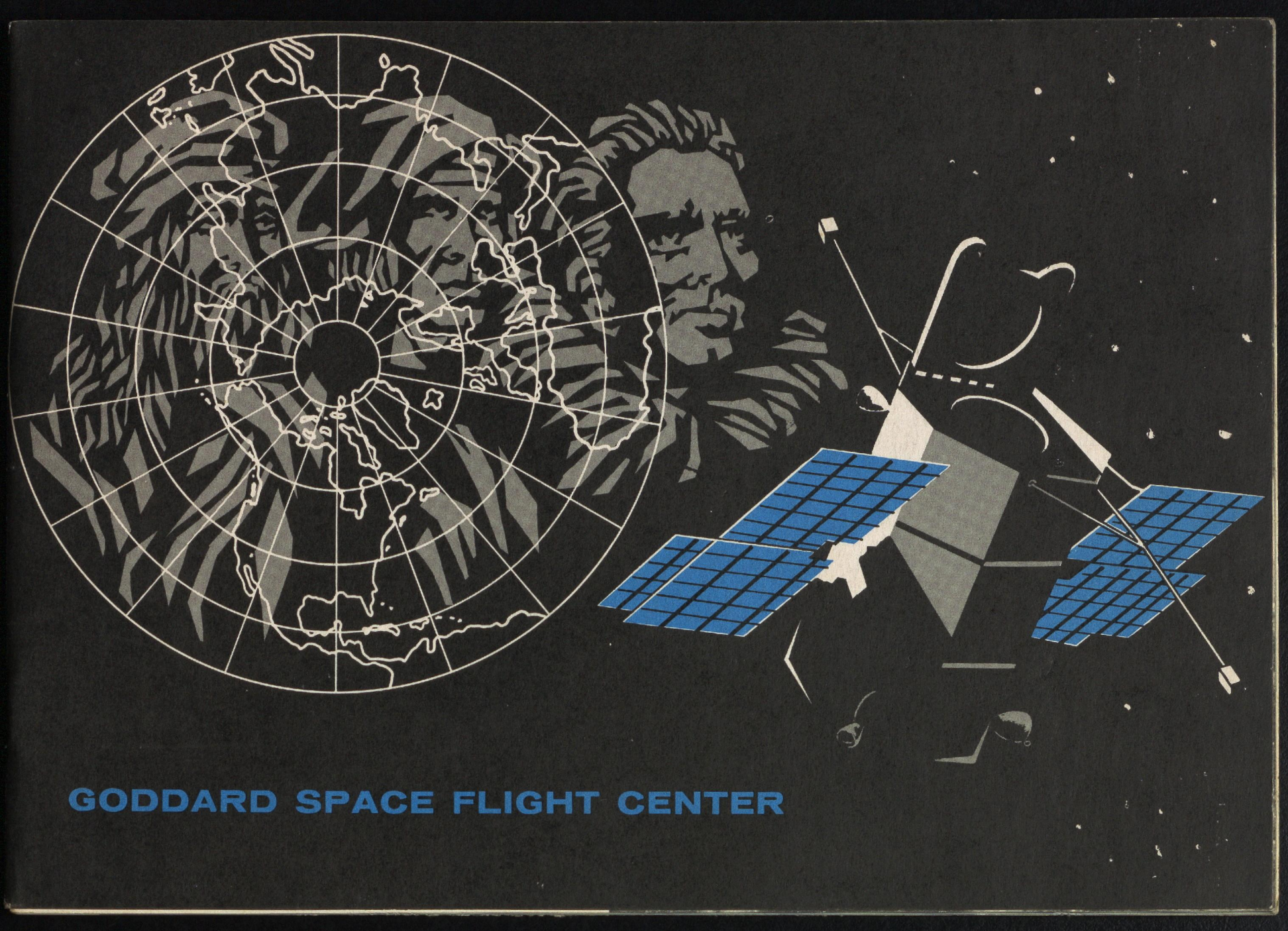
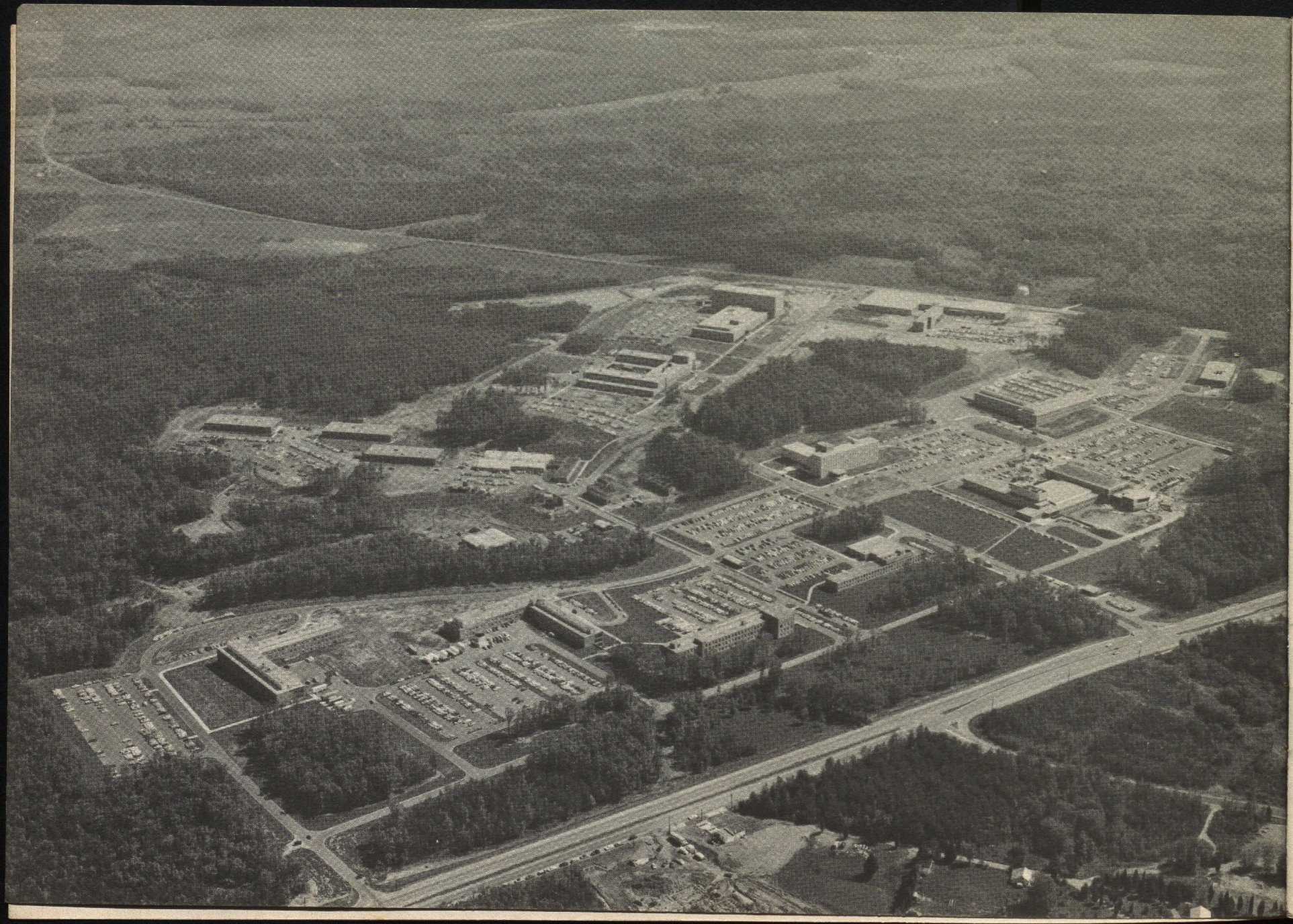


GODDARD SPACE FLIGHT CENTER

Space is no longer silent

With orbiting satellites and space probes man has embarked on a great adventure to explore the universe. This has been his dream and challenge for ages, for man has a purpose in space . . . the same purpose which motivated Galileo, Columbus and Admiral Byrd. The United States, through the National Aeronautics and Space Administration, is spearheading the systematic, scientific search for space knowledge. Deeply concerned with this massive national effort, are the skills, energies and hopes of the staff of the Goddard Space Flight Center of the National Aeronautics and Space Administration.



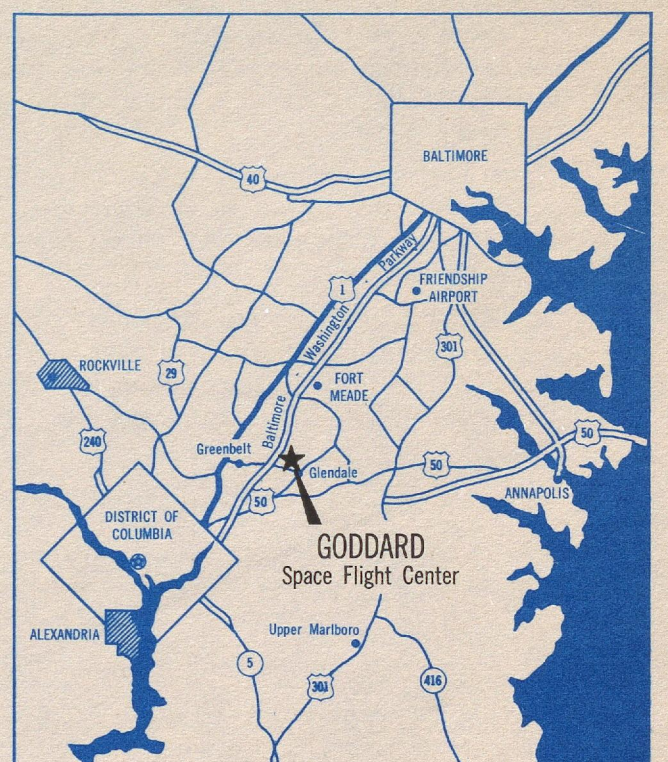
GODDARD SPACE FLIGHT CENTER

The Goddard Space Flight Center, first major United States laboratory devoted entirely to the investigation and peaceful exploration of space, is located on 550 acres of wooded land near Greenbelt, Maryland—about 10 miles northeast of Washington, D. C. The Center was established on May 1, 1959. It was named after Dr. Robert H. Goddard, American pioneer in rocketry.

The Center staff numbers more than 3,600. While the majority are at the Greenbelt site and at various continental United States installations such as the Goddard Institute for Space Studies in New York, other members of the Goddard team are located throughout the world, operating satellite tracking and communications network stations, and some are working with foreign nations on international space projects.

The Center is responsible for complete development of sounding rockets and orbiting spacecraft experiments in basic and applied science. The work covers scientific satellites and applications technology satellites which orbit in cis-lunar space (region between the earth and the moon). In addition, the Center manages NASA's Delta rocket and two world-wide Tracking, Data Acquisition and Data Reduction Networks.

By virtue of the extremely wide variety of projects and responsibilities, Goddard is one of the few installations in the world, capable of conducting a full range space science experimentation program—from theory, through experiment, design and construction, satellite fabrication and testing, and tracking, data acquisition and data reduction.



EXPLORING SPACE

Space science is science in space. From the vantage point provided by an orbiting satellite or a space probe, scientists attack some of the most important and challenging scientific problems of today.

Scientific disciplines that heretofore had gone their separate ways with only occasional interactions now tackle, in close partnership, the problem of understanding the phenomena and properties of outer space.

At Goddard, physicist, astronomer, geodesist, mathematician, geologist, engineer, astrophysicist, and many others explore the innermost workings of the universe. Each one of these disciplines is finding that it has a new frontier.

The program is of great importance. It provides the basic scientific data essential to a better understanding of the world and of the universe and produces the knowledge needed for both manned space flight and for applications (weather and communications) satellite projects.

The areas being studied by Goddard scientists can be divided into three general areas of interest.

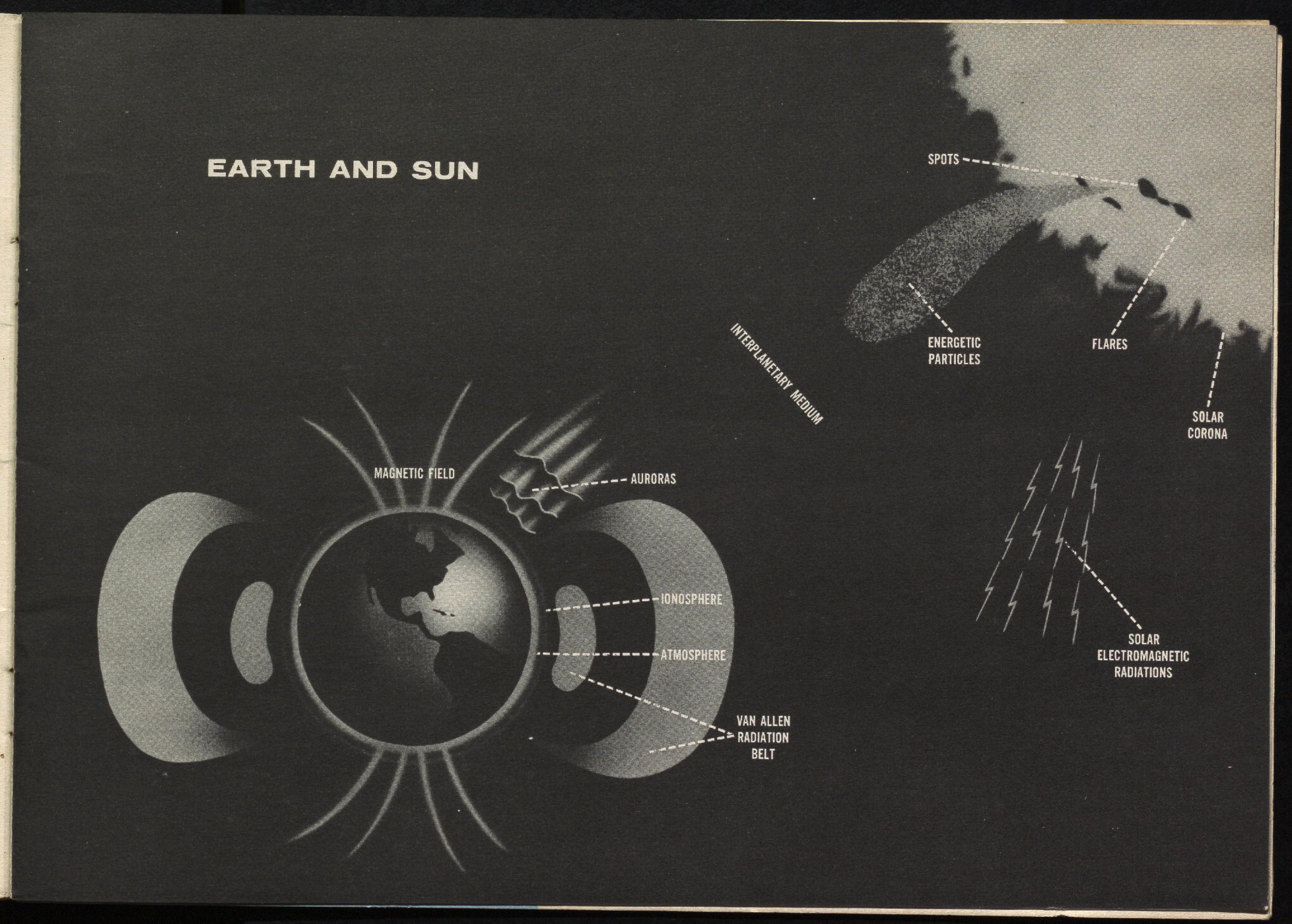
The first concerns the sun itself, the "mother" star of our universe. Before the advent of the satellite, man studied the sun as if through a translucent blindfold, because the earth's atmosphere cuts out a high percentage of the sun's radiation. One objective of Goddard's sun-earth studies from satellites is to observe details and effects of sun-spots and solar flares which are a basic cause of many of the phenomena experienced on earth.

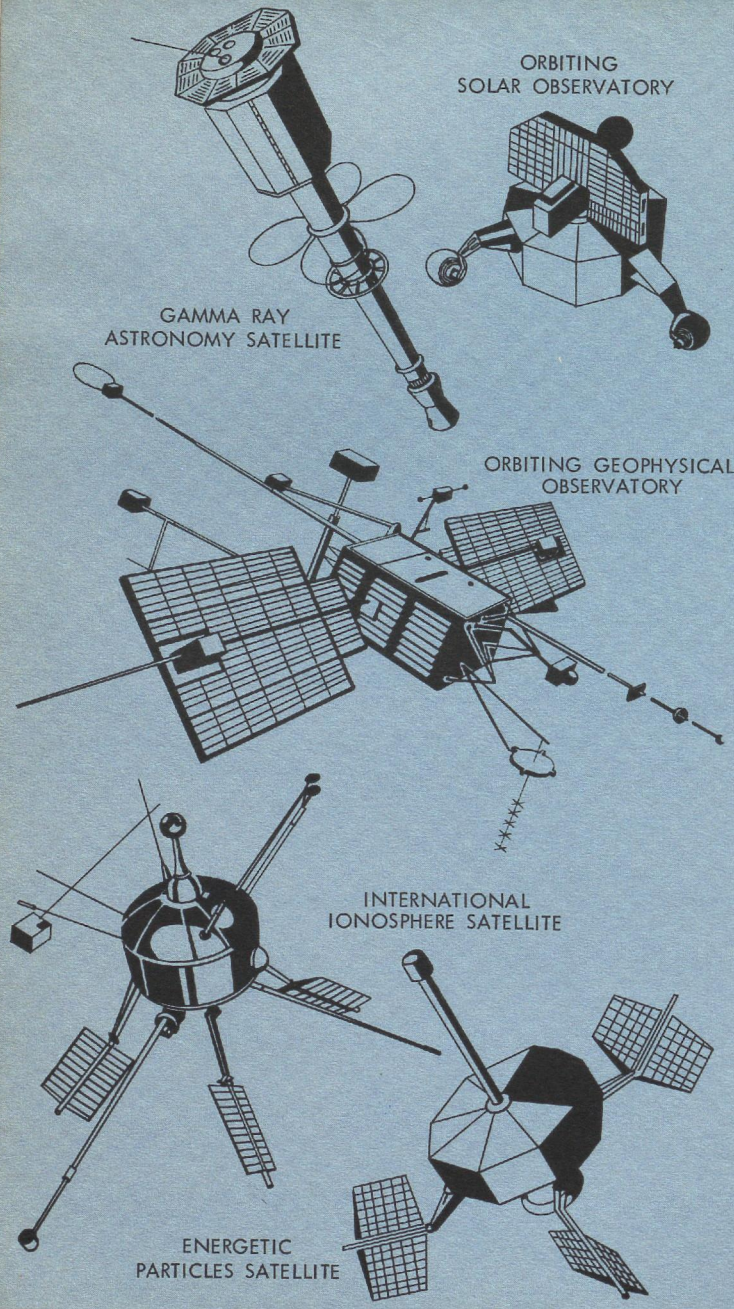
The second study area is referred to as interplanetary space. It is distinguished from the near-earth region because the phenomena in the interplanetary region are dominated by the sun, and relatively uninfluenced by the earth. In this interplanetary region it is possible to observe the sun's electromagnetic radiations and solar activities essentially unaffected by the earth's magnetic field.

The third region being investigated is the near-earth region called the magnetosphere. This is a region in which the magnetic field of the earth exerts a major influence. It acts as a protective shield and prevents a major portion of the sun's radiations from reaching the earth. At the equator, the magnetosphere extends up some six earth radii, or 24,000 miles; at the magnetic poles this shield is much thinner and solar effects such as the aurora occur at much lower altitudes.

Typical spacecraft associated with basic research are sounding rockets and space probes, satellites of the Explorer series, Orbiting Geophysical Observatories, Orbiting Astronomical Observatories, and Orbiting Solar Observatories. The applications program chiefly involves research and development with meteorological and communications satellites, such as the TIROS and NIMBUS meteorological spacecraft, and the Applications Technology Satellites.

EARTH AND SUN





SCIENTIFIC SATELLITES

Scientific satellites are orbiting laboratories which conduct extended observations at and beyond the edge of the earth's atmosphere. Satellites about the moon, sun or the planets will permit prolonged observations of those bodies.

The satellite's immediate environment at the edge of space is "empty" only by earthly standards. Actually, space is filled with energy, radiation and particles of great variety. With the aid of satellites, scientists now explore this strange environment through which the spacecraft moves. Thus, man can look out into the universe and record information that can never reach the earth's surface because of the intervening atmosphere, or he can look down at the earth as it has never been seen before.

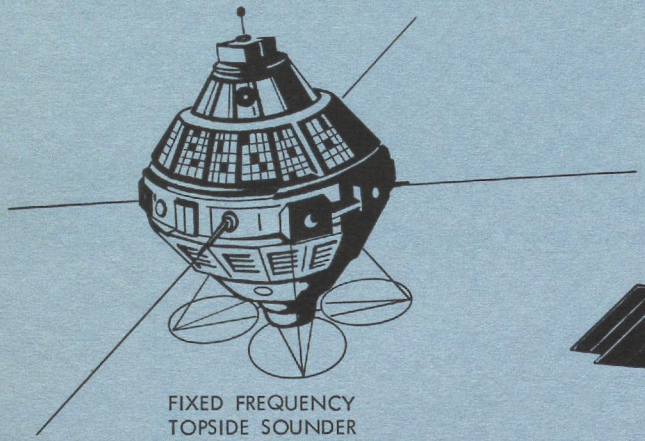
Out of this scientific research will come new knowledge about the universe and its laws; about the earth and its atmosphere; the sun and its influence on the earth and finally, knowledge about physical life, its origins and fundamental nature.

Scientific satellite projects managed by Goddard personnel include the following:

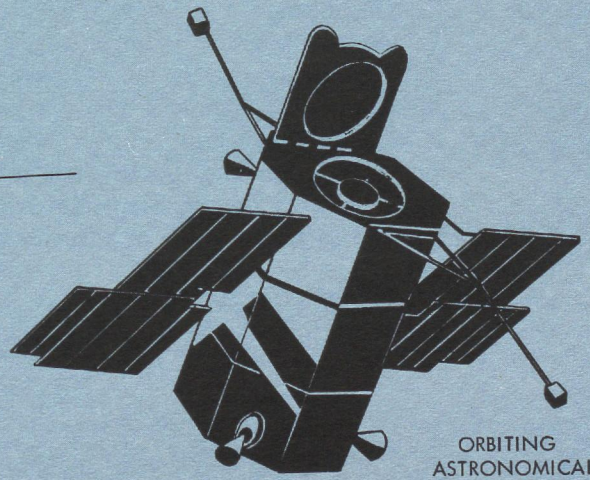
PROJECT	OBJECTIVE
Orbiting Solar Observatories	Studies of electromagnetic radiation from the sun.
Orbiting Astronomical Observatories	Telescopic stellar observations in the ultraviolet spectrum.
Atmospheric Structure Satellite	Study of composition, density, pressure and temperature of earth's upper atmosphere.
Swept Frequency Topside Sounder	Studies of upper ionosphere
Fixed Frequency Topside Sounder	Studies of upper ionosphere

Orbiting Geophysical Observatories	Broad scale geophysical studies encompassing radiation belts, ionospheric phenomena, and magnetic fields.
Energetic Particles Satellites	Radiation and magnetic fields.
International Satellites	To provide cooperative experimental capabilities in space to the international scientific community.
Electron Density Profile Probes	Ionospheric electron concentration and radio wave propagation studies.

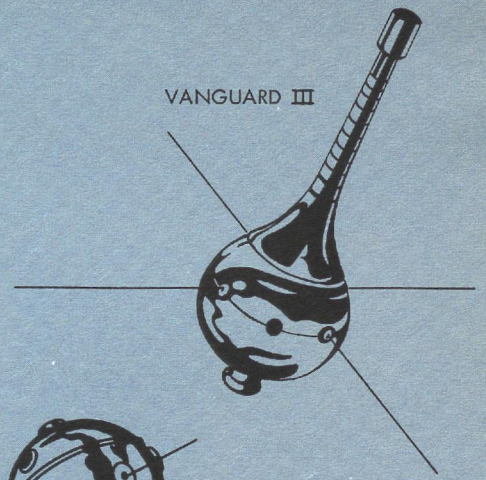
These satellites will be launched from the Atlantic or Pacific Missile Range. Their orbits will vary, from circular to highly elliptical and equatorial to polar, as required by the nature of the experiment.



FIXED FREQUENCY TOPSIDE SOUNDER

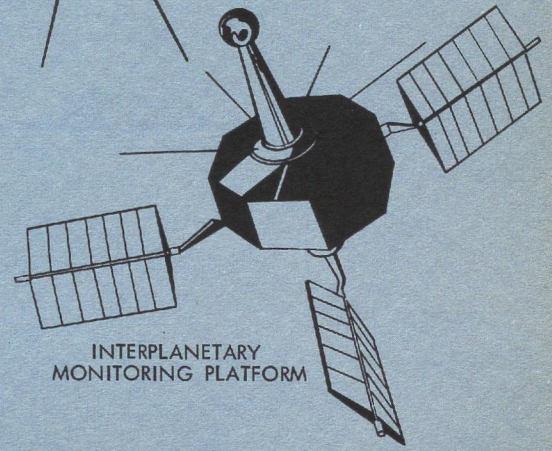


ORBITING ASTRONOMICAL OBSERVATORY

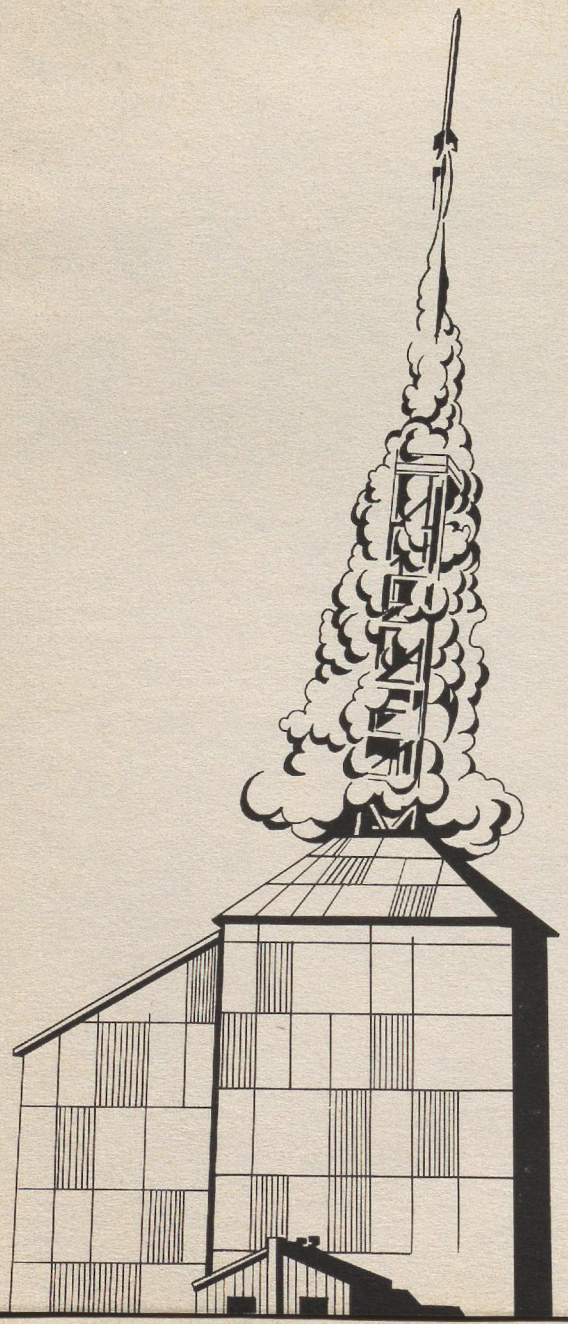


VANGUARD III

ATMOSPHERIC STRUCTURE SATELLITE



INTERPLANETARY MONITORING PLATFORM



SOUNDING ROCKETS

An important area of research and development is carried out with sounding rockets. These vehicles are used to conduct experiments in and beyond the earth's atmosphere; they also serve as "test beds" for instrumentation to be flown in satellites.

The Goddard Space Flight Center is responsible for aerodynamic design, integration of payloads and flight test firings in the NASA's sounding rocket program. It is part of a broad research program embracing American industry, government, universities and other nations.

Sounding rockets fly in nearly vertical trajectories, carrying packages of scientific instruments to heights of from 50 to several thousand miles. A sounding rocket's effective lifetime until it drops back to earth lasts from only a few minutes to several hours. All the scientific data that the rocket will make available, must be collected in this brief period.

Sounding rockets are usually launched from Wallops Island, Virginia; Woomera, Australia; or from Fort Churchill, Canada.

Fort Churchill is the launching site for upper altitude sounding rockets because it is far north where the magnetosphere is the thinnest. It is well situated to study polar cap and auroral events. It also is the best place to peer through the magnetosphere and sample what goes on outside the shield.

It is fairly easy to recover sounding rocket payloads and to obtain samples for detailed examination. One method used is the nuclear emulsion technique. Nuclear emulsions are blocks of photosensitive emulsion used to coat photographic plates. Via sounding rockets these are sent up to altitudes of about 1,300 miles. Upon recovery the emulsions are developed to see what has hit them. It is thus possible to get a sample of particles which some 30 minutes earlier had been on the sun.

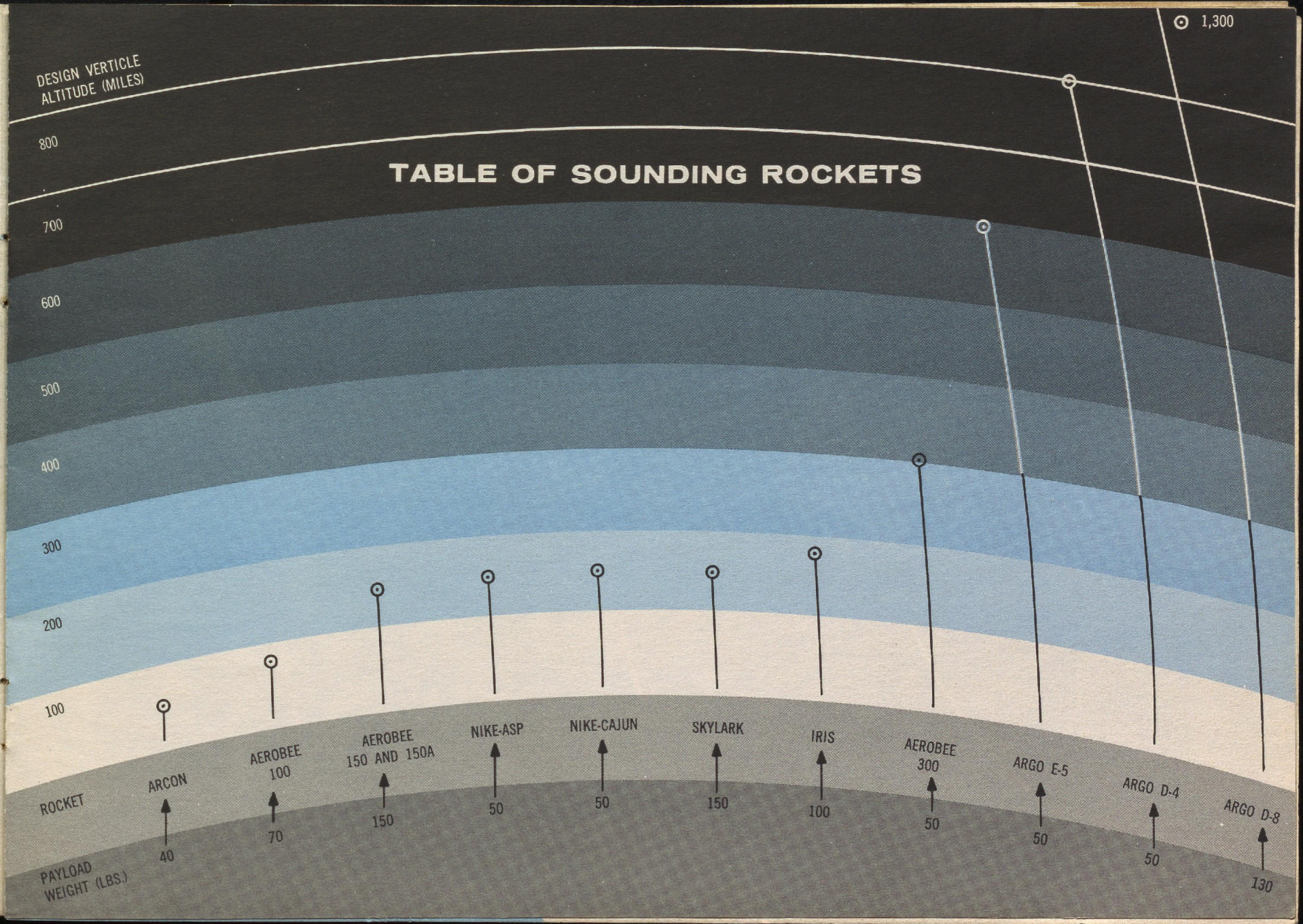
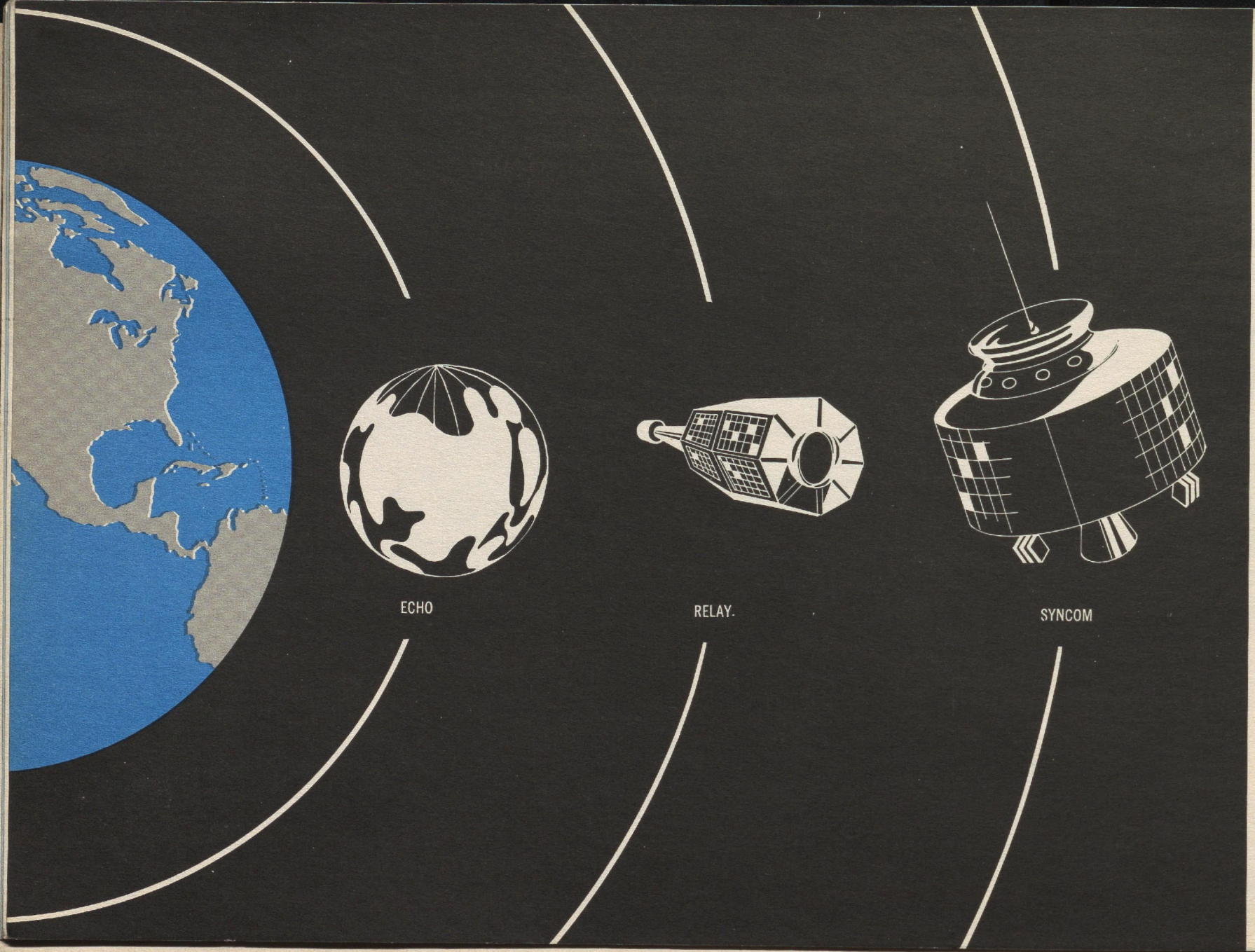


TABLE OF SOUNDING ROCKETS
DESIGN VERTICLE ALTITUDE (MILES)
800
700
600
500
400
300
200
100
1,300
ROCKET
PAYLOAD WEIGHT (LBS.)
ARCON
40
AEROBEE 100
70
AEROBEE 150 AND 150A
150
NIKE-ASP
50
NIKE-CAJUN
50
SKYLARK
150
IRIS
100
AEROBEE 300
50
ARGO E-5
50
ARGO D-4
50
ARGO D-8
130


ECHO
RELAY
SYNCOM

APPLICATION SATELLITES

Man is fast learning how to better his daily life with the use of orbiting satellites. Goddard scientists are active in two major areas involving satellite applications: meteorology and communications.

COMMUNICATION SATELLITES

This program has consisted of passive communication systems such as ECHO and the active repeater systems: RELAY and SYNCOM. (NASA, through Goddard Space Flight Center, also assisted Telstar, a commercially sponsored communication satellite experiment.)

The ECHO project was designed to explore the feasibility of lightweight uninstrumented inflatable spheres as "passive" reflectors of radio and other electronic signals.

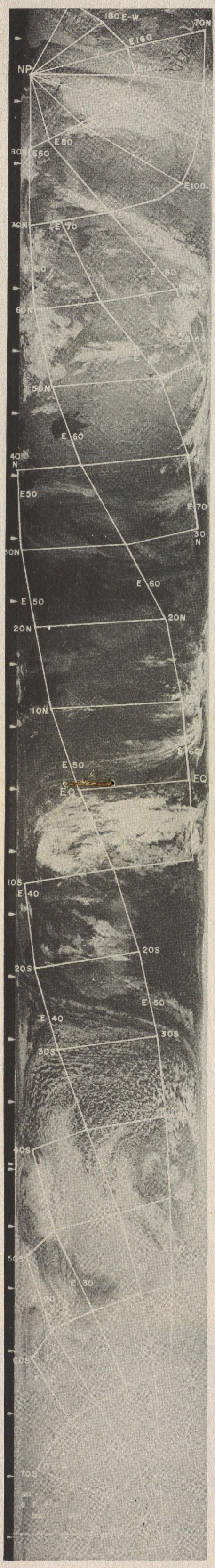
RELAY and SYNCOM were active communication satellite projects. These satellites contained on-board electronics—they receive a signal from earth, amplify it and rebroadcast it back to earth. Solar cells operate the electronic equipment aboard the spacecraft.

Project RELAY demonstrated the feasibility of wide-band communications via a medium altitude (6,000-10,000 miles) active satellite. SYNCOM traveling in an earth-synchronous orbit at an altitude of some 22,300 miles proved the feasibility of a communications satellite which appeared to be stationary above the earth. This concept has subsequently been adopted for the world's first commercial communications satellite "Early Bird".

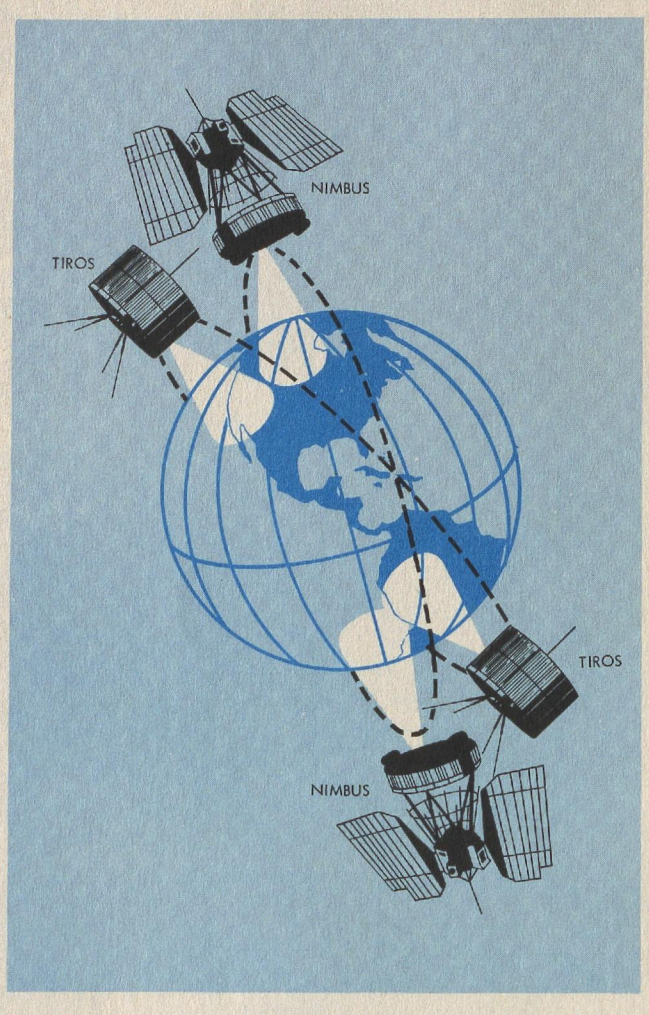
APPLICATIONS TECHNOLOGY SATELLITES

The Applications Technology Satellite project was conceived to further extend spacecraft technology in meteorology, communications and scientific observation at the medium (6,000 nautical miles) and synchronous (22,300 nautical miles) orbits.

A major goal of the ATS project is to provide basic design information on spacecraft orientation at high altitudes. Another objective is to investigate and flight test spacecraft technology common to a number of spacecraft applications for the stationary or synchronous orbits. This includes such areas as materials research, navigational applications, attitude determination and spacecraft stabilization.



Nimbus satellite took this photograph of the worlds weather from pole to pole.



WEATHER SATELLITES

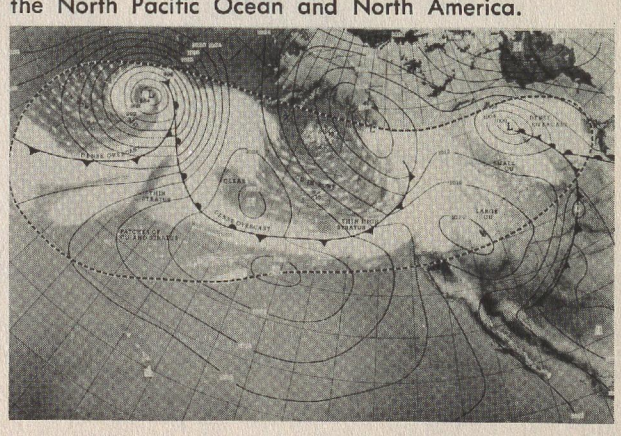
The Goddard-managed NASA meteorological satellite program includes two major systems, TIROS and NIMBUS. These will progressively improve monitoring and prediction of world-wide weather conditions and man's understanding of meteorological activity. Weather satellites provide information on the earth's cloud cover, storm locations, temperature and heat balance. Goddard's program is concerned with the spacecraft, and with on-board equipment to obtain and handle the data and satellite-to-earth communication systems.

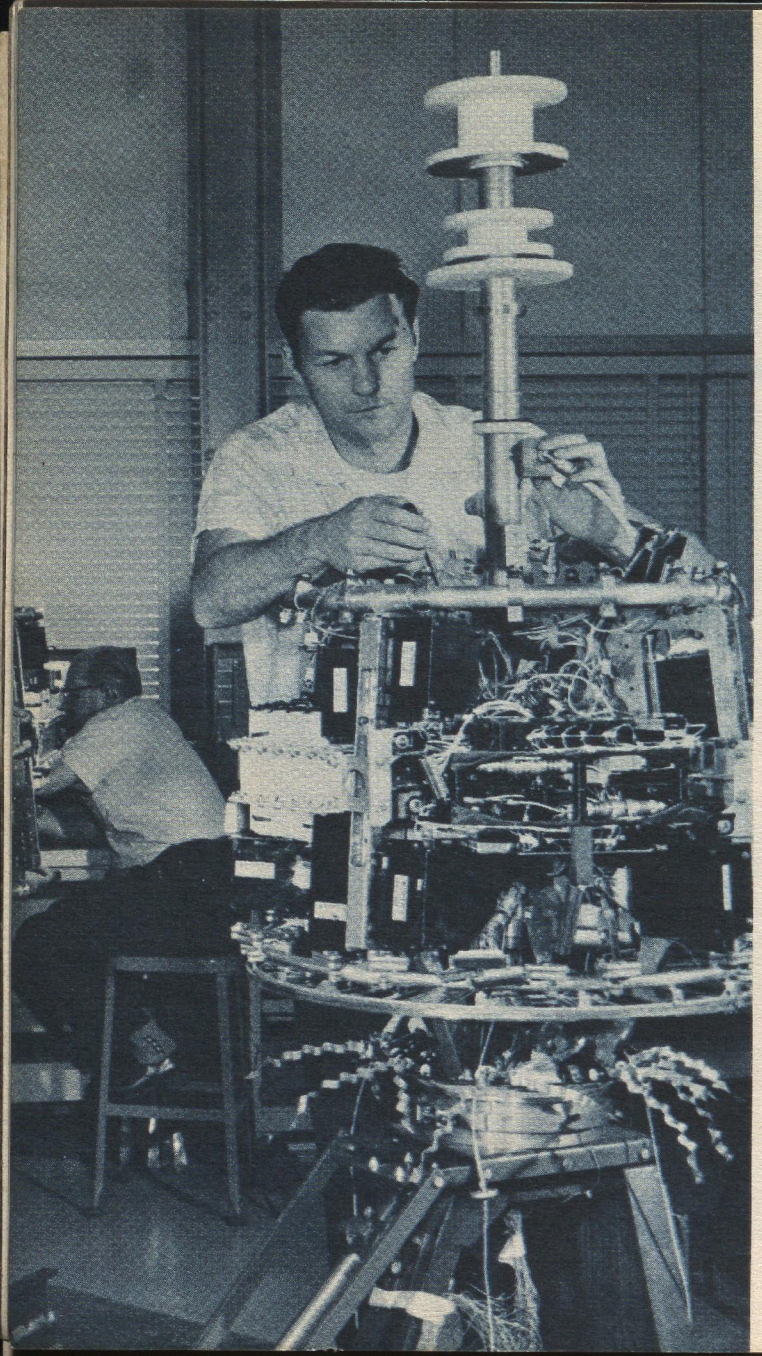
The first weather satellite was the *T*elevision *I*nfra-*R*ed *O*rbiting *S*atellite. The TIROS satellite is spin-stabilized. This highly successful series of meteorological satellites has already provided weather forecasters throughout the world with valuable meteorological data, not heretofore available. The U.S. Weather Bureau has funded a number of operational TIROS Satellites which will be launched by NASA.

Its successor, the NIMBUS satellite, will be more versatile. Also, cameras for NIMBUS will have a higher resolution than those in TIROS. At night, infra-red radiation sensors will be used to record cloud formation.

A unique camera system, called Automatic Picture Transmission (APT), has been developed for the NIMBUS spacecraft. This relatively simple and inexpensive system provides meteorologists throughout the world with instantaneous photographs of cloud patterns. The APT camera received initial test and evaluation aboard the TIROS satellite.

"Mosaic" of cloud photographs viewed by TIROS 1 (above) superimposed on a weather analysis map of the North Pacific Ocean and North America.





FABRICATION AND TESTING

A satellite is not a mass-produced item, but usually a one-of-a-kind spacecraft containing a complex array of the most delicate scientific and electronic equipment.

At Goddard, scientist, engineer and technician work as a team on the design, fabrication and testing of scientific and application satellites.

Manufacture of these space vehicles is accomplished either "in-house" by the Center's staff of skilled fabricators, under contract with American industry, or through a combination of both. The Center's fabrication staff consists of a small, but highly specialized team of engineers and technicians skilled in machining, forming, optics, electronics, and satellite assembly.

Once fabricated, the spacecraft must survive environment stresses due to ground handling and launching, and must operate effectively in space for its expected lifetime. The task is not a simple one, since today's spacecraft contain equipment heretofore used only under the ideal environment of a laboratory. These instruments must operate reliably at great distances and under conditions where they will be subjected to solar radiation, space vacuum, extreme coldness, radiation belts and solar flares. And unlike a laboratory, there can be no experienced experimenter in attendance, making adjustments and taking readings.

A complex, labeled as Goddard's Spacecraft Test Facility serves as a large scale laboratory to test Goddard-developed spacecraft, and probes. Here a satellite may be exposed to man-made conditions of extreme temperature, humidity, shock, vibration, structural loadings and various combinations of both, to ensure that Goddard-developed projects can take the punishment which they will face on their orbital missions.

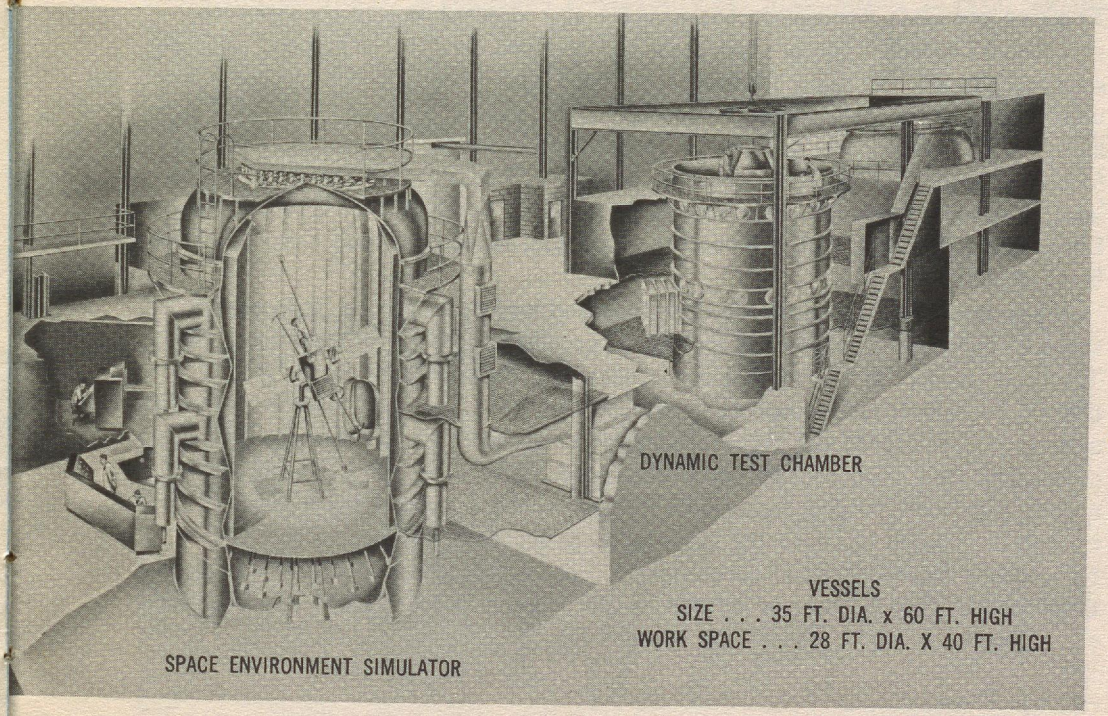
These facilities are able to handle one 4,000 pound payload, plus two 1,000 pound loads simultaneously, measuring up to 25 feet. Two major items in the Spacecraft Test Facility are a dynamic test chamber, and a space environment simulator. These chambers simulate some of the forces converging on a spacecraft from initial ground handling through launch, and flight.

The dynamic test chamber, a stainless steel structure, is 33½ feet in diameter and 58 feet high. Powerful mechanical pumps reduce inside pressure to 0.1 mm

of Mercury. Here dynamic balancing, solar paddle erection, spacecraft orienting, etc., may be tested.

In the laboratory's space environment simulator, a spacecraft may be exposed to simulated conditions of cold outer space, extreme vacuum and solar radiation.

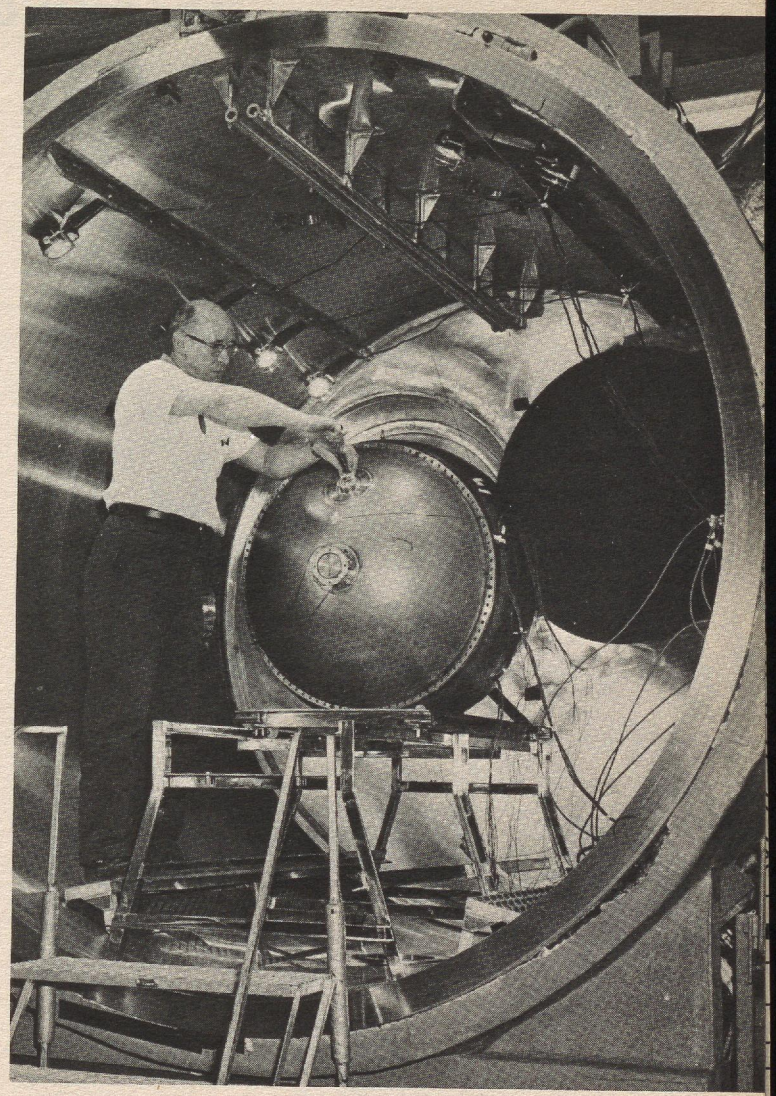
The laboratory is able to test any payload capable of being launched by an Atlas-Agena vehicle. Goddard's OAO and OGO are tested here.



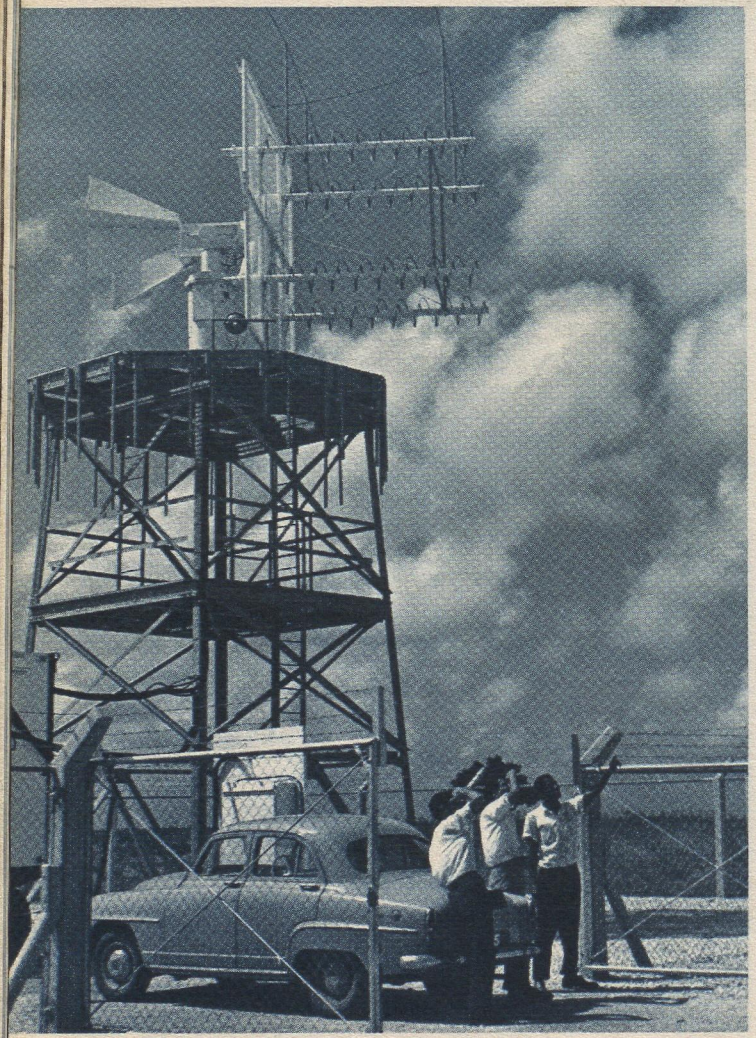
DYNAMIC TEST CHAMBER

VESSELS
SIZE . . . 35 FT. DIA. x 60 FT. HIGH
WORK SPACE . . . 28 FT. DIA. X 40 FT. HIGH

SPACE ENVIRONMENT SIMULATOR



TRACKING & DATA ACQUISITION AND REDUCTION



Tracking station in Zanzibar, East Africa.

A spacecraft with the finest scientific instruments, launched perfectly into orbit, is worthless unless it can be tracked to determine where it is, and its scientific information can be received and recorded on the ground. Then the data, recorded on magnetic tape, must be reduced into facts and figures so that the scientist can analyze the results of his space-borne experiments.

To accomplish this task, the Goddard Space Flight Center serves as the tracking, communications and computing hub of NASA's world-wide Satellite Tracking and Data Acquisition (STADAN) and Manned Spaceflight Networks.

The STADAN stations which serve as "eyes and ears" for unmanned scientific satellites provide precision tracking, command and telemetry data to the Communications Center at Goddard. The stations are located at Blossom Point, Maryland; East Grand Forks, Minnesota; Fort Myers, Florida; Goldstone Lake, California; Fairbanks, Alaska; Tananarive, Malagasy Republic; St. Johns, Newfoundland; Winkfield, England; Johannesburg, Republic of South Africa; Quito, Ecuador; Lima, Peru; Santiago, Chile; Woomera, Australia; Rosman, North Carolina; Canberra, Australia.

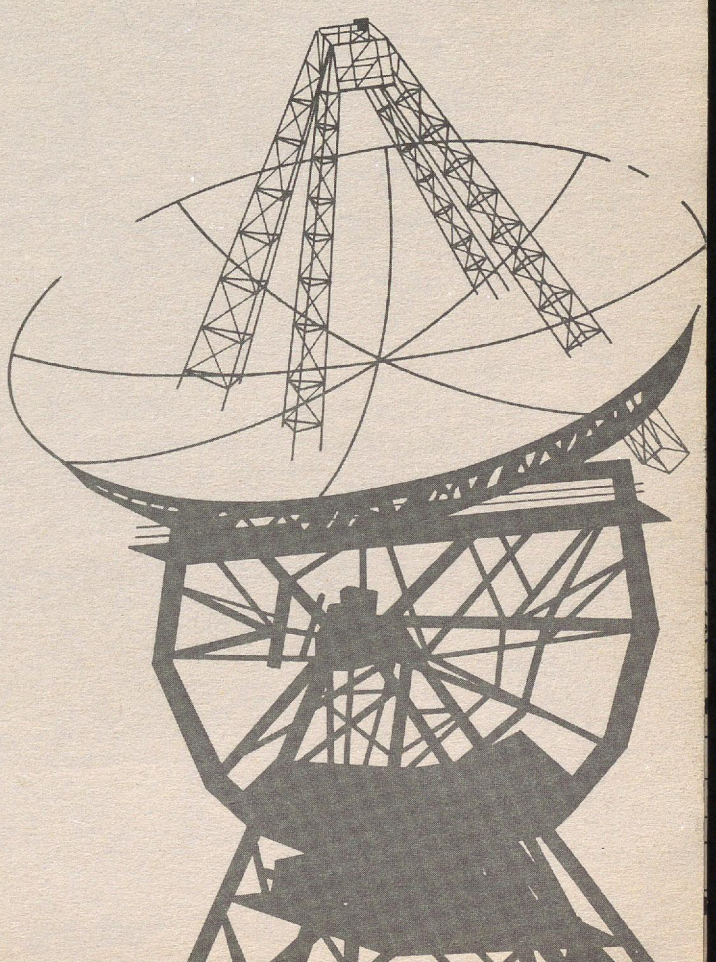
For the manned exploration of space, Goddard operates a global network of stations for tracking, telemetry, and voice communications on a "real-time" basis. The focal point of this integrated communications system is Goddard's Space Control Center which determines and predicts satellite orbits, and controls a voice network, called SCAMA, linking all stations in the network. Triplexed high speed computers, each with a "real-time" capability, make constant flight contingency recommendations, predict flight paths, determine the time to initiate re-entry and predict the impact point of the capsule on a near-instantaneous and continuous basis during the mission. These computers, in the simplest mathematical explanation, can add, for instance, a column of 10-digit numbers ¾ of a mile in length every second.

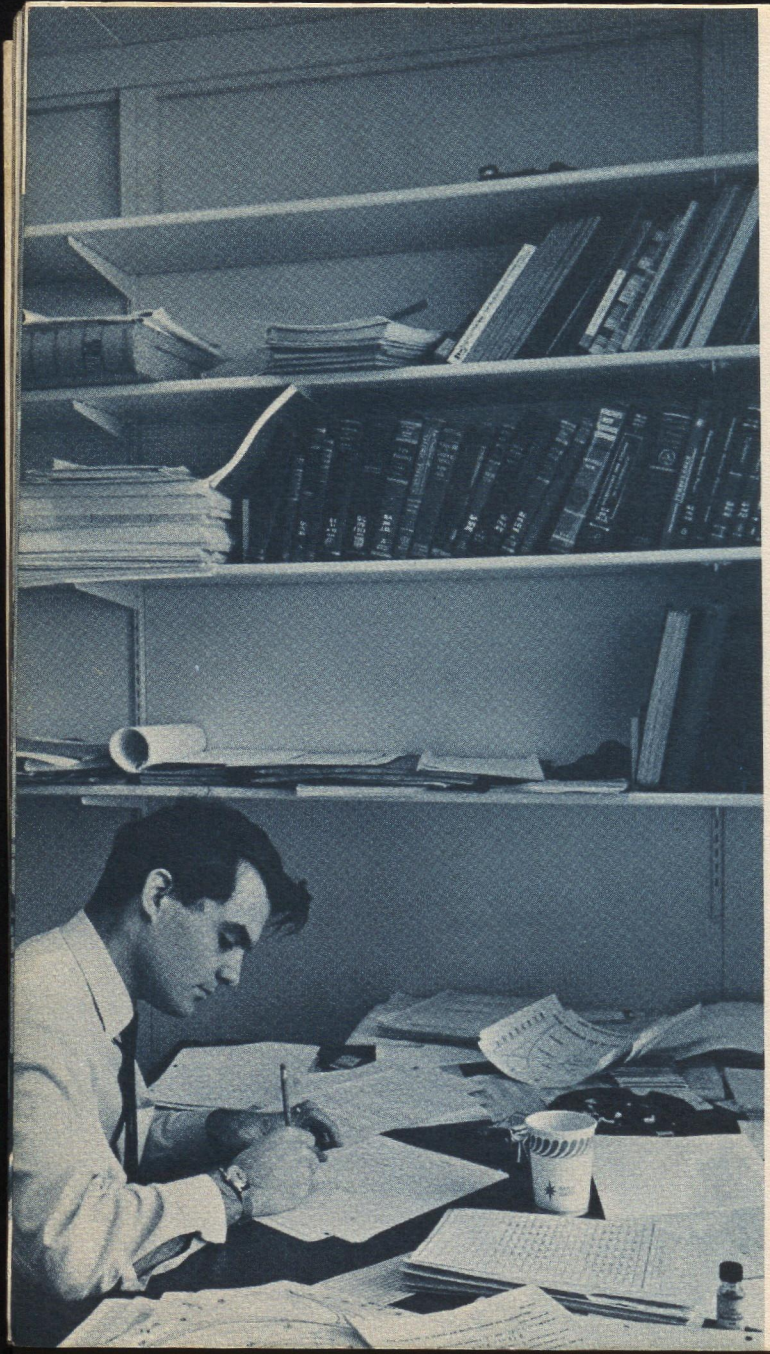
The network spans three continents and three oceans, interconnected by global communications links. It uses land lines, undersea cables and radio circuits, with special communications equipment installed at switching stations in both the Eastern and Western hemispheres.

The system includes buildings, computer programming, communications and electronic equipment, and related support facilities required to direct, monitor, and provide contact with the manned spacecraft via the mission control center.

Altogether, the Manned Spaceflight Network involves approximately 62,000 route miles of communications facilities to assure an integrated network with world-wide capability for handling spacecraft data. It comprises 173,000 actual circuit miles—102,000 miles of teletype, 51,000 miles of telephone, 8,000 miles of high-speed data circuits and 12,000 miles of tone remoting circuits.

Goddard's site facilities include equipment for acquiring the spacecraft; long range radars for automatic tracking; telemetry equipment for controlling the manned vehicle from the ground if necessary, and voice channels for ground-to-air communications.





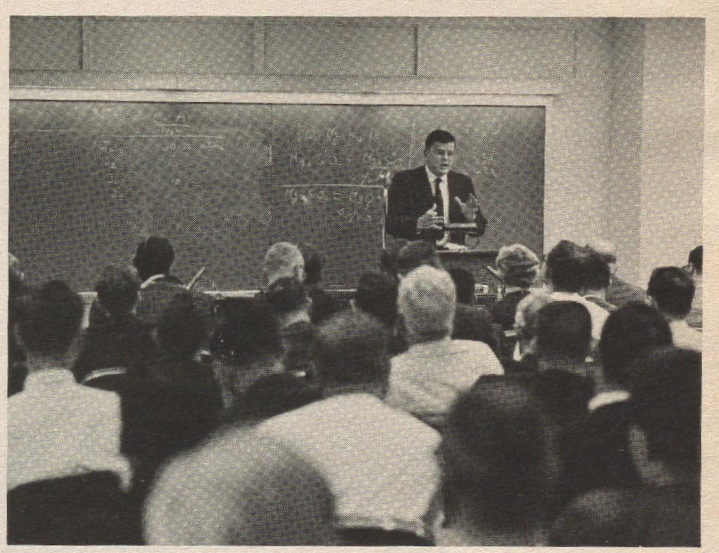
GODDARD INSTITUTE

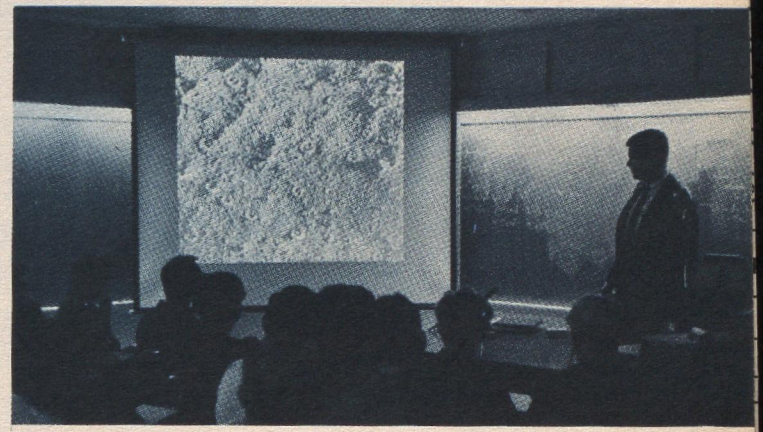
The Goddard Institute for Space Studies has been established in New York City to do basic theoretical research.

The Institute emphasizes broad areas of astronomy, physics and the earth sciences, with particular attention to physics of the earth's interior; meteorology; physics of the upper atmosphere and ionosphere; plasma physics and its applications to the interplanetary plasma; gravitational astronomy, including celestial mechanics in geodesy, and stellar structure and evolution. Its studies contribute to the development of experiments for Goddard and NASA in general.

E

FOR SPACE STUDIES



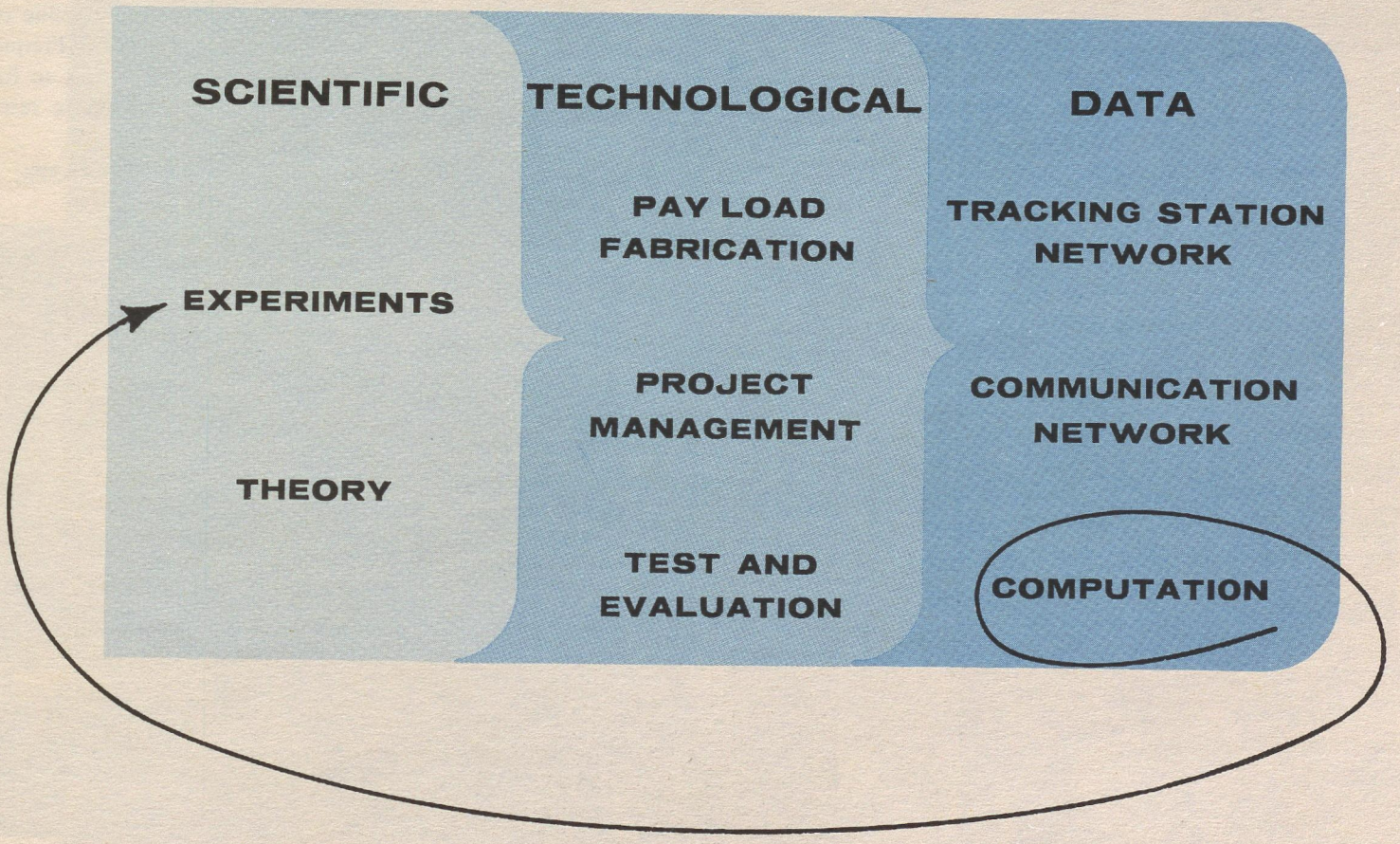


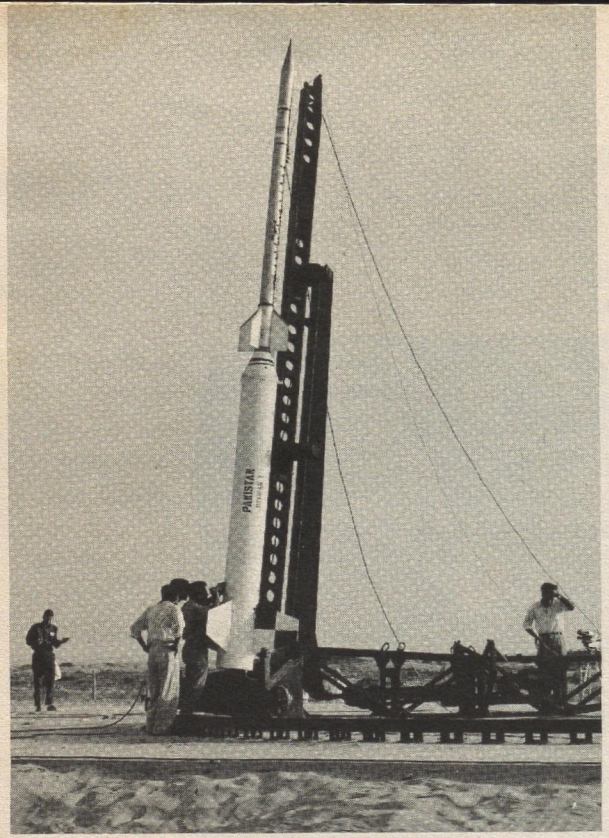
The Institute serves as a space science study catalyst reaching into the staffs and graduate student bodies of space-interested colleges and universities. Its location near the campus of Columbia University, enables the Institute to draw on the talents of Columbia, New York University, City College of New York, Brooklyn Poly-technic Institute, Yale, and Princeton. The Institute has also attracted, on a consultant basis, leading scientists from throughout the United States and the free world.

A BUSY TEAM

The scientific staff of the Goddard Space Flight Center, one of the largest groups of space scientists in the free world, has been concerned primarily with the near earth measurements in magnetic fields, high and low energy particles, ionosphere, aeronomy, meteorology, micrometeorites, solar physics, and astronomy. Of all the scientific experiments flown in space vehicles by the United States and selected in open competition from proposals made by university, industry, and other NASA scientists as well as foreign scientists, approximately one-third have been conceived, designed, and built by the scientists at Goddard. At the same time, the Center has had the management responsibility for over 50 percent of the earth satellites launched by NASA.

SPACE SCIENCE CYCLE





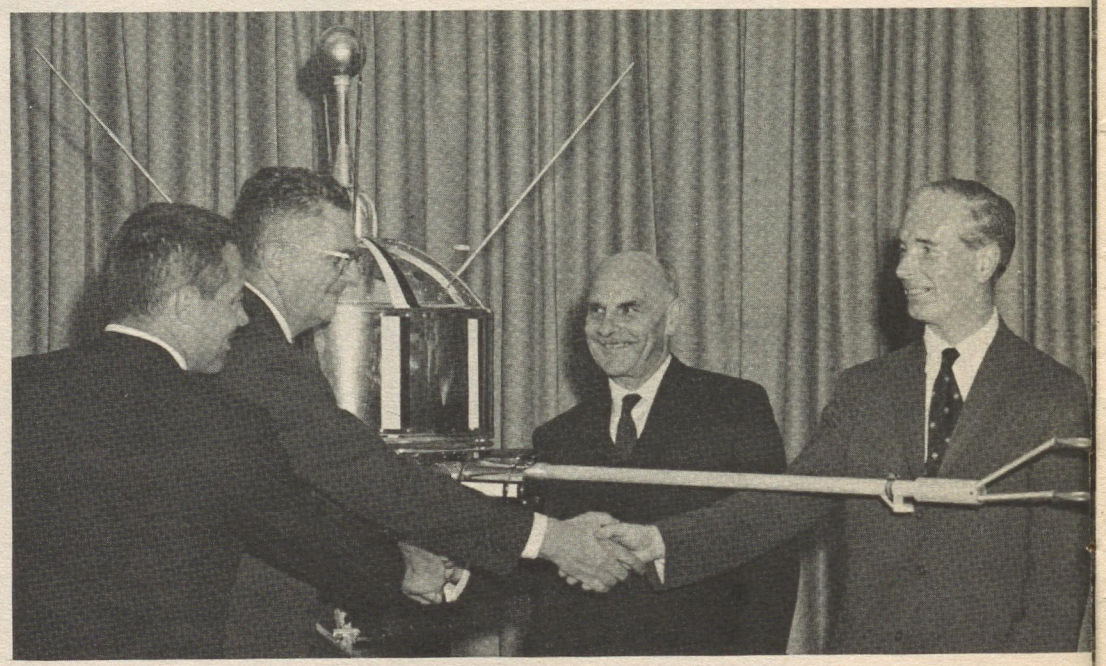
Goddard technicians assisting Pakistan in first sounding rocket experiment.

Foreign journalists at Goddard Space Flight Center.

INTERNATIONAL COOPERATION

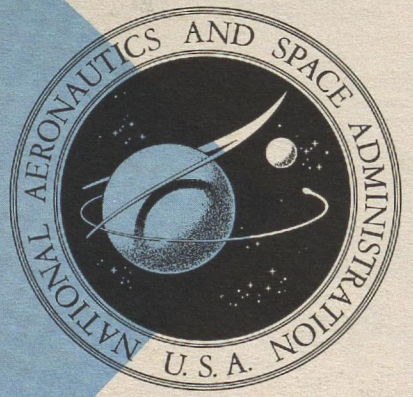
Space science and research requires the cooperation of the international community. Scientific exploration, communications and meteorological satellites, the world-wide networks of tracking and data acquisition stations, all call for the support of many scientific and technical disciplines in many lands. Whether it is the exchange of scientific data, the launching of an international satellite or the tracking of a spacecraft, space science crosses boundaries and oceans. Frequently, Goddard personnel work in foreign countries, while the Center is host to foreign scientists and technicians who join their American colleagues in space research.

U.S. scientists (left) congratulate their U.K. colleagues on successful launch of ARIEL, first U.S./U.K. satellite experiment.



Goddard-managed Delta Vehicle
launching an International Satellite.

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



On July 29, 1958, the President of the United States signed an Act of Congress creating the National Aeronautics and Space Administration. The Act declared "that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of mankind". On October 1, 1958, this new agency was established.

Congress provided that aeronautical and space activities sponsored by the United States shall be directed by this civilian agency, "except for activities peculiar to or primarily associated with the development of weapons, military operations, or the defense of the United States". The Act further states: The aeronautical and space activities shall be conducted so as to contribute materially to one or more of the following objectives:

The expansion of human knowledge of phenomena in the atmosphere and space;

The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;

The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;

The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;

The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian non-military and space activities, of information as to discoveries which have value or significance to that agency;

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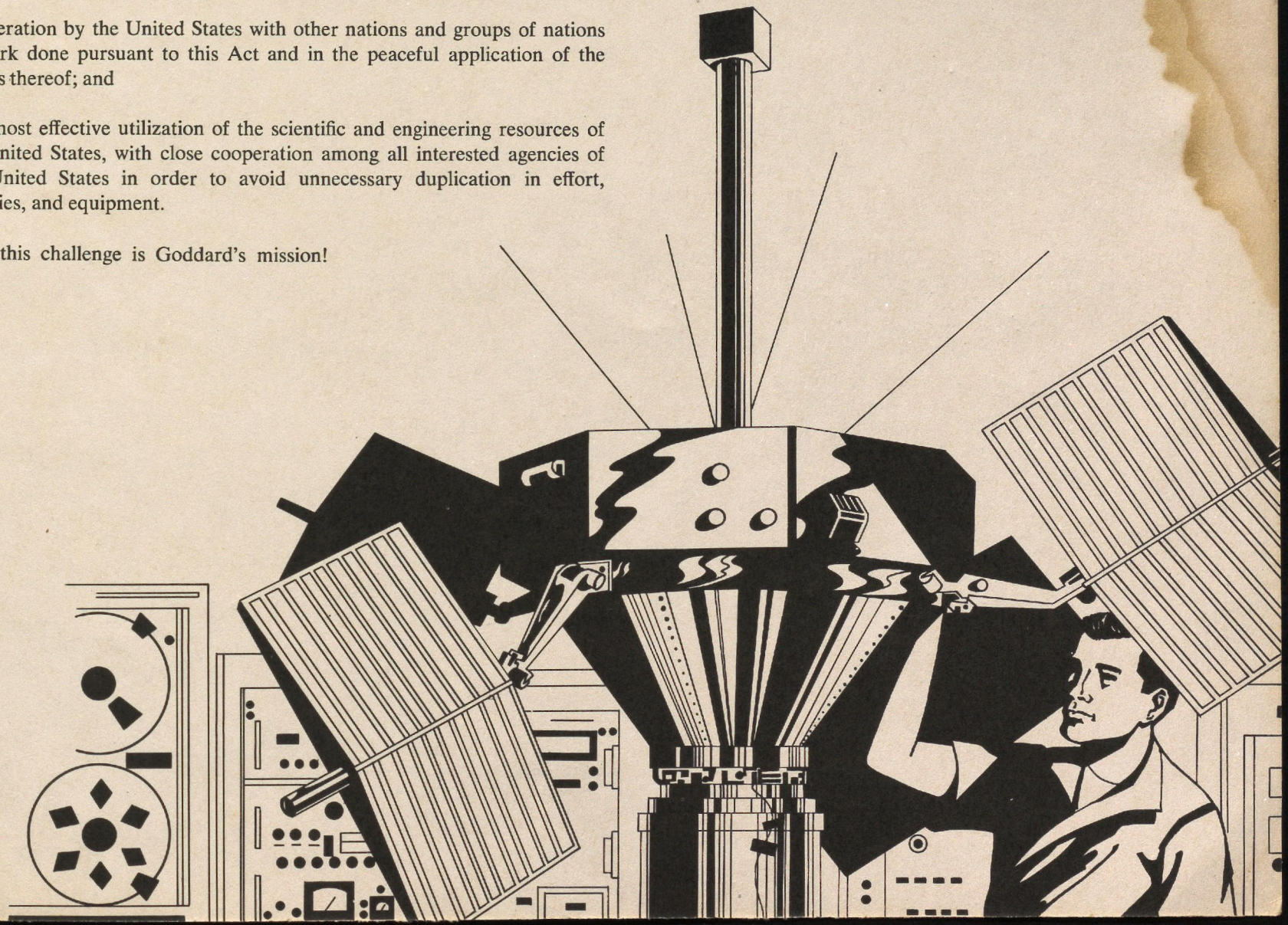
Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and

The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication in effort, facilities, and equipment.

To meet this challenge is Goddard's mission!



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