With the 1970 lunar touchdown already in its sights, NASA's Office of Manned Space Flight seeks to make the United States pre-eminent in space.

A Nation Goes to the Moon

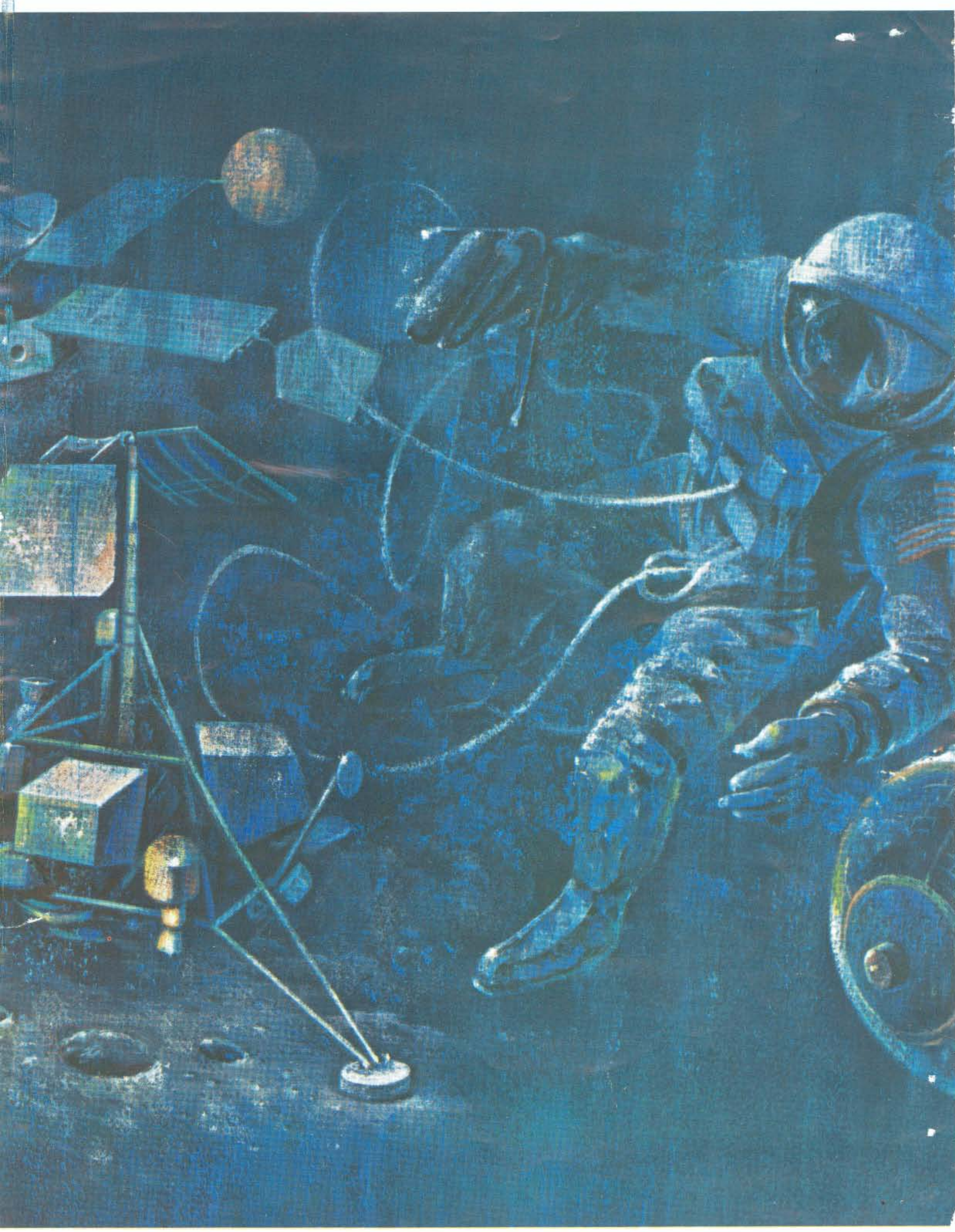
"Now is the time to take longer strides—time for a great new American enterprise—time for this nation to take a clearly leading role in space achievement which in many ways may hold the key to our future on earth. I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth. . . . It will not be one man going to the moon . . . it will be an entire nation."

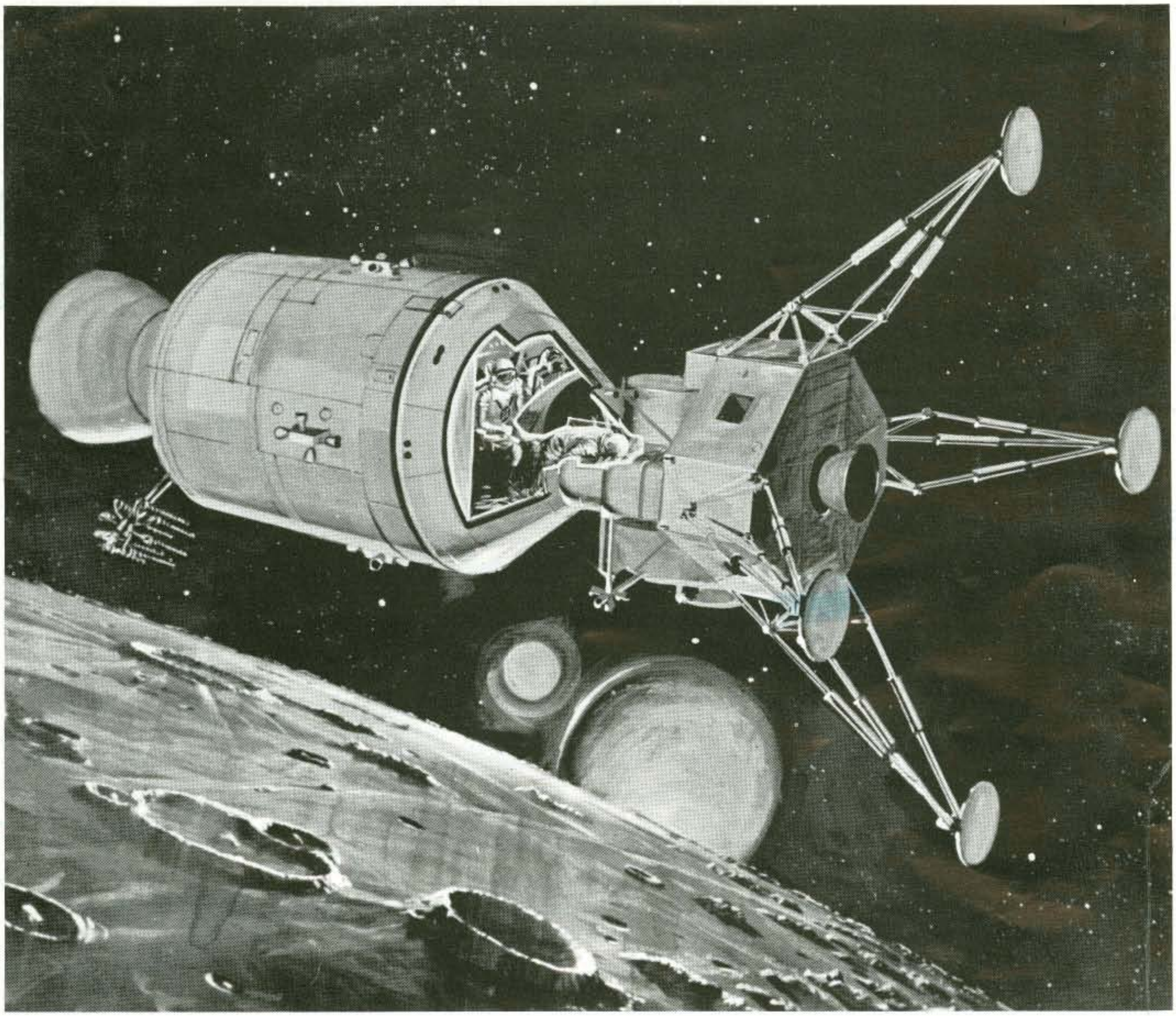
—President John F. Kennedy

Five years ago the United States took its first tiny steps toward the moon when Commander Alan Shepard became the first American to be rocketed into space. And the entire nation—indeed the whole world—witnessed his flight, sharing in the tension and the triumph. Today, at the halfway point in the ten-year program to land a man on the moon and return him to earth safely, the United States manned space program has both lengthened and quickened its stride. And the distance from the earth to the moon doesn't seem quite that far anymore.

In developing the elements and capabilities for this decade's manned lunar landing, NASA has marshalled the men and machines that will make it possible to undertake a wide range of space missions beyond the initial moon touchdown. Indeed, as Dr. George Mueller comments, "manned lunar flight serves as the focal point of a program whose principal goal is to give the United States world leadership in all elements of space activity. The Gemini and Apollo-Saturn programs are equipping this nation with the ability to carry men and instruments into hitherto inaccessible regions of space for hitherto unachievable periods of time."

Dr. George E. Mueller
Associate Administrator
Office of Manned Space Flight

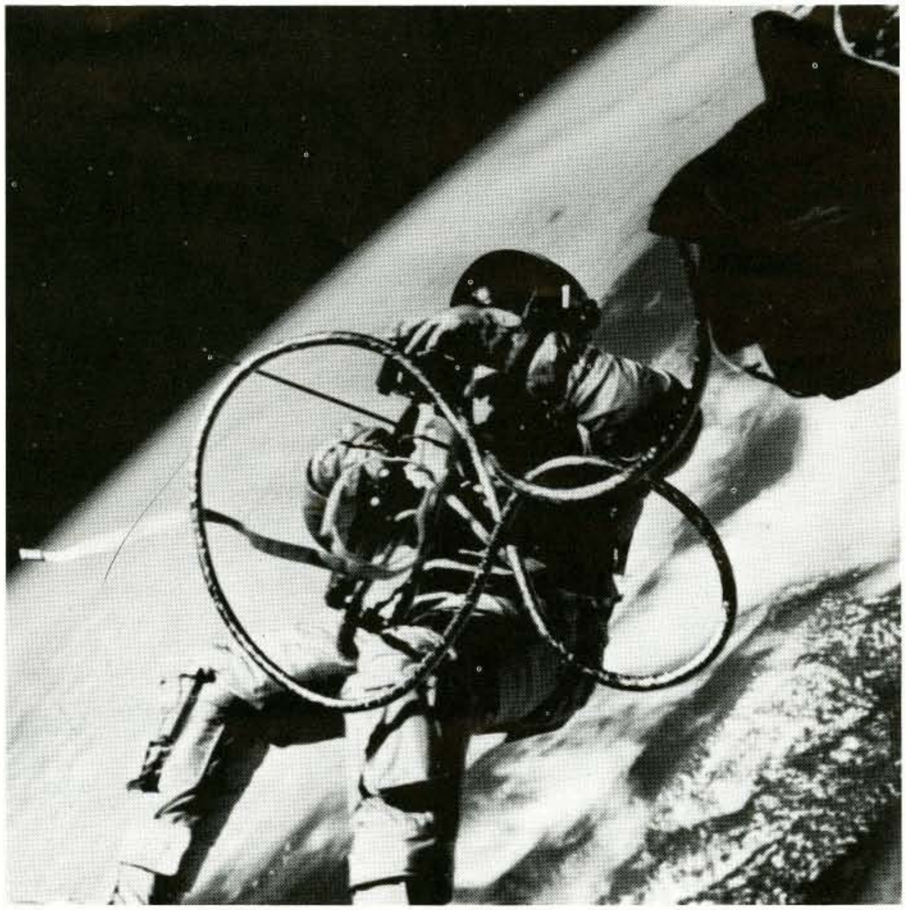




Dr. Mueller, Associate Administrator for NASA's Office of Manned Space Flight, bases his appraisal on the remarkable progress that has been made in the tri-lateral manned flight program—Projects Mercury, Gemini and Apollo. Together the three constitute the greatest single engineering enterprise in this nation's history. The manned space flight program is carried out by some 300,000 men and women. They work in NASA's Washington, D.C. office, at three field centers—the John F. Kennedy Space Center in Florida; the Manned Spacecraft Center near Houston, Texas, and the George C. Marshall Space Flight Center at Huntsville, Alabama—and at some 20,000 industrial plants in every part of the country. Dr. Mueller directs this competent crew by means of a geographically dispersed program office structure which penetrates directly through the functional organizations of the field centers and the prime contractors, to the subcontractors and the vendors. It has been said that Dr. Mueller's techniques of managing so vast a research and development program may, in the long run, prove to be one of the most valuable assets derived from the program.

The first phase of the tri-lateral manned space flight program, Project Mercury, set the stage for the sophisticated space maneuvers of today and tomorrow. Using experimental one-man vehicles, Project Mercury put the first Americans into space and laid a solid foundation for the technology of future manned space flights. It demonstrated the effects of space on man, and proved that men could increase the reliability of spacecraft controls. NASA logged its first manned space flight success on May 5, 1961, the day Astronaut Shepard rode his Freedom 7 space capsule on a 19-minute suborbital mission, 116 miles high into space. Another Mercury milestone was achieved the following February. Astronaut John Glenn became the first American in orbit, completing three global circuits. The following spring Gordon Cooper completed a 22-orbit mission of 34 and one-half hours, triumphantly ringing down the curtain on Project Mercury.

Dr. Mueller was a witness to, rather than a participant in, NASA's manned flight program at the time of the Mercury space spectaculars, although he was deeply involved in other aspects of aerospace technology. During the five years before he joined NASA in 1963, he was associated with Space Technology Laboratories, Inc., serving successively as director of the electronics labs, program director of the "Able" space program, vice president of space systems management, and finally vice president for research and development. In this last position, he had overall responsibility for the technical operations of the company. While at STL, Dr. Mueller headed the design, development and testing efforts of the systems and components for Atlas, Titan, Minuteman and Thor ballistic missiles. He also played a major role in the development of Pioneer I, the United States' first successful space probe, and had overall responsibility for several other space projects, including Explorer VI and Pioneer V, and for the establishment of the Air Force satellite tracking network.



Gemini Twin Ed White maneuvers 120 miles above the Pacific Ocean, connected to Gemini 4 spacecraft by an umbilical cord. Extravehicular activity, operational term for walking in space, is a basic technique required for manned space flight capability.

Mercury's Dividends

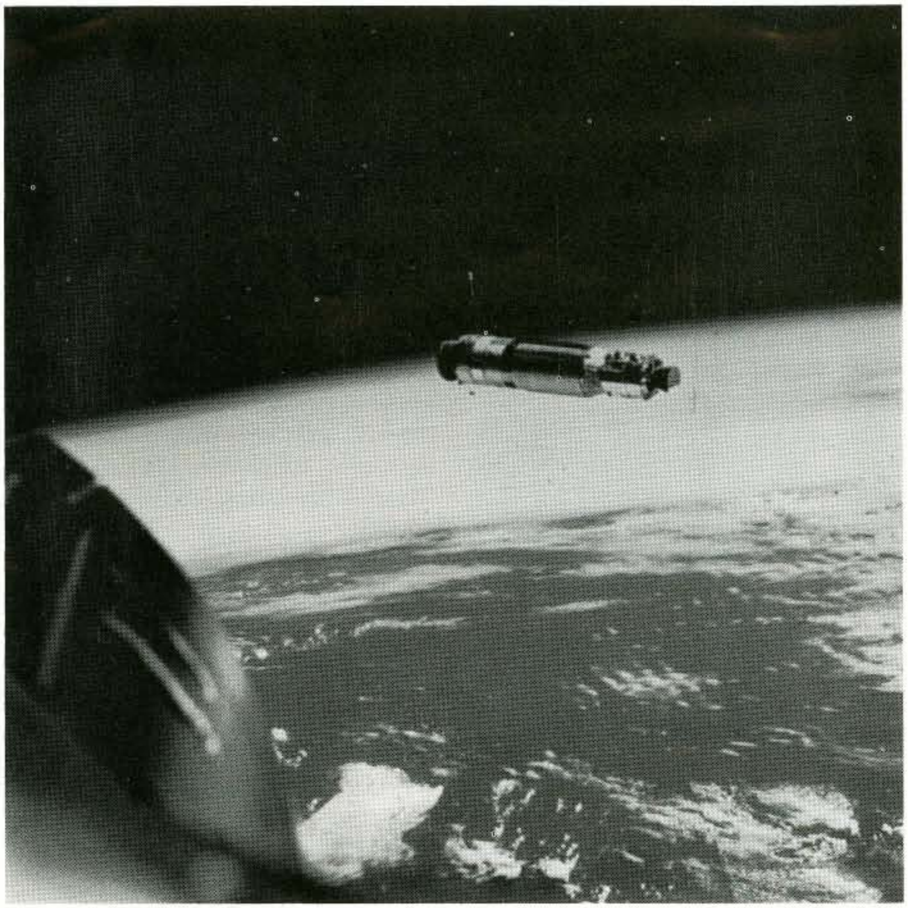
Dr. Mueller adds this footnote to the story of Project Mercury which had just concluded when he became Associate Administrator for the Office of Manned Space Flight: "Originally, NASA *assigned only two broad mission objectives to Project Mercury—first, to investigate man's ability to survive and perform in the space environment; and second, to develop the basic space technology and hardware for manned space flight programs to come. But the dividends Mercury paid went beyond those basic goals. They include the development of a* NASA *management system to carry forward more advanced manned space flight ventures; exploration of the fundamentals of spacecraft re-entry; raising a family of launch vehicles from existing rockets that led to new booster designs; expansion of the aerospace industry through* NASA *contracts; setting up an earth-girdling tracking system, and training a cadre of astronauts for future space exploration programs."*

Small wonder, then, that NASA was encouraged by this successful first step on the path to the moon, and forged ahead with the second phase, Project Gemini.

Named for the twin-star constellation of Castor and Pollux, Project Gemini called for a two-man spacecraft system to conduct orbital flights around the earth for up to two weeks' duration. Twelve flights were scheduled for the Gemini series—ten of them manned. One of NASA's prime objectives was to determine man's performance and behavior during prolonged orbital flights, including his ability to pilot and control his spacecraft. Other mission objectives were orbital rendezvous; docking or joining two spacecraft, and maneuvering the joined spacecraft as one unit; astronaut activity outside an orbiting spaceship, and a series of scientific experiments.

Dr. Mueller and his capable manned space flight crew are justifiably proud of the stand-out achievements of the Gemini program and the early successes of Apollo-Saturn—achievements which can only be described as spectacular in light of the stepped-up pace of the United States manned space flight schedule. In the spring of 1964 the first unmanned test flight of the Gemini-Titan II space vehicle was flown. By spring of this year Gemini astronauts had logged more than 1,300 man-hours in space, and traveled some 11 million miles—that's almost fifty times the distance from the earth to the moon.

Other mission objectives have been fulfilled. Last year, during the third revolution of an extended earth orbital flight, Gemini 4 Astronauts James McDivitt and Ed White carried out the first extravehicular activity in the manned space flight program. White left the spacecraft to walk in space, becoming a human satellite orbiting the earth at an altitude of 120 miles. Command pilot McDivitt remained



Astronaut David Scott's camera captures orbiting Agena target docking vehicle as Gemini 8 spacecraft hovers about 190 feet away. Michael Collins and John Young maneuvered near this same rocket during the Gemini 10 mission in July.

at the controls with the difficult task of keeping the spacecraft in a stable attitude so that White would have a constant and dependable point of reference to gauge his movements outside the capsule.

Orbital rendezvous was another mission objective. Dr. Mueller recalled the events which led to its achievement: "Within hours after Tom Lovell and Ed Borman took off on their two-week Gemini 7 flight, preparations began for launching their rendezvous ship. Gemini 6 lifted off eleven days later, with Wally Schirra and Tom Stafford aboard. For five hours Schirra and Stafford carried out a complicated series of maneuvers. Then, 185 miles above the Pacific, they rendezvoused with Gemini 7. Despite their speeds of 17,000 miles an hour, Schirra was able to guide his spacecraft to within one foot of the other. I might add that he was aided by some very fine guidance and control equipment." Docking in space was added to the plus side of the mission objective ledger in March of this year after Astronauts Neil Armstrong and David Scott docked their Gemini 8 spacecraft with an unmanned Agena target vehicle.

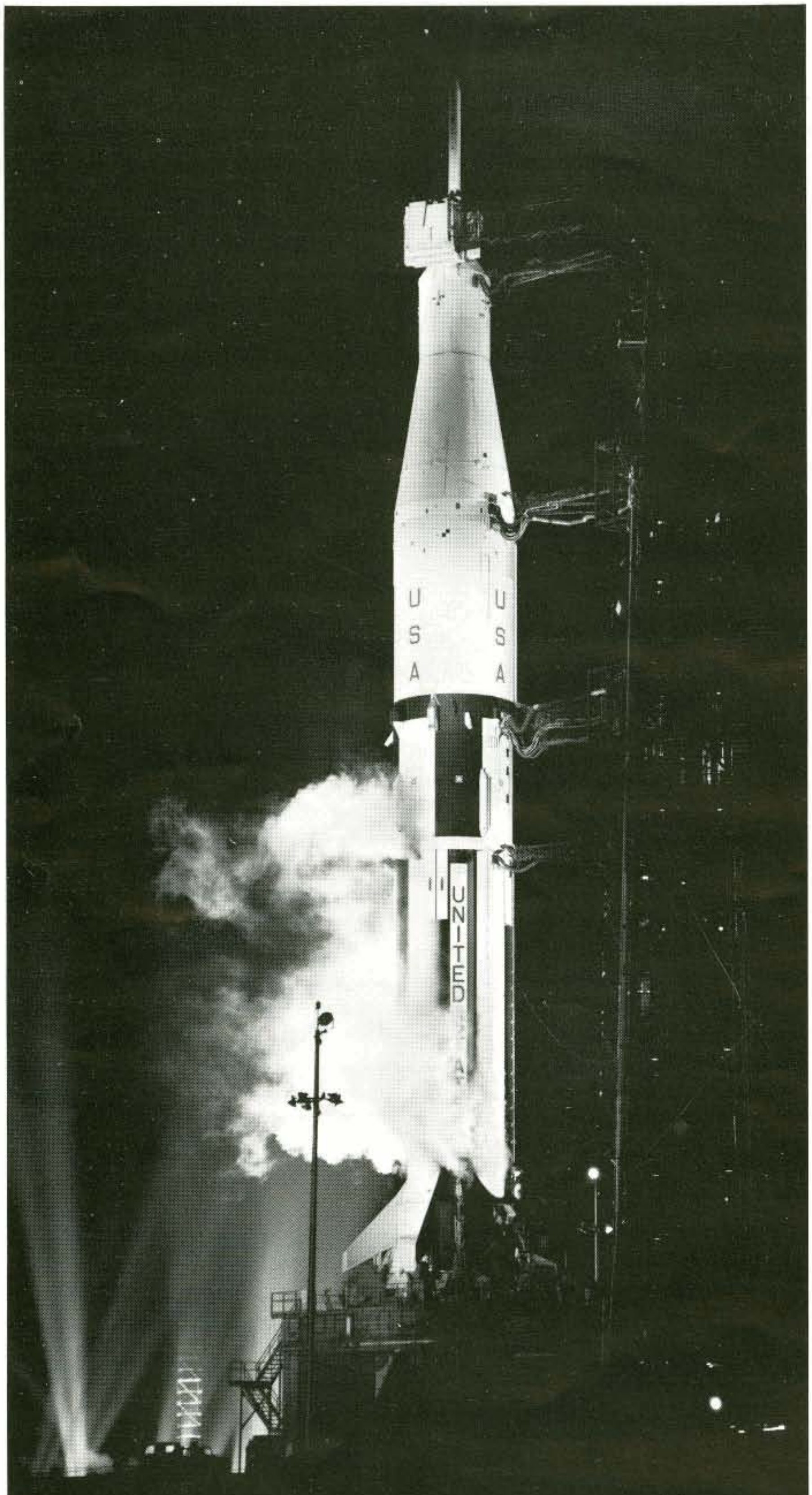
Among the most remarkable Gemini space successes was the Gemini 10 flight in late July. During that record-setting three days, astronauts Michael Collins and John Young chased and linked up with a fuel supply Agena rocket and spent nearly 39 hours linked with the other statellite; fired the rocket engine of the captured Agena for the first manned launching at orbital altitudes; soared to an orbit of nearly 475 miles—deeper into space than man has ever gone; opened the hatch of their capsule to the space environment three times; maneuvered near the orbiting Agena 8 rocket and retrieved a package from it, and accomplished a 25-minute space walk.

One of the most significant results of the Gemini missions to date, according to Dr. Mueller, is that in every case, the men returned in excellent physical and mental health. From the medical point of view the flights show that well-trained men can live and work in space for extended periods of time, and the condition of weightlessness does not appear to cause any serious aftereffects. The astronauts' state of health is measured continuously, before flight, during flight and after their return. The overall appraisal of NASA's medical team is that flights lasting a month or more are feasible.

Talented Management

Another noteworthy aspect of the Gemini program is the talented management Dr. Mueller gives it. A little more than a year ago, the program was behind schedule, and there was grave concern about the possibility of cost overruns. "We instituted a new kind of contract administration," Dr. Mueller remarked, "one in which the profit of the Gemini program contractors is tied to their total performance. As a result, schedules have been accelerated and costs are under control. I think the operation of these contracts has constituted one of the finest examples of the proper working of the free enterprise system."

The manned space flight program has a valuable asset in the person of George Mueller (pronounced Miller). The "Show Me" state native received a bachelor's degree in electrical engineering from the Missouri School of Mines, then moved to Indiana to earn a master's in the same discipline at Purdue University. He came east to the Bell Telephone Laboratories where he conducted television and microwave and measuring experiments, and pioneered in the measurement of radio energy from the sun, in microwave propogation, and in the design of low field electrons. After a stint of graduate study at Princeton University, George Mueller joined the faculty of Ohio State University as assistant professor of electrical engineering; later he bacame a full professor. At Ohio State, he conducted research on the study and design of broadcast and dielectric antennas, cathode emission, low field magne-



Uprated Saturn I on Cape Kennedy launch pad just before it successfully boosted unmanned Apollo spacecraft into a 300-mile high suborbital flight. The February 26, 1966 flight marked the first test in space of the Apollo command and service module, the craft which will house America's moon explorers.

trons and traveling wave tubes, and was awarded a Ph.D in physics. The next stop was Redondo Beach, California and the Space Technology Laboratories where Dr. Mueller spent the next five years before he assumed direction of NASA's manned space flight program.

Dr. Mueller was one of the originators of the concept and design of the Telebit digital telemetry system. He holds seven patents in electrical engineering, and is the author of more than 20 technical papers. With E. R. Spangler, he is co-author of a book, "Communication Satellites." Dr. Mueller is an active participant in national and international conferences on space communications and space technology.

Successful Stepping Stones

The Mercury and Gemini space successes are the stepping stones to the Apollo moon landing missions and to other space operations of the future. The Office of Manned Space Flight is moving ahead with Gemini and expects to accomplish all the remaining program objectives in the additional flights scheduled over the remaining months of this year. Simultaneously, remarkable progress is also being made in the Apollo program, the largest research and development program the United States has ever undertaken.

Project Apollo calls for NASA to develop two major launch vehicles and a three-man spacecraft; to assemble a nation-wide government-industry team; to construct a complex of advanced launch facilities, and to carry on a comprehensive testing program . . . all on a coordinated schedule. Under George Mueller's direction, they're doing just that.

America's moon men will make the half-million-mile round trip in the three-man Apollo spacecraft now under development at NASA's Manned Spacecraft Center (MSC) near Houston, Texas, where a cattle range was converted to a modern installation in less than three years. Dr. Robert Rowe Gilruth directs MSC, an organization responsible for the design, development and testing of manned spacecraft and associated systems, for the selection and training of astronauts, for support of manned flight operations and for managing the work of the industrial team which shares the work load.

The MSC Giant

Probably the biggest thing at MSC these days is the Apollo spacecraft. Weighing in at 45 tons and standing 84 feet tall, the spacecraft is divided into three sections—a command module, a service module and a lunar module. The command module, something like the crew compartment of a commercial jet airliner, is designed so that the astronauts can eat, sleep and work and relax in a shirt sleeve environment. It is furnished with life support equipment and is chock full of controls and instruments to enable the astronauts to maneuver their craft. Since the command module will return to earth, it is constructed to withstand the tremendous deceleration forces and intense heating caused by re-entry. It's a room with a view. The double-walled pressurized chamber has three windows in front of the astronauts' couch, and two more windows on the side. A tower-like launch escape system perches atop the command module for use in an emergency launch situation. It is jettisoned after the second stage of the launch vehicle ignites.

Beneath the command compartment is the service module, a 128-foot diameter cylinder weighing about 50,000 pounds. Inside are supplies, fuel and an engine which the astronauts use to maneuver their craft into and out of lunar orbit or alter their course and speed in space.

Once the Apollo spacecraft is orbiting around the moon, two of the astronauts crawl through a hatch into the bug-like third section, the lunar module. "The bug" detaches from the combined command-service module and descends to the moon's surface. The lunar module has its own complete guidance, propulsion, computer, communications and environmental control systems. The vehicle has two stages. The bottom stage contains the rocket engine and spidery legs which extend for lunar landing. This unit is detachable and forms the "launch platform" for the upper stage which houses the astronauts. Attached to the upper stage is the rocket engine which America's lunar explorers will ignite when they are ready to rejoin the hovering command-service module. After the astronauts crawl back into the command module, the lunar module is jettisoned and the trio heads back to earth. Just before re-entry, the service module is also detached. Parachutes are deployed to slow down the re-entry forces just before splashdown.

The Manned Spacecraft Center is an outstanding example of the advanced facilities, unique in both size and capability, which NASA has constructed to meet Apollo program objectives. MSC is the home of the Mission Control Center—an office/laboratory combination where engineers, scientists and technicians team up with computers to direct operations of manned space flights. Support functions at the Center include recovery control, recovery communications, meteorology and trajectory data, network support and monitoring devices for life support and vehicle systems. MSC is also the site of the country's largest "man-rated" space environment chamber. Altitudes of about 80 miles can be simulated in this chamber and spacecraft can be subjected to temperatures and solar radiation conditions that will be experienced on a flight to the moon.

Muscle for Apollo

The muscle for the Apollo program is provided by the Saturn family of heavy launch vehicles. Development of these mammoth boosters is the responsibility of Dr. Werner von Braun, director of NASA's George C. Marshall Space Flight Center (MSFC) at Huntsville, Alabama. Some 7,000 MSFC employees are engaged in the research and development of the Saturn workhorses—from conception through design, development, fabrication and assembly of the hardware, and testing.

Baby of the Saturn family is the 120-foot tall, 21.5-foot diameter Saturn I. It has been flight tested with a perfect record of ten successes in ten launches, a record without parallel in the development and operation of large launch vehicles. In unmanned test flights Saturn I has placed test versions of the command and service modules of the Apollo spacecraft into orbit. With its cluster of eight rocket engines burning refined kerosene and liquid oxygen, Saturn I develops 1.5 million pounds of thrust in its first stage. Its second stage has six engines which burn liquid hydrogen and liquid oxygen, producing 90,000 pounds total thrust.

Also under development at MSFC is the uprated Saturn I with an improved first stage version of the Saturn I, and a new and more powerful second stage. With 1.6 million pounds booster thrust, and 200,000 pounds second stage thrust, the uprated Saturn I will boost Astronauts Virgil Grissom, Ed White and Roger Chaffee into earth orbit for a long duration mission of up to two weeks.

Saturn V Moon Rocket

Big Daddy in the Texas-size booster corral is the Saturn V, a vehicle of gigantic size and power. The Saturn V moon rocket tops the 250-foot high Statue of Liberty by 31 feet. Assembled on the launch pad with the three modules of the Apollo spacecraft on top, the moon rocket stands 364 feet tall and weighs about six million pounds. Its first stage has a diameter of 33 feet, and is powered by a cluster of five engines packing a wallop of 7.5 million pounds of thrust. Another million pounds of thrust will be furnished by a cluster of five engines in the second stage. On top of the first two is the third stage which is identical to the uprated Saturn I second stage.

The Saturn's first stages are built by NASA's Michoud Assembly Facility in New Orleans, Louisiana, and later are floated by barge into Mississippi for rumbling static tests at NASA's Mississippi Test Facility. The second and third stages of Saturn V are built in California. At Mississippi the gigantic stages are lifted directly from the barges onto the test stands, held captive and run through full strength, full duration "hot" firings. After testing, the rocket stages are replaced on the barges and floated via a complex canal system to Cape Kennedy.

Other flight equipment, manufactured and tested at NASA's nation-wide facilities, are also shipped to the John F. Kennedy Space Center (KSC) in Florida, where an integrated government/industry team takes over assembly, checkout and launch of the moon-bound space ships under the direction of Dr. Kurt Debus. KSC, the major launch organization for manned and unmanned space missions, is the focal point for the development of launch philosophy, procedures, technology and facilities. So huge and so complicated are the Apollo-Saturn launch vehicles that NASA had to devise new approaches to assembling them. Thus a new generation of space facilities was born. Towering over the Kennedy Space Center terrain is the VAB (vehicle assembly building), a 524-foot high plant where four Saturn rockets can be assembled simultaneously and checked out stage by stage. Scheduled for completion this year, the VAB provides for assembly and checkout of the moon rockets in a controlled environment which eliminates the hazards weather could wreak on rockets and time schedules.

After assembly, the Saturn V rocket, its mobile launch tower and mobile platform leave the VAB through a doorway 456 feet high. A monstrous tractor trundles the works to the launch pad. The Kennedy moonport will have two Saturn V launch pads, with the capability of launching about six vehicles a year after 1968.

The pieces in this massive jigsaw puzzle called manned space flight are falling into place. Excellent progress is being made on the development of the Saturn launch vehicle; hardware is being assembled for a 1967 test flight of the Apollo lunar module, astronauts are being trained.

At the pivotal halfway point in the program this spring, Dr. George Mueller, the man who manages this engineering enterprise had this to say: "The government/industry team required to carry out the manned flight program is in place and working. The program is on schedule, a schedule set when the program began. And, if progress continues, we will accomplish the manned lunar landing and safe return of America's astronauts in this decade."

But Dr. Mueller doesn't want to stop there. He has emphasized many times that the lunar mission is just one of the many possible missions which can use the capabilities of the Apollo-Saturn program. "The first successful manned lunar landing will just scratch the surface. Its greatest achievement will be a demonstration of the ability to travel a quarter of a million miles from earth, land on that heavenly body and return safely here. Other journeys must follow. We must use the Saturn rockets, the Apollo spaceship and the launch facilities . . . over and over again to gain the fullest return on our investment.

"We can make many flights in orbit about the earth, about the moon or to the moon's surface. By using our capabilities effectively and imaginatively, we will be able to carry out a wide variety of missions of great scientific value and of direct benefit to mankind." ■

In Mission Operations Control Room at the Manned Spacecraft Center near Houston, Texas, personnel monitor Gemini space flight. Mission Control Center is the focal point of a global network of tracking and communications stations which provide centralized control for orbital flights.