subfields of physics.

The American Psychological Association developed and is testing a computer-readable magnetic tape edition of *Psychological Abstracts* which can be searched on a wide variety of computer equipment.

University-Centered Information Systems

Research libraries on university campuses have traditionally served the major information requirements of the academic community. In support of these libraries, computerized science information systems are being developed at six universities to exploit the machine-readable data bases produced by the professional societies. This past year marked the beginning of cooperative projects on a number of campuses to pool computer capabilities and share information system resources. A remote terminal at the University of Pittsburgh will provide access to data bases that can be searched more effectively and economically at the University of Georgia. Lehigh University has initiated plans to extend its system to serve a consortium of universities in the Delaware Valley region.

The University of Pittsburgh is expanding its chemical information system into a multidisciplinary campus-based information service. The Ohio State University began development of a computerized general science information system closely coordinated with its existing library facilities. A final grant was awarded

for development of the Treaty Information System at the University of Washington. The University of Arizona received a grant to study the feasibility of an Arid Lands Information Network involving the major arid lands research institutes in the United States.

INFORMATION SERVICES AND PUBLICATIONS

The Foundation's program for support of information services and publications is designed to help various scientific and engineering discipline organizations maintain information systems and services at an operational level sufficient to meet the essential needs of scientists and engineers.

Thirty projects received support for the operation or production of a variety of science information systems, services, and publications. Forty percent of the total obligation of about $3.5 million was for the support of the Science Information Exchange, which will be supported in the future by the Smithsonian Institution.

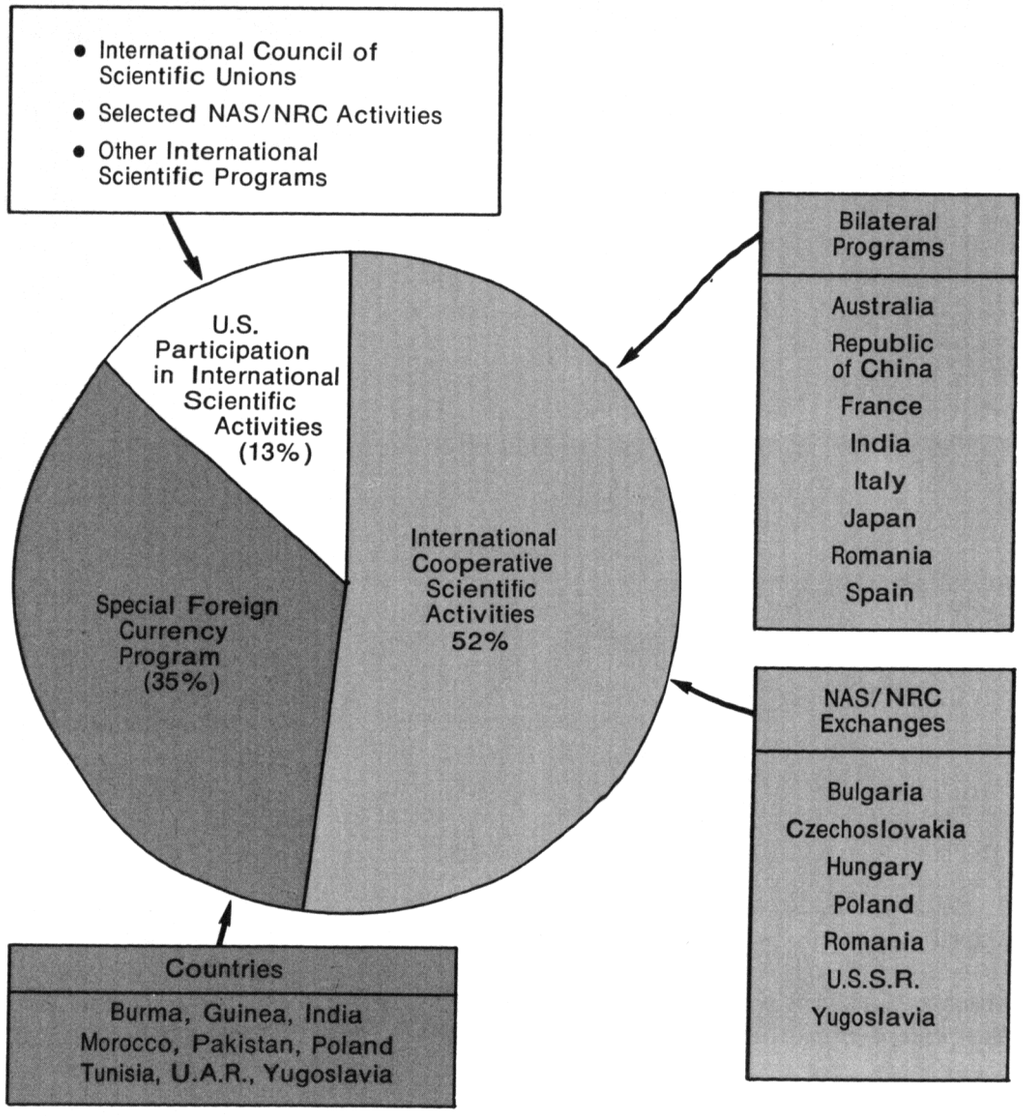
Major emphasis was directed to the existing communication system for science and engineering, which will continue to be central in the emerging national network of science information systems. Support was provided to activities in the fields of biology, psychology, physics, geology, engineering, and atmospheric sciences.

Support for primary publications was limited to one journal and two monographs, one of which recorded the geological history of the Alaska earthquake of 1964. A significant project of data compilation in the field of nuclear physics was undertaken with NSF support.

SCIENCE INFORMATION RESEARCH

Support for science information research during fiscal year 1971 was reoriented to cover a broad spectrum of research efforts ranging from basic through applied studies and pilot demonstrations in such problem areas as information formatting, data manipulation, library innovation, networking studies, system evaluation measures, user studies, and user education techniques.

DISTRIBUTION OF FUNDS AWARDED BY THE OFFICE OF INTERNATIONAL PROGRAMS IN FISCAL YEAR 1971



SPECIAL FOREIGN CURRENCY PROGRAM FOR SCIENTIFIC AND TECHONOLOGICAL INFORMATION

Science information activities supported under the Agricultural Trade Development and Assistance Act of 1954 (Public Law 480) involve the use of foreign currency credits in countries where such credits are in excess of normal U.S. governmental requirements. Contracts with nine foreign organizations resulted in the translation and republication in English of approximately 70,000 pages of primary journals, patents, and monographs from Russian, East European, Japanese, and other languages, as well as preparation of abstracts, compilation of annotated bibliographies, and preparation of guides to foreign scientific institutions and information services.

INTERNATIONAL SCIENCE ACTIVITIES

International scientific activities of the Foundation are designed to foster the interchange of information between U.S. and foreign scientists, to produce new scientific knowledge, and to enrich the national scientific effort with foreign ideas and approaches, with concurrent advancement of U.S. foreign policy interests.

As much as 10 to 15 percent of the funds obligated by the National Science Foundation in fiscal year 1971 may be identified with projects having international implications. Among the more apparent are the Global Atmospheric Research Program, the International Decade of Ocean Exploration, and the International Biological Program. Less obvious are Foundation-supported research grants that include funds to enable the principal investigator to visit a laboratory in a foreign country, awards to foreign scientists to attend Foundation-funded summer institutes, and grants to American scientists for travel to international scientific meetings.

Name of Program	*Year Initiated*	*Activity Summary, FY 1971*
United States-Japan Cooperative Science Program	1961	Fifteen awards were made for joint research in mathematics, biochemistry, biology, meteorology, physics, and geophysics; 18 joint seminars were held. Support was provided for the continuation of the United States-Japan Science Film Project. An Eminent Visiting Scientists Program was initiated. Funds obligated: $212,890
India-United States Exchange of Scientists Program	1967	Eight Indian scientists visited the United States for familiarization with research centers and activities; seven U.S. scientists traveled to India to lecture and consult. Funds obligated: $22,565
United States-Italy Cooperative Program in Science	1967	One award was made for a seminar in mathematics held in Udine, Italy. Funds obligated: $8,500
United States-Australia Agreement for Scientific and Technical Cooperation	1968	One joint seminar on "Recent Advances in Photosynthesis" was held in Canberra. Funds obligated: $4,000
United States-Republic of China Cooperative Science Program	1969	Five U.S. scientists traveled to Taiwan to teach and conduct research in engineering, mathematics, biochemistry, and palynology. Funds obligated: $79,200
Agreement of Friendship and Cooperation between the United States and Spain	1970	Activities were limited to program development. No funds obligated.
United States-France Exchange of Scientists Program	1970	Grants were made to 11 French scientists for study in the United States. Awards were received by 12 U.S. scientists for study in France. Funds obligated: $113,647
Program of Exchange between the United States and Romania	1970	One joint research project on atomic and plasma physics was supported; 17 Romanian scientists visited the United States for familiarization with U.S. technology and research activities; and five American scientists went to Romania for research and study. Funds obligated: $90,000

The above activities are discussed elsewhere in appropriate sections of this report. Programs described on the following pages are those administered directly by the Office of International Programs.

INTERNATIONAL COOPERATIVE SCIENTIFIC ACTIVITIES

During fiscal year 1971, the Foundation served as executive agency for bilateral research and exchange programs with Australia, the Republic of China, France, India, Italy, Japan, Romania, and Spain. The cooperative programs with France, India, and Romania involve exchanges of scientists between the United States and those countries; the other bilateral programs include support for the U.S. portion of joint research projects, seminars, and scientist visits. The Foundation assumed responsibility for the United States-France Exchange of Scientists Program on July 20, 1970, and accepted executive agency responsibility for the science and technology aspects of the United States-Spain Agreement of Friendship and Cooperation on December 14. The table lists the eight current bilateral programs, the year initiated, and a summary of activities in fiscal year 1971.

The Foundation supports the National Academy of Sciences Exchange Program with the Academies of Science of the U.S.S.R. and East European countries. During fiscal year 1971, 27 U.S. scientists visited the U.S.S.R. and 25 Soviet scientists visited the United States under this program.

Fifty U.S. scientists also visited research institutes of the East European Academies of Science during fiscal year 1971: Czechoslovakia, 12; Poland, 17; Romania, 15; and Yugoslavia, 6. Twenty-seven East European scientists visited the United States for an average stay of 4 months each.

U.S. SCIENTIFIC PARTICIPATION IN INTERNATIONAL PROGRAMS

The Foundation provided funds to the National Academy of Sciences (NAS) for staff and other assistance to U.S. representation in 30 international organizations. These funds support meetings of the U.S. national committees for various international scientific unions, program reviews and meetings held by the Advisory Committee on International Organizations and Programs, and U.S. dues to the International Council of Scientific Unions (ICSU) and its 16 affiliated unions.

Other Foundation support to the National Academy of Sciences enabled U.S. scientists to participate in discussions of a proposed center for the study of problems of advanced societies. Several meetings among British, French, Italian, Soviet, United States, and West German officials have resulted in the drafting of a charter, the formation of a site-location committee, and an official name for the center: the International Institute for Applied Systems Analysis.

Partial support was provided for the NAS Committee for International Environmental Programs (IEPC). The IEPC has prepared position papers for U.S. participation in the 1971 Economic Commission for Europe Conference in Prague, the UNESCO Man and Biosphere Program, and the United Nations Conference on the Human Environment to be held in Stockholm in 1972. The IEPC also serves as the adhering committee to the ICSU Scientific Committee on Problems of the Environment, establishes communication with nongovernmental national organizations in other countries, and acts as a national information center on international environmental activities.

An American scientist conducts a short course in gas chromatography at the University of Punjab, India. (Photo American Chemical Society)

SPECIAL FOREIGN CURRENCY PROGRAM FOR SCIENTIFIC RESEARCH AND RELATED ACTIVITIES

The first project to be approved (in April 1971) was support for a Regional Conference on Planning and Design of Tall Buildings in Bled, Yugoslavia. In May, another 18 research projects were approved: 14 in Yugoslavia, two in Egypt, one in Poland, and one multicountry project involving research in Tunisia, Morocco, and Egypt. Twenty-one international travel grants were awarded for program development and consultation in special foreign currency countries. These activities are supported under the Agricultural Trade Development and Assistance Act of 1954 (Public Law 480).

SCIENCE EDUCATION IMPROVEMENT PROGRAM IN INDIA

This program, started in 1966, is supported entirely by funds transferred to NSF by the Agency for International Development. The objective of the program is to improve scientific and technical education in biology, chemistry, mathematics, and physics at the high school and college levels, technology at the junior college level, and engineering at the college level. During fiscal year 1971, 63 consultants for curriculum development and institutional development activities were supported under this program. Other activities included a binational conference on education and research and the presentation of six American Chemical Society short courses.