Writing 2,000 years ago, Plutarch observed: "The child's mind is not an urn to be filled, but rather an ember to be kindled." And few will question that the space exploits of the past decade have ignited the imagination of our nation's youth, stimulated their interest in science and technology, and sparked a virtual revolution in education.

Space Sparks a Renaissance in Education

"The spin-off from the space program in education has been tremendous," states Vice President Hubert Humphrey. Mr. Humphrey, who also serves as chairman of the National Aeronautics and Space Council, continues, "Since its beginnings in 1958, the space program has served as a spring tonic to the American education system. It has done this from the grade schools through the post-graduate university. It has challenged — and will challenge increasingly — our finest and most creative minds to the solution of new, vital and complex tasks."

Look at the effect on George Ehrgott, Jr., for example. He was born October 2, 1958—the day after the National Aeronautics and Space Administration came into being. Now, just weeks shy of a mutual tenth birthday celebration, the mini-scientist chats with ease from a surprisingly sophisticated base of knowledge about the solar system, astronauts' voyages and the re-entry problem; he and his school mates have even formed a "flying saucer" club.

A few decades back, George Sr., an engineer at General Electric's Missile and Space Division, reveled in the paper exploits of Jules Verne's heroes and followed the comic strip adventures of Flash Gordon and Buck Rogers. But the fast-breaking space research and development efforts generated in NASA's first decade have changed all that. Junior and 60 million other American youngsters have the real thing.

Elementary school teachers note the same reaction in younger children, including those whose parents are butchers, bakers or cabinet makers. "In my own experiences," one educator told CHALLENGE, "I'm continually amazed not only at the interest of all the youngsters in space science and technology, but also their broad knowledge."

Studies of space, the universe and the solar system now comprise about 25 percent of the science programs in a good many of the nation's elementary schools. Sixth graders in Memphis have charted the universe—the earth, the atmospheric layers surrounding it and their uses, and the constellations. Others have studied manned space flight and worked on designs for space clothing which will resist extremes of heat and cold, radiation and meteoritic impact. Students have built miniature moon colonies and traced the history of space from Galileo to Glenn.

The United States Office of Education has made funds available to elementary schools for equipment which heretofore only high schools in the wealthier communities acquired. Microscopes and micro-projectors, planetaria and vivaria are as common as crayon and chalk in classrooms all over the land. Fifth and sixth graders explore embryology—a level of science that three or four decades ago would not be attained until the sophomore or junior year of college.

Observing this trend, many educators believe there has been developed a sustained long term stimulus to education as a result of the space program. Some go so far as to say that the stimulus to education is overwhelmingly the most important byproduct of the space program.

Other educators claim that a stimulus and energy have been given to a determined upgrading of the education system. They say that initially this upgrading was concentrated in the sciences, but it is now spreading over much broader fields, a development which, in time, should re-establish a more balanced emphasis in all the fields of learning. Dr. Raymond Bisplinghoff, head of Massachusetts Institute of Technology's department of Aeronautics and Astronautics, comments: "I have observed one heartening trend in the science education reforms in elementary and high schools in the United States. This is a trend toward active participation by the child. He's no longer limited to reading or talking about something. All of the national programs attempt to design activities so that he will perceive basic concepts and relationships in science for himself. There is more emphasis on self-learning skills. And, the fact that this trend can take place at all, must be . . . a tribute to the stimulus of the space program."

The stimulus to education can be traced directly to the educational programs which were established by NASA because it was evident that long-term success of the space program would be critically dependent upon the assistance and training provided by educational institutions at all levels.

At the upper end of the educational spectrum are the universities. As a chief source of new knowledge and highly trained people, the nation's universities were pin-pointed as an essential element of, and strong influence on, the direction and success of the space program. NASA's two-part university program includes:

—Project-oriented research grants and contracts supported by NASA program offices and centers,

—A Sustaining University Program (SUP), with grants for special training, research and facilities.

From 1958 through 1967, the space agency invested about $572 million in universities; $379 million of the total in project-oriented grants and research contracts and $193 million in the Sustaining University Program.

About 1,400 grants and research contracts are now under way. These efforts are selected, supported and monitored directly by NASA's 30 program divisions and field installations. As integral parts of NASA's entire effort, these project grants and research contracts cover a broad range of diverse disciplines. Among them, physical and mathematical sciences—primarily astronomy and astrophysics; engineering—electronics, controls, propulsion, space vehicle system studies; environmental sciences — atmospheric and earth sciences; life sciences — biological and aerospace medicine; and behavioral sciences—related to the impact of science and technology on the socio-economic structure.

The second phase, the Sustaining University Program, established in 1961, is aimed at strengthening universities which are contributing to NASA programs and to offset some of the burdens imposed by a heavy load of strictly project-related research. The three main elements of SUP are training grants to support students doing pre-doctoral graduate work in areas of interest to NASA; facility grants for the construction of new space sciences laboratory facilities on university campuses throughout the country; and research grants which permit universities to develop their academic and research strengths by pursuing space-related studies largely of their own choosing.

Starting modestly with grants to ten universities to cover the education of ten students in each, SUP has increased steadily over the years. In 1965, for example, 3,132 students were studying for their doctoral degrees in 142 universities in all 50 states. The diffusion of knowledge resulting from such a program figures to be considerable. It is.

The facilities construction segment of the Sustaining University Program represents "heavy involvement and high potential," according to Don Holmes, chief of Research Facilities of NASA's Office of University Affairs. NASA has invested some $44 million in 37 grants to 33 universities and the Lowell Observatory, the famed, non-profit, planetary research center in Flagstaff, Arizona.

Starting at the University of California at Berkeley in 1962, the facilities building program next shifted to the University of Chicago, then westward again to Stanford. Among the others, Harvard received the smallest grant for an addition to an existing cyclotron facility, and MIT, the largest for its Center for Space Research, dedicated earlier this year. Other alterations to campus landscapes include rocket test facilities at Purdue, and Southern California's human centrifuge.

The dividends paid on NASA's investment are considerable. Comments Francis Smith, assistant administrator for University Affairs, "Universities throughout the country have become extensively involved in the space program and have made major contributions to the nation's space efforts. University scientists have conceived and developed satellite experiments which contributed directly to new scientific knowledge. They have carried out research in university laboratories on communications and meteorological satellites, and manned flight operations. They serve on advisory groups which plan and evaluate space activities. They train the thousands of scientists, engineers and managers who run the space program. And they are increasingly working with industry and regional organizations to quicken the pace by which research findings may be applied for the public good.

"But, most significantly," he emphasizes, "this has not been a one-way benefit. NASA has, of course, benefited directly. The universities gained the new knowledge and experience necessary to their continued scientific, technical and academic advancement, and have developed strengths and capabilities which previously were largely nonexistent. And the total store of scientific and technological knowledge available has been increased many fold."

One of the nation's distinguished educators agrees. Dr. Roger Heyns, chancellor of the University of California notes: "Through the stimulation of NASA programs, new fields of study and research have been created—in the atmospheric sciences, the physics of the solar system, exobiology and others. The agency has stimulated new and already productive interdisciplinary efforts in the physical sciences and the social sciences."

What about the youngsters years away from the groves of academe? NASA provides for them too. At the elementary and secondary school level, NASA's Educational Programs Division has brought space down to earth for an estimated 50 to 75 million youngsters. Working primarily through teachers, EPD gives a big assist in the acquiring of basic understandings of space age developments.

Among the many services provided by EDP are curriculum supplements. These, according to EDP Chief Dr. James Bernardo, are designed to assist teachers, supervisors, curriculum committees and textbook writers in relating the latest developments from space to elementary and secondary science, mathematics and technical art courses.

The division also conducts a NASA Teacher Services Program to provide space-related courses, workshops, seminars and institutes for elementary and secondary school teachers. In fiscal 1968, comments EPD's Fred Tuttle, NASA education offices served more than 1,250 teacher education programs in the 50 states with an enrollment of more than 37,000 teachers.

EDP also provides countless publications, films, visual aids, exhibits, tours of NASA centers, speakers and lecturers, as well as assistance in planning, organizing and conducting space information programs.

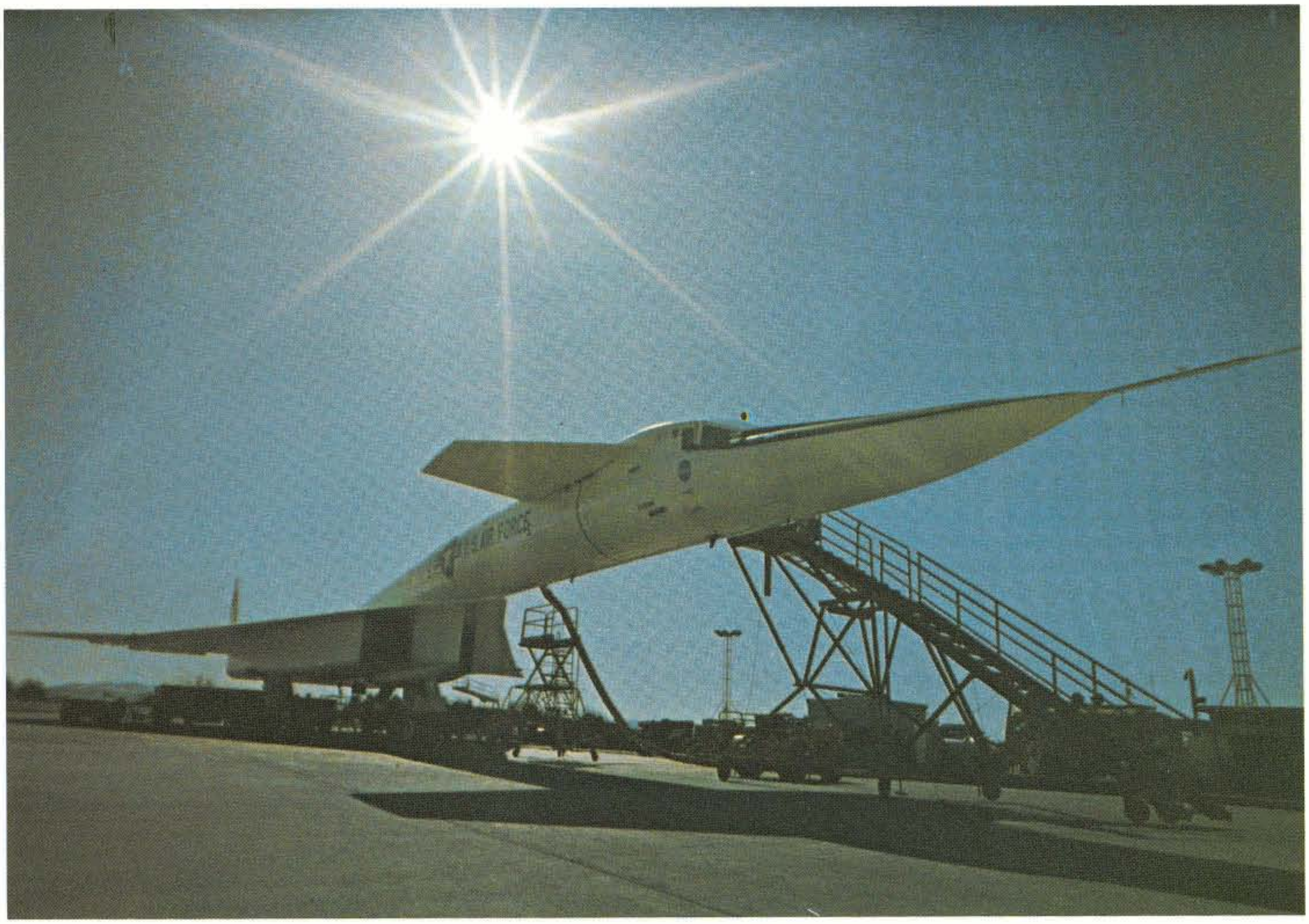
Then there's the road show—NASA's Spacemobile, a paneled truck fitted out with models of spacecraft and launch vehicles and a driver who doubles as lecturer and discussion leader.

From grade school crayon drawings of space ships—to doctoral dissertations on exobiology — the National Aeronautics and Space Administration education program is far reaching. The space-spawned stimulation to education and the motivation of America's talented youth which this natural interest provides cannot be measured. But both serve to point up the splendid benefits to be derived as their effect reverberates downstream.

NASA's Homer Newell, associate administrator, Office of Space Science and Applications, sums up: "Between the nation's educators and the national space effort, there is a fundamental and urgent community of interest . . . If we are to solve many of the critical problems of our day, we will require an organized and conscious interplay of educated minds and advancing technology. Only by combining the two can man enlarge and apply that understanding of himself and his environment. To enlarge and apply that understanding, we must extract the fullest measure of benefit from those pacesetting programs which produce new knowledge of our environment, which use forces, controls and materials in new ways to explore that environment.

"Certainly, the school community has been conscious of its responsibility for creating a climate of science and technology which can prepare the future citizen to comprehend his world and the future scientist or engineer to contribute to it."

Say, Mr. Plutarch, got a match?



1

1 The XB-70 aircraft is readied for first flight, April 1967, under program management by NASA in a continuation of a joint NASA-Air Force agreement. The XB-70 research program is to investigate dynamic loads, and to define and evaluate stability and control characteristics and handling qualities of large supersonic vehicles.

2 Nestled under the wing of a giant B-52 Air Force bomber from which it is launched, this sleek X-15 research plane is poised for another of its many experimental missions. It has far exceeded its assigned goals and holds records for both speed and altitude.

2

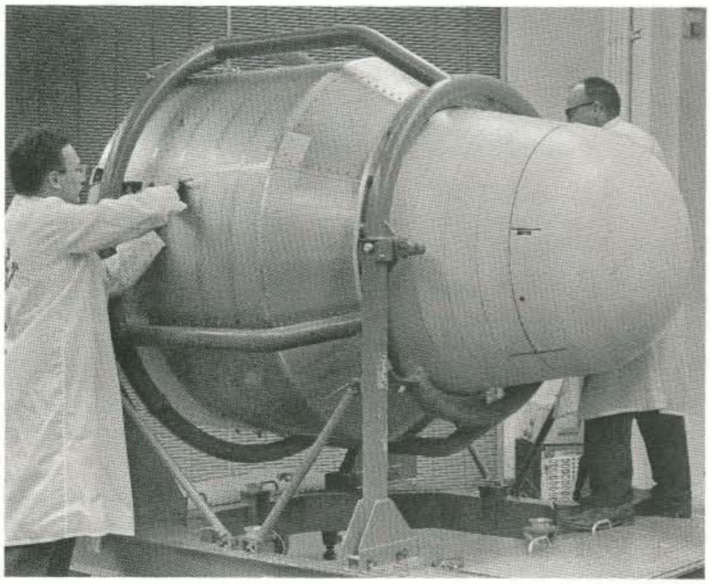
1

1 Original Astronaut team lines up for flight training. From left, Scott Carpenter, Gordon Cooper, John Glenn, Gus Grissom, Wally Schirra, Alan Shepard and Donald "Deke" Slayton.

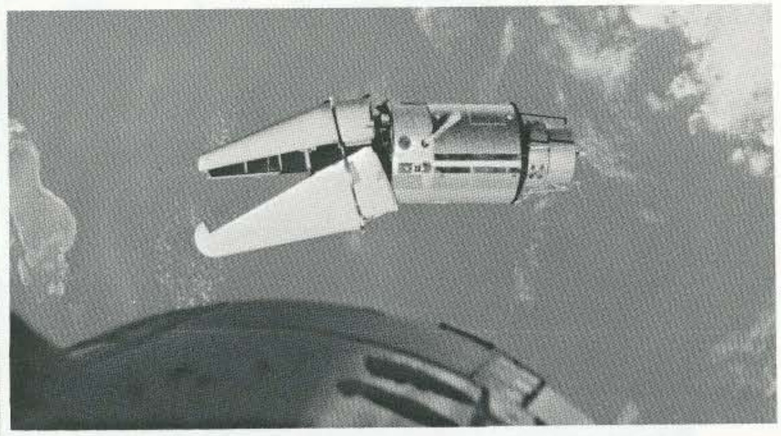
2 Technicians work on Biosatellite vehicle in manufacturing area of General Electric's Re-entry Systems Center, Philadelphia. Biosatellite, developed for NASA's Ames Research Center, is designed to learn effects of weightlessness and radiation on terrestrial life.

3 The drama of space exploration offers equally dramatic photo possibilities.

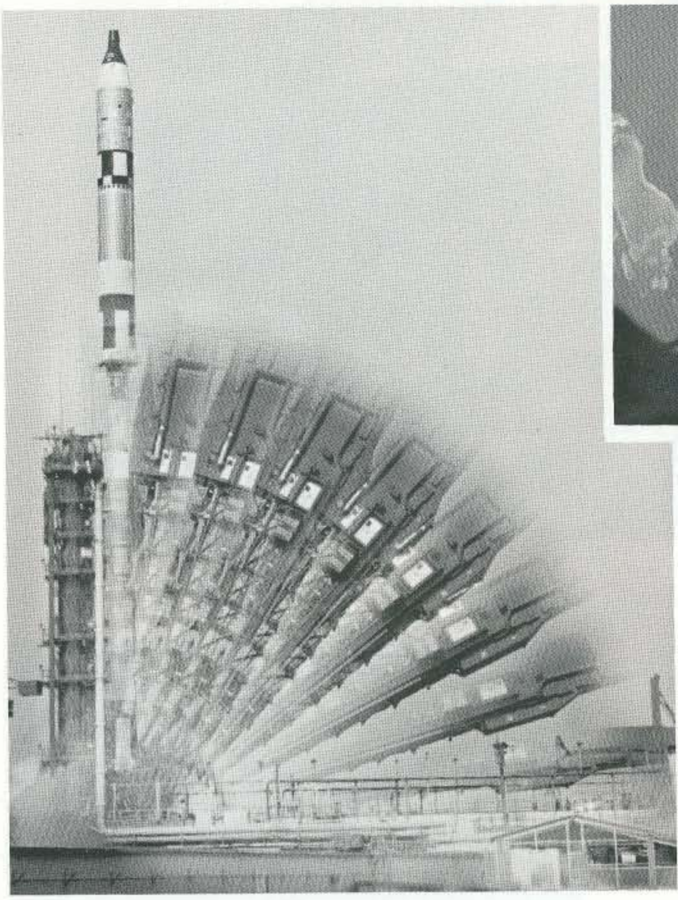
2



3

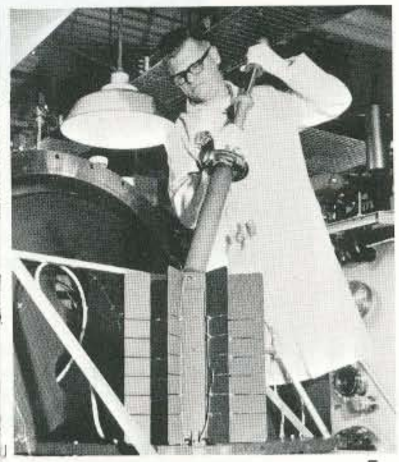


3



1

4



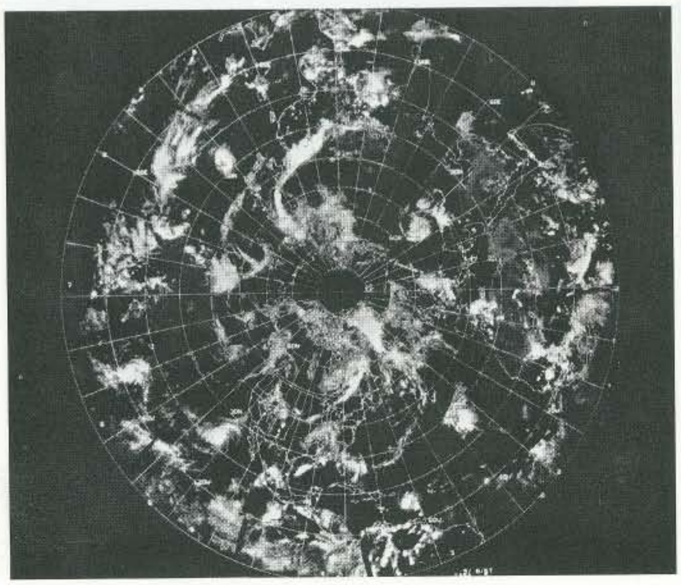
5

1 This multiple exposure photo was result of 11 separate exposures on one sheet of film when the Gemini 10 spacecraft was rocketed into orbit from Cape Kennedy.

2 Digital mosaic of cloud pictures taken by ESSA 5 satellite shows more than a dozen storm areas, including hurricanes Beulah, Doria, Chloe, Monica and Nanette.

6

2



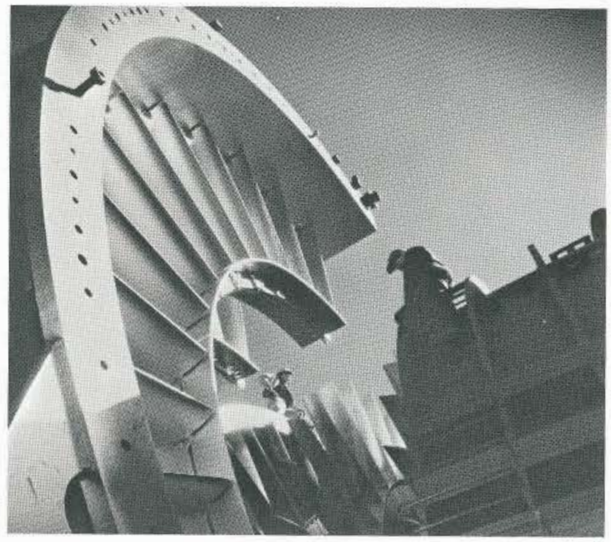
3 "Angry Alligator" was nickname given to Augmented Target Docking Adapter with fiber glass cover still attached. Photo was taken from orbiting Gemini 9 spacecraft.

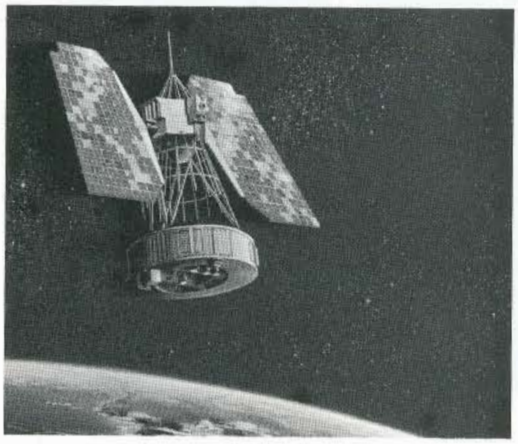
4 Hughes Aircraft technicians check full-scale structural model of Applications Technology Satellite. This is spin-stabilized synchronous version of ATS.

5 Engineer at General Electric Valley Forge Technology Center inserts hot fuel capsule into SNAP-27 generator. The SNAP program is a cooperative effort of NASA and the Atomic Energy Commission.

6 Gemini Astronaut Gordon Cooper shot this view of Mexico and Baja, Calif., looking southeast. Cooper and Astronaut Charles Conrad made a series of black and white and color photos which are still being studied by scientific community.


1


4


2


5


3

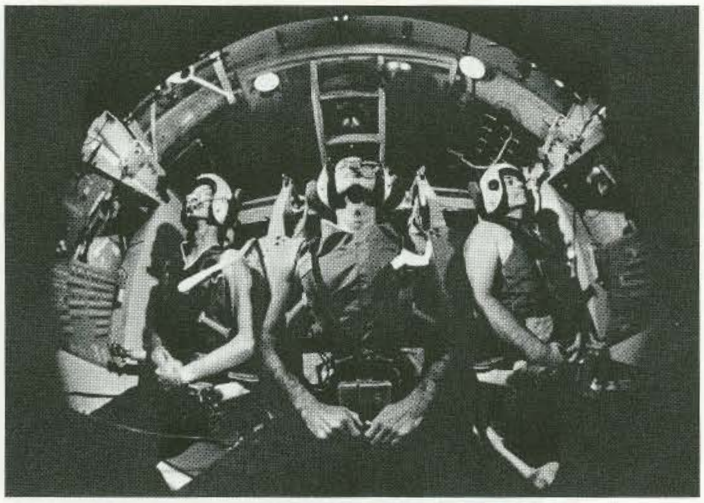
1 NASA headquarters in Federal Office Building No. 6, at 400 Maryland Ave., in Washington, D.C.

2 Artist concept of Nimbus 2. The 912-pound meteorological satellite continues to return cloud cover photos.

3 Interior of reactor containment vessel at NASA's Plum Brook nuclear facility. This Sandusky, Ohio station is operated by the Lewis Research Center; their mission is propulsion and space power generation.

4 Three-stage axial flow fan is part of main drive system which circulates air through 14-foot transonic wind tunnel at Ames Research Center.

5 Officer of 5th Weather Wing, Langley AFB studies facsimile picture of cloud cover photographed by Nimbus 2.



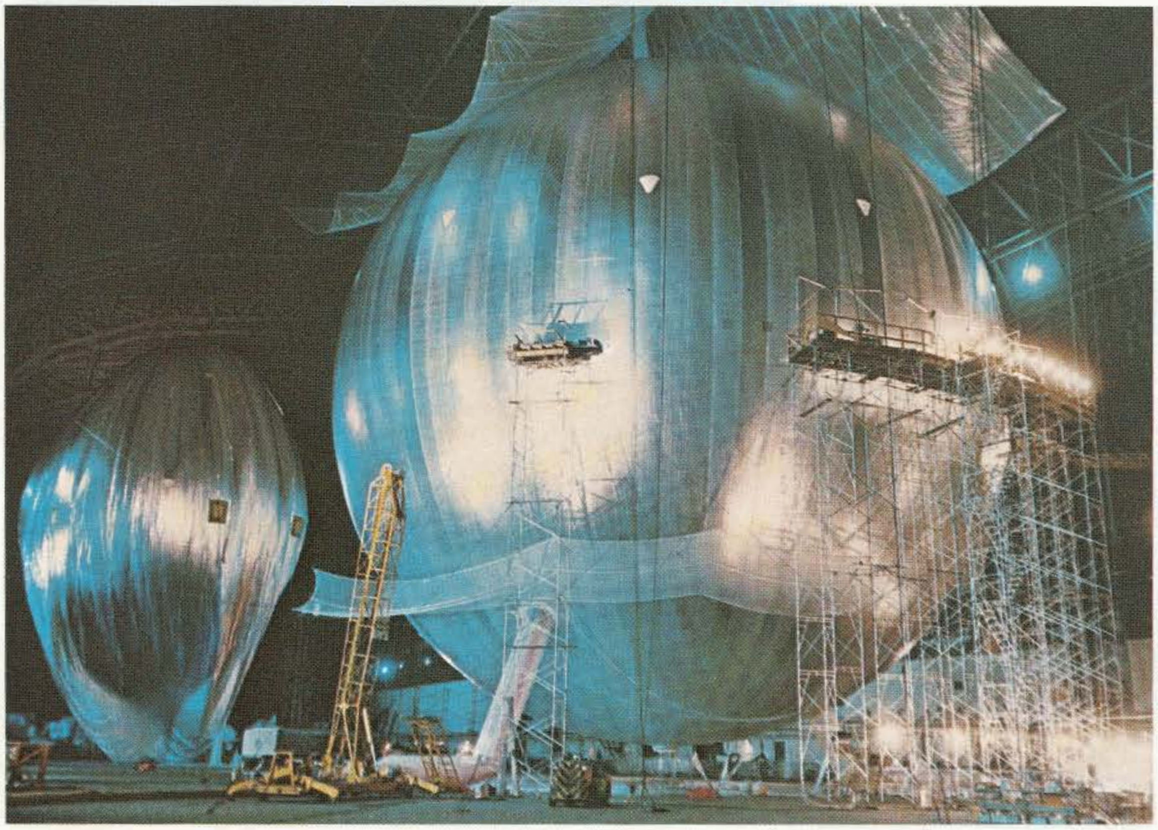
1

2

1 Three test subjects ride inside the gondola of centrifuge at the Manned Spacecraft Center, Houston during test run made to man-rate the facility.

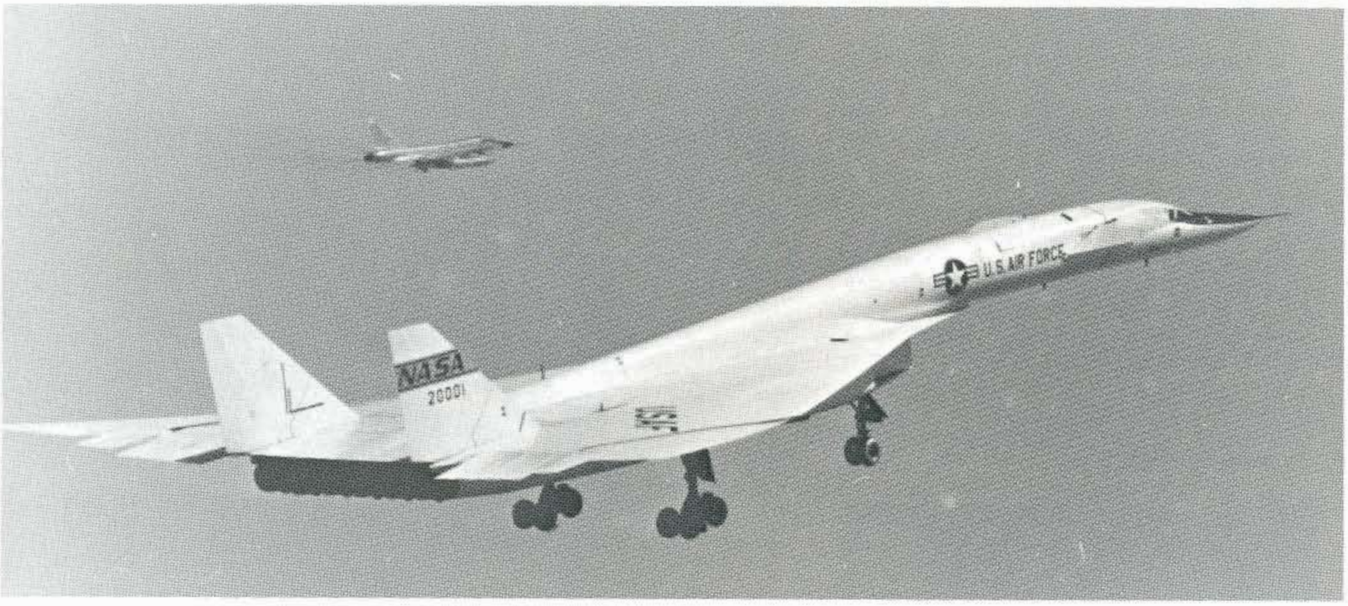
2 Apollo 6, the second unmanned space vehicle in the Apollo/ Saturn 5 program, arrives at Launch Complex 39, February 1968. The 363-foot, three-stage rocket and spacecraft, weighing 6,286,000 pounds when fueled, was transported on mobile launcher by transporter. The transporter moved over specially constructed crawlerway designed to support loads of approximately 18 million pounds.

3 Echo communications satellite proved it possible to communicate between distant areas on earth by reflecting radio microwaves from a manmade satellite. Radio signals are bounced off the satellite from one point on the earth to another.

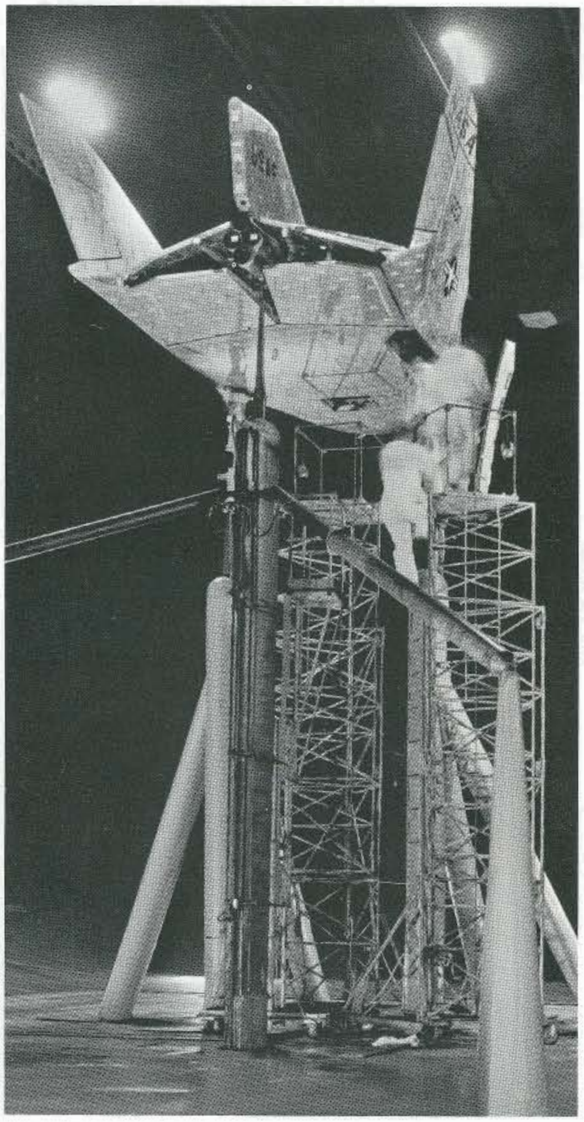


3

1



2

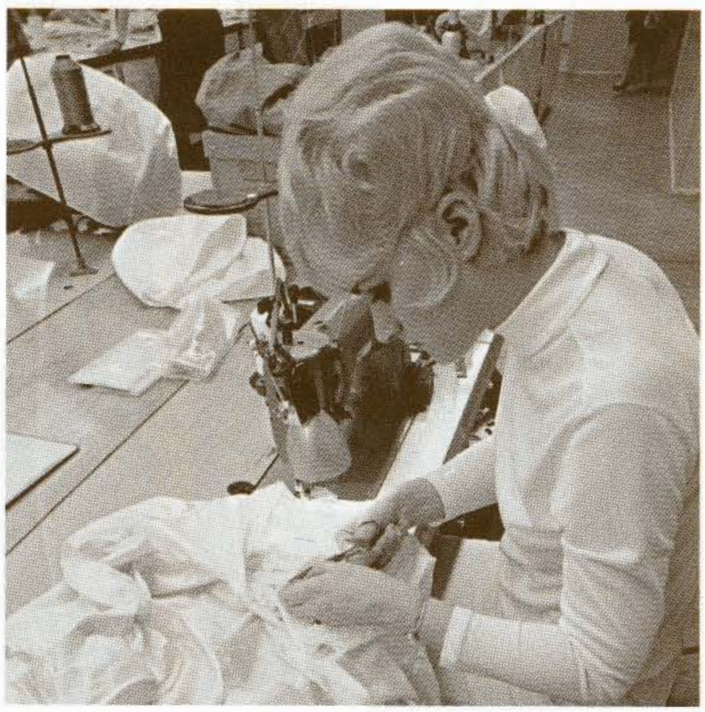


1 The XB-70 number 1 takes off in spring of 1968 on one of its research flights in a continuation of a joint NASA-Air Force program to investigate dynamic loads, and to define and evaluate stability and control characteristics of large supersonic vehicles in support of the National SST Program.

2 Engineers at Ames Research Center prepare the X-24A lifting body for the wind tunnel to study its airflow characteristics. Small white pieces of tape hold tufts of material so that engineers can see details of airflow over the surface of the X-24A.

3 Integrated thermal micrometeoroid garment (Apollo space suit) is stitched together at ILC plant in Delaware. The Apollo space suit is covered with Beta fabric, a non-flammable fiberglas cloth.

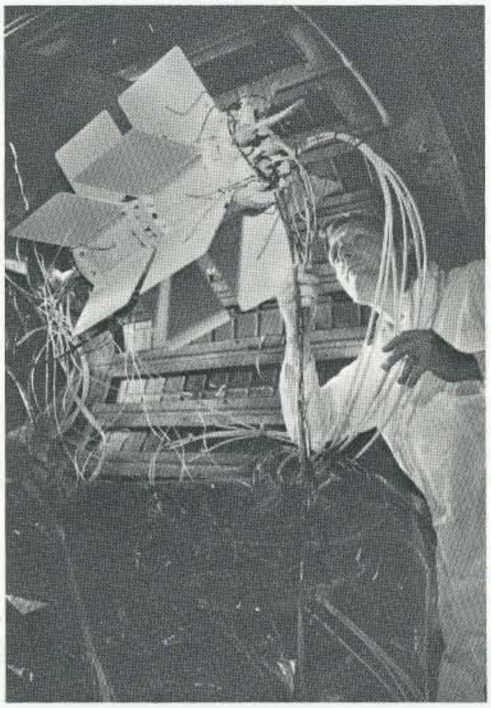
3



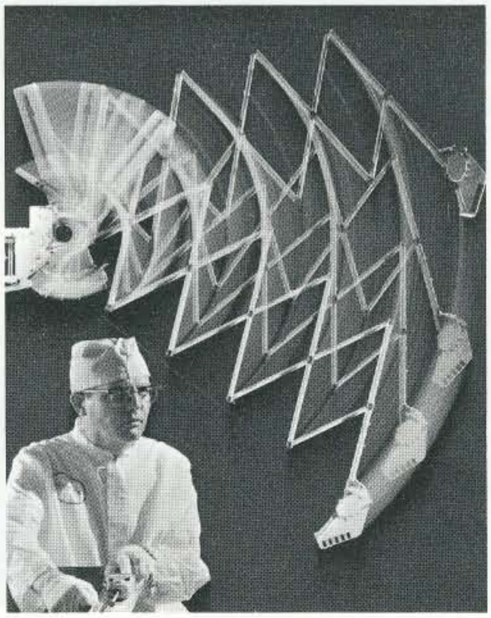
1 Technician adjusts wiring on two SNAP-19 nuclear generators ready to undergo a 12-day test in a thermal vacuum chamber. Data collected during test assured Martin Company engineers that both generators could perform efficiently in the severe space environment.

2 Multiple exposure of Surveyor surface sampler movement. The Surveyor soil mechanics-surface sampler is a scoop device and digger used to manipulate the soil of the lunar surface, enabling scientists to analyze the moon's bearing strength to a depth of about 18 inches.

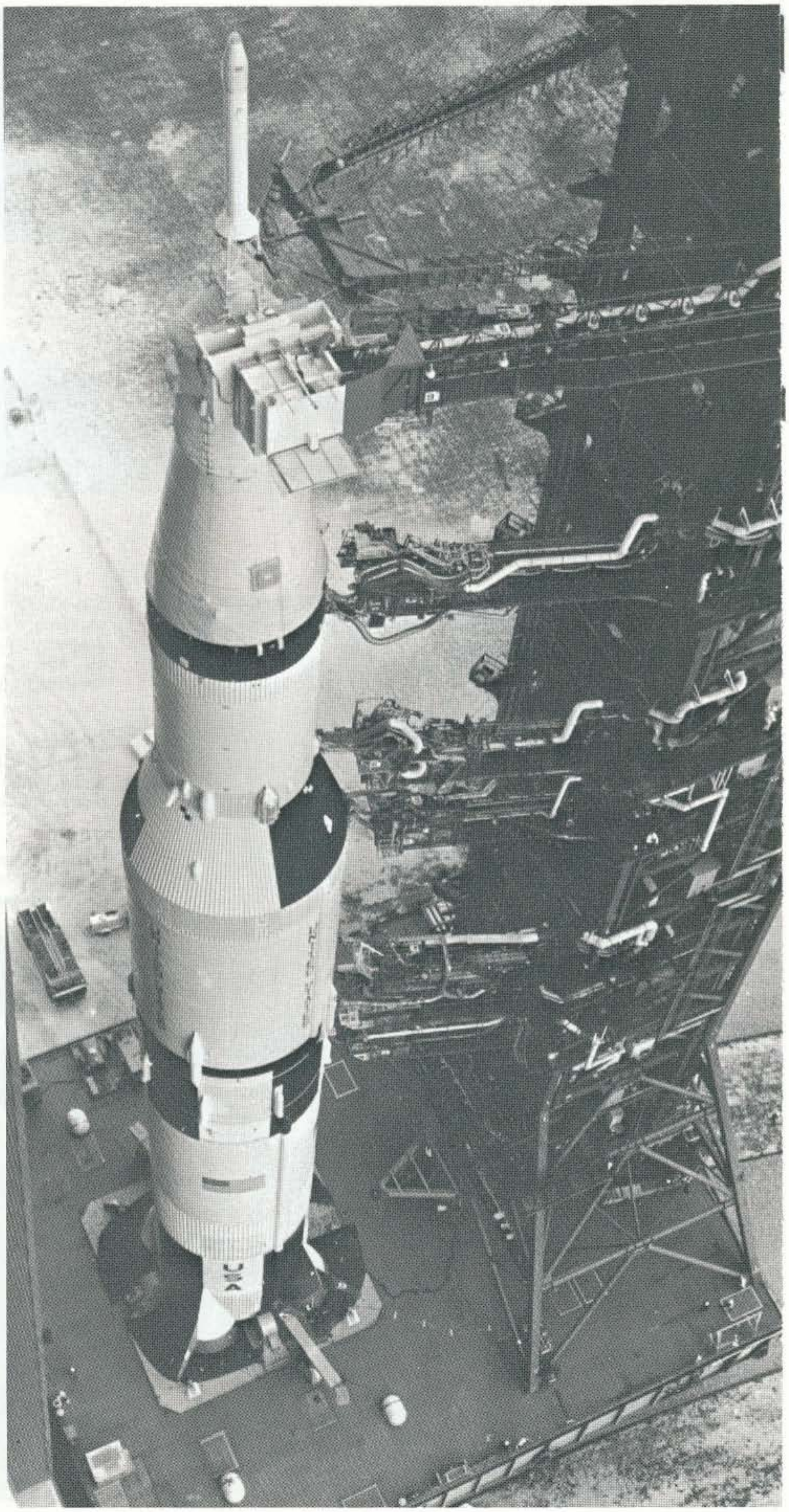
3 Another view of Apollo 6/Saturn 5 erected at Pad A of Kennedy Space Center Complex 39.



1



2



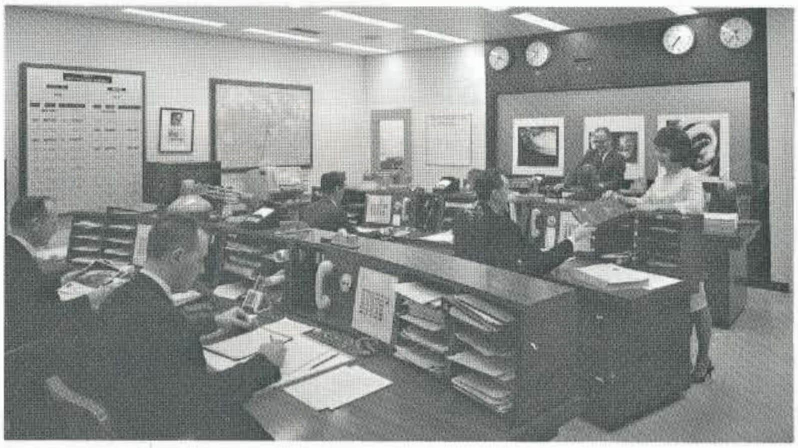
3

1 Heart of the NASA Communications Network at the Goddard Space Flight Center is the digital computer system. This system receives, examines, stores, cues, routes and transmits messages at a very high speed.

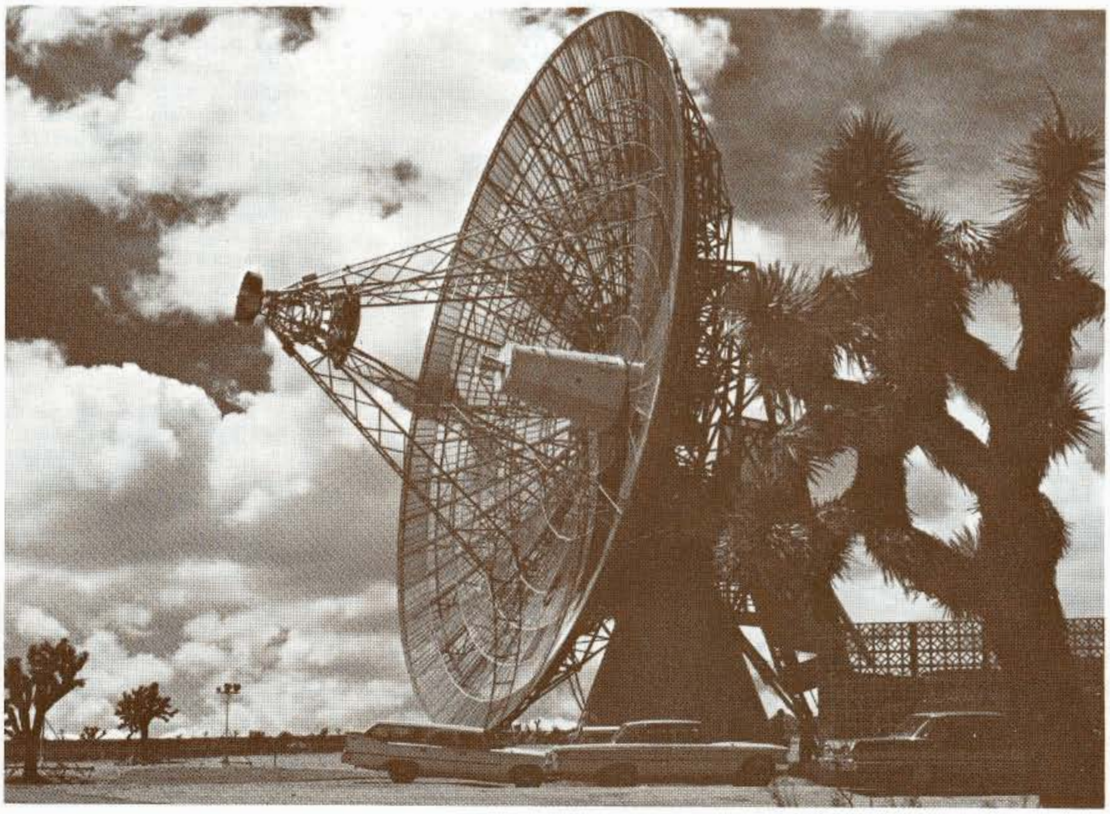
1

2 Controllers of NASA's Tiros Technical Control Center at Goddard keep tabs on Tiros weather satellites, monitoring their precise positions, locations in space and the status of the ground stations.

3 This 85-foot parabolic antenna at Goldstone Tracking Station in California's Mojave Desert keeps the station in contact with orbiting spacecraft. NASA's Tracking and Data Acquisition operation supports unmanned and manned space flights, transmits commands, and accumulates and processes data into a usable form for realtime decisions and flight control.

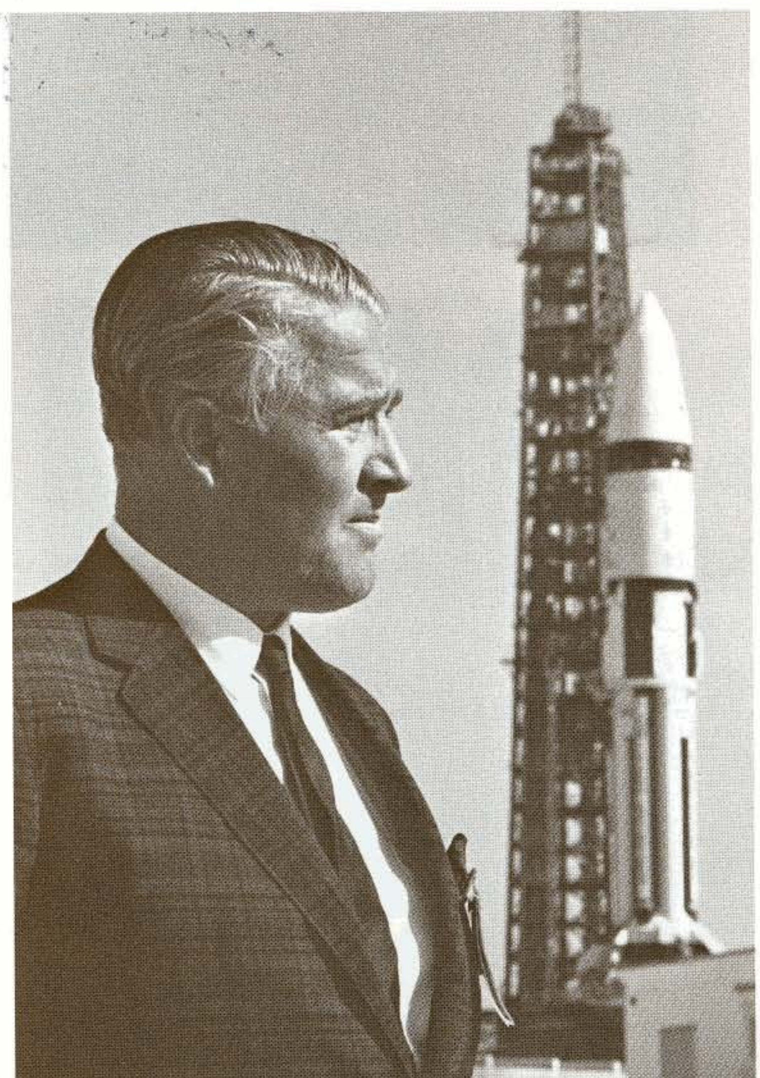


2



3

1



2

1 Firing room 2 during the Apollo 6 mission at the Kennedy launch control center. The electronic "brain" of Launch Complex 39A contains display, monitoring and control equipment used for both checkout and launcher operations. Adjacent to the Vehicle Assembly Building, the center has telemeter checkout stations on its second floor and four firing rooms on its third floor. Firing rooms have some 450 consoles which contain controls and displays required for the checkout process and 15 display systems in each firing room, with each system capable of providing digital information instantaneously. Sixty television cameras are positioned around the Apollo/Saturn 5, transmitting pictures on ten modulated channels. Much of Apollo's ground support equipment has been designed, built and is maintained by GE's Apollo Systems Department.

2 Dr. Wernher von Braun, director, Marshall Space Flight Center, at Complex 37 during Apollo countdown contemplates one-quarter-million-mile journey three American astronauts will take to the moon . . . a preface to the next decade of space progress.