MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FACT SHEET #291
FEBRUARY 1965

GEMINI PROGRAM

The National Aeronautics and Space Administration announced December 7, 1961, a plan to extend the manned spaceflight effort by development of a two-man spacecraft. On January 3, 1962, the program was officially designated "Gemini" and named after the third constellation of the zodiac, featuring the twin stars Castor and Pollux.

OBJECTIVES

The Gemini Program is managed by the Manned Spacecraft Center, Houston, Texas, under the direction of the Office of Manned Space Flight, NASA Headquarters, Washington, D. C.

Primary objectives of the Gemini program, which were decided upon after it became evident to NASA officials that an intermediate step between Mercury and Apollo was required, are:

*To provide a logical follow-up program to Mercury with a minimum of time and expense.

*To subject two men and supporting equipment to long duration flights, a research and experience requirement for projected later trips to the moon or deeper space.

*To effect rendezvous and docking with another orbiting vehicles; and to maneuver the combined spacecraft in space, utilizing the propulsion system of the target vehicle for such maneuvers.

*To experiment with astronauts leaving the Gemini spacecraft while in orbit and determining their ability to perform extravehicular activities such as mechanical or other type tasks.

*To perfect methods of reentry and landing the spacecraft at a pre-selected landing area.

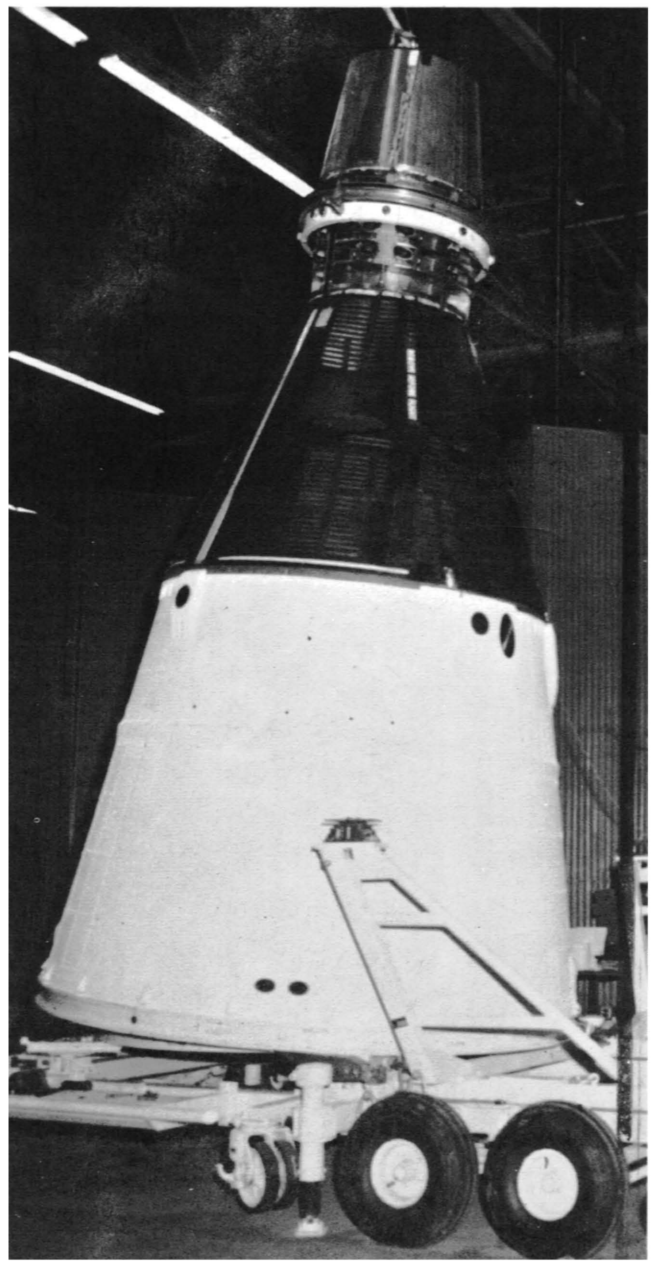
*To gain additional information concerning the effects of weightlessness, and physiological reactions of crew members during long duration missions, and other medical data required in preparation for the lunar missions of the Apollo Program.

*To provide the astronauts with required zero-gravity and rendezvous and docking experience.

GEMINI SPACECRAFT

The Gemini spacecraft is similar to the Mercury spacecraft in shape but is, of necessity, considerably larger. The reentry module alone is 11-feet high and 7½-feet in diameter at the base as compared to the nine-feet high, six-feet in diameter Mercury spacecraft.

The combined weight of the Gemini spacecraft and its adapter module, which is about 19-feet high, is approximately 7,000 pounds as compared to Mercury's



THE GEMINI SPACECRAFT, on a dolly, is shown as it arrives at Hangar AF at Cape Kennedy, Florida.

4,000 pounds. The cabin section has about 50 percent more volume than was available in Mercury.

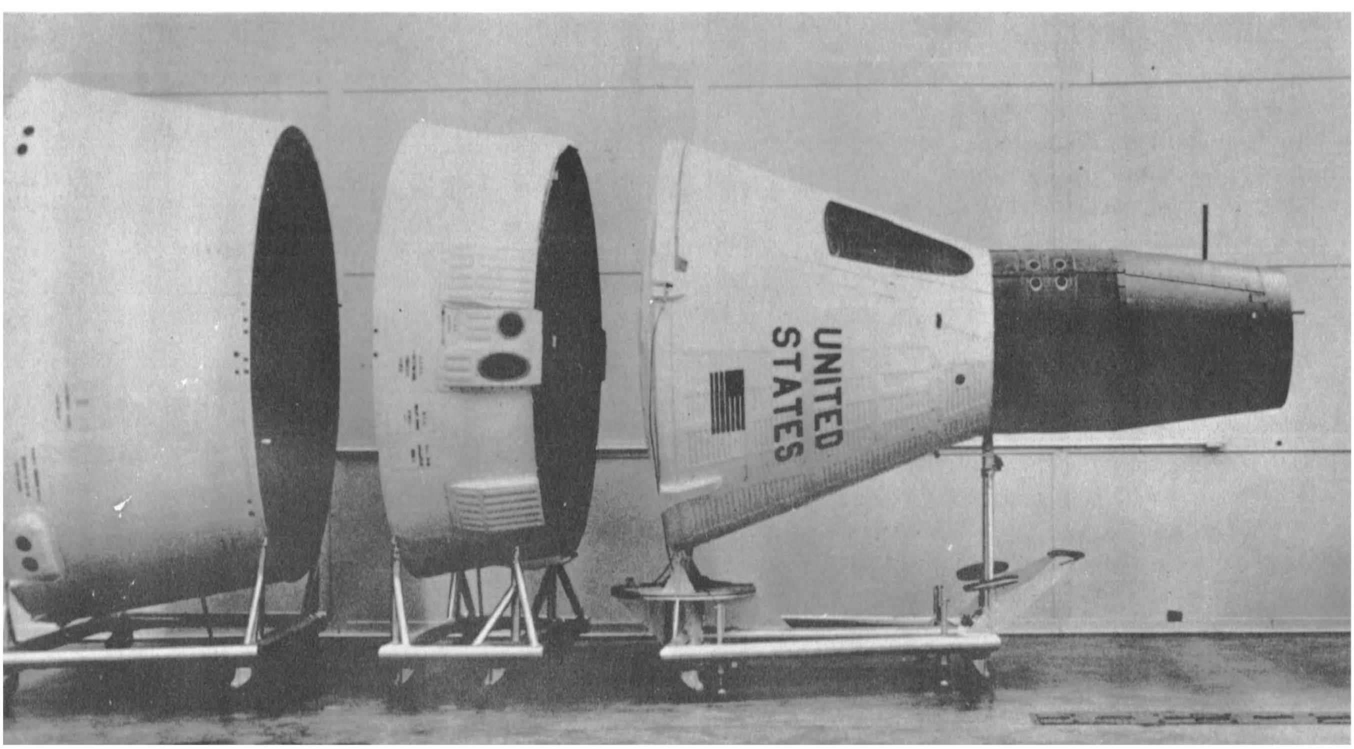
There are many other major changes incorporated in the Gemini spacecraft as compared to Mercury. Since Mercury was primarily a research and development vehicle, it was designed to provide completely automatic control from the ground although it had built-in capabilities for switchover to pilot control. Due to difficulties encountered in the various systems in Project Mercury flights, and the fact the astronauts capably handled such difficulties, the Gemini spacecraft is primarily designed to be controlled by the astronauts throughout the flight.

Another major difference between the two spacecraft is the type and placement of sub-systems and components. In Project Mercury, most of the systems were in the pilot's cabin, with many components stacked in "layer-cake" fashion, and when troubles were encountered it was sometimes necessary to disturb a number of systems to get at the one causing trouble. By comparison, in Gemini, the systems are modularized by placing all pieces of each system in compact packages. Packages are so arranged that any system can be removed without tampering with any other system, and spare packages are completely checked and kept ready for rapid replacement if any troubles occur. These packages are located on the outer wall of the pilots' pressurized cabin, permitting easy access in the event replacement is necessary. Only the visual instruments, controls, communications equipment and life support equipment and materials such as food, water, waste handling equipment, survival gear and breathing apparatus is located in the pilots' cabin section.

Another major change between the spacecraft concept of America's first two-manned space program is the difference in approach to pilot safety should an abort occur. Mercury had an escape tower, while in the Gemini Program ejection seats will be used. The use of ejection seats is made possible in Gemini because the fuel used by the Gemini launch vehicle, a modified Air Force Titan II, burns on contact with the oxidizer rather than exploding as did the fuel used by the Atlas launch vehicle in the Mercury program. The ejection seat method provides an additional benefit in that it can be utilized during reentry at low altitudes in case trouble develops during that phase of the mission.

The complete Gemini spacecraft contains two major units; an adapter module, consisting of a retrograde section and an equipment section; and the reentry module, consisting of the rendezvous and recovery section, the reentry control section, and the cabin section. The heat shield is attached to the cabin section. A nose fairing, attached to the forward end of the rendezvous and recovery section, is ejected during the launch phase of the mission.

It is not practical to list all of the components and systems housed in these sections of the spacecraft for such would mount into the hundreds, but following are some of the major items in each:



A MOCK-UP OF THE Gemini spacecraft is shown broken down to indicate major sections of the spacecraft. From left to right are the adapter module equipment section, the adapter module retrograde section, and the reentry module which consists of the cabin section, the reentry control section, and the rendezvous and recovery section.

*Rendezvous and Recovery Section: radar equipment for use in rendezvous missions, and the drogue and main parachutes.

*Reentry Control Section: fuel and oxidizer tanks, valves, tube assemblies, and thrust chamber assemblies for the reentry control system.

*Cabin Section: an internal pressure vessel serving as the crew station and including those items mentioned previously. This pressurized compartment is ballasted to provide the correct water flotation position. The space between the pressurized crew station and the external skin of the cabin section houses instrumentation packages and electronic gear among other items. The cabin also incorporates two hatches symmetrically spaced on the top side. These hatches are hinged on the outside and each is manually operated by means of a handle and mechanical latching mechanism. Both of the hatches have visual observation windows consisted of an inner and outer glass assembly.

*Retrograde Section: provides spaces for the installation of the four retrograde rockets and six orbital attitude maneuvering thrust chamber assemblies.

*Adapter Equipment Section: the part of the spacecraft which is mated to the launch vehicle, and also houses the primary oxygen supply, batteries and/or fuel cells, coolant, electrical and electronic components. Ten orbital attitude maneuver thrust chamber assemblies are mounted on the large diameter end of this section.

GEMINI LAUNCH VEHICLE (TITAN II)

The Gemini Launch Vehicle (GLV) is the Air Force Titan II, modified to fit the needs of the Gemini program. By using this proven vehicle, NASA has again, as in the Mercury program, utilized existing hardware to the maximum rather than developing a special launch vehicle for the program.

The GLV is a two-stage vehicle which uses storable hypergolic propellent (the fuel and oxidizer burn on contact). The height of the GLV without the spacecraft is 90 feet and it is 10 feet in diameter. The liftoff weight of the total configuration is approximately 150 tons. The two first stage engines provide 430,000 pounds of thrust at sea level; and the single second stage engine provides 100,000 pounds of thrust at its ignition altitude (the first stage engines burn out and the second stage engine ignited at approximately 200,000 feet).

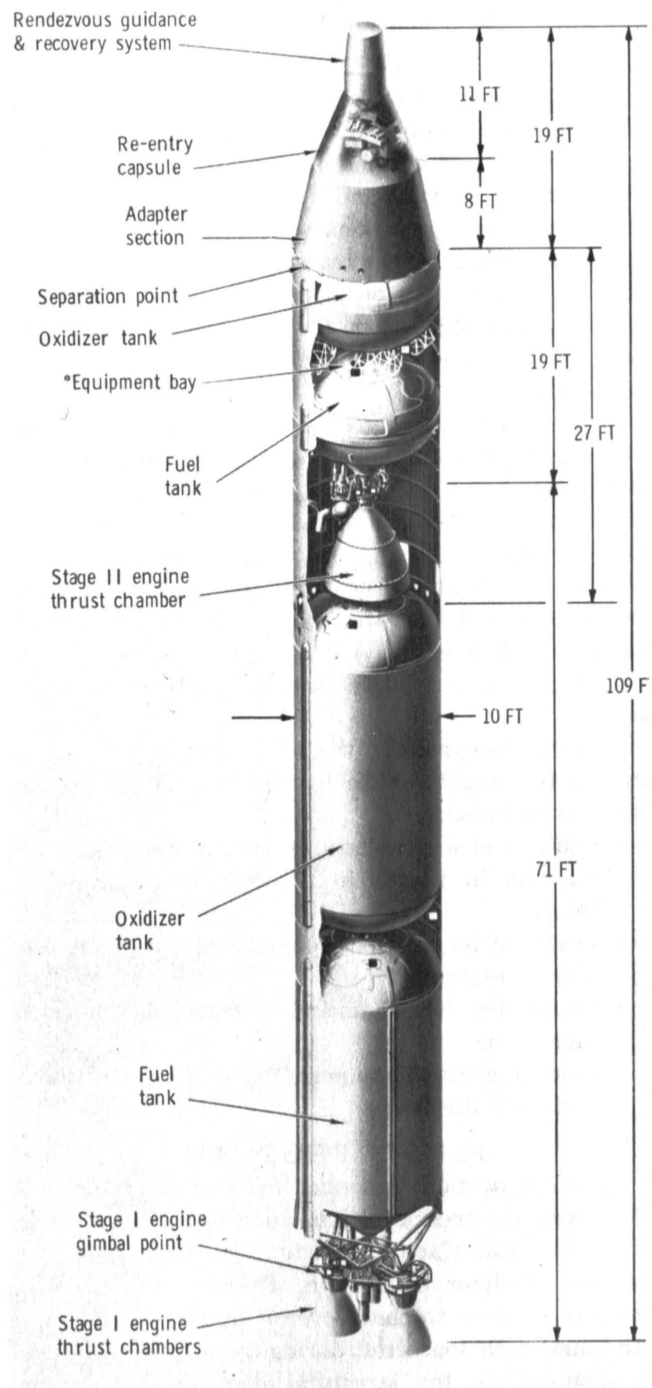
In order to assure the reliability and safety requirements for use of the Titan II in the Gemini program, the following modifications were developed and made:

*A malfunction detection system (MDS) to sense problems in any of the vital launch systems, and transmit this information to the astronaut crew.

*A redundant flight control system which can take over the job of the primary system if it should fail in flight.

*Redundancy in the electrical system with necessary changes to provide power for such added launch vehicle equipment as the MDS.

*Substitution of radio guidance for the inertial guidance to provide weight reduction.



A CUTAWAY GRAPHIC illustration of the Gemini launch configuration showing some major items of hardware.

*A new truss in the second stage of the launch vehicle to hold much of the new flight control, MDS, and guidance equipment.

*New Stage II forward oxidizer skirt assembly to mate the rocket with the Gemini spacecraft instead of a warhead.

*Redundancy in the hydraulic systems to assure pilot safety, such as installation of dual hydraulic actuators for engine gimbaling.

*Instrumentation to provide additional data during preflight checkout and flight.

AGENA D

A modified Agena D vehicle will be used as the target vehicle for Gemini rendezvous and docking missions. This vehicle will be launched by a standardized space launch vehicle, and following burnout of the Atlas, its propulsion system will be turned on until it attains an altitude of approximately 181 statute miles. The Agena will then be placed into a circular orbit and its power shut down to be turned on again for maneuvering following completion of docking with the spacecraft.

The Agena D, as inserted in orbit with its nose cone is 32-feet long; without the nose cone, which is jettisoned after being in orbit, it is about 24½-feet long without the adapter. The Agena is five-feet in diameter and also uses storable hypergolics to develop its capability of 15,000 pounds of thrust. Its engine will be at the opposite end from the docking adapter, and when the astronauts start the Agena engine to maneuver the two spacecraft as a single unit, they will be propelled backward.

Modifications made to the Agena D to make it suitable as the target vehicle for the Gemini rendezvous missions included:

- addition of a secondary propulsion system
- increase in length to accommodate larger fuel tanks
- provision for restart capability in the main propulsion system
- electronics for command signals and docking maneuvers
- a docking adapter to permit mooring of the spacecraft and the target

FLIGHT PROGRAM

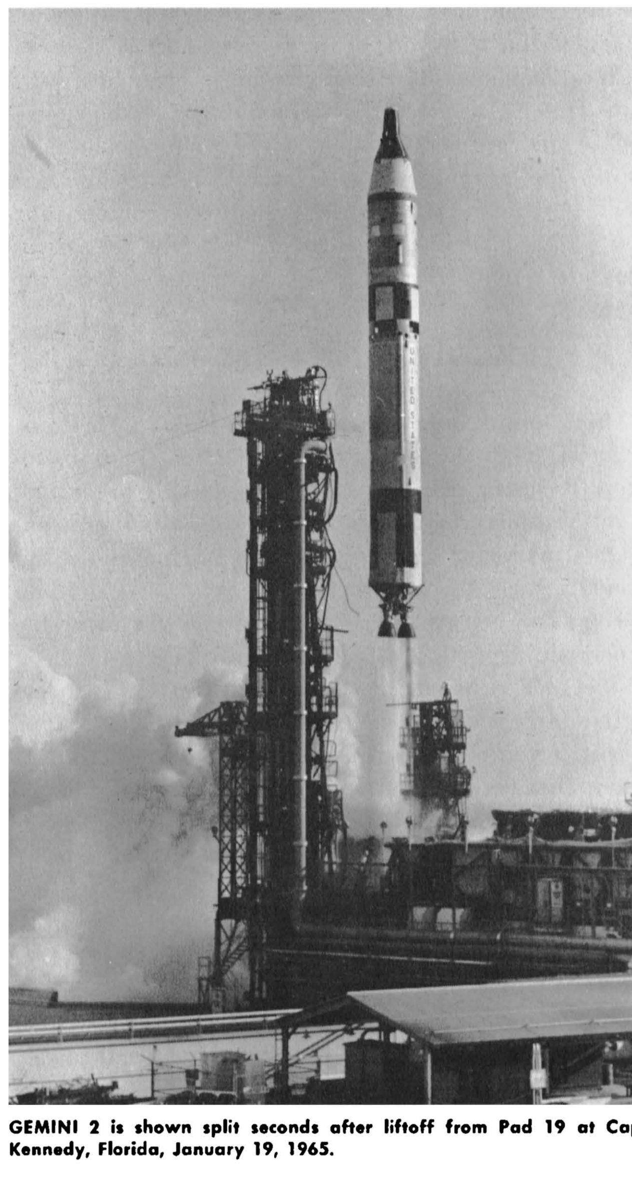
The Gemini flight program was started on April 8, 1964, with the successful launching of GT-1 (Gemini-Titan I) from Cape Kennedy, Florida, following a flawless five-hour countdown. Primary objectives of the mission were to check overall dynamic loads on a structural shell spacecraft during the launch phase and to demonstrate the structural compatability of the spacecraft and launch vehicle.

Since recovery of the spacecraft and separation of the Gemini from the Titan's second stage were not planned, these two pieces of hardware went into an elliptical orbit with a perigee (low point) of about 100 statute miles and an apogee (high point) of 204 statute miles, with an orbit time of 89.27 minutes. Velocity achieved during this mission was more than 17,500 miles per hour.

GT-1 reentered the earth's atmosphere over the South Atlantic and burned up on its 64th orbit.

The Gemini flight schedule, beginning with the start of calendar year 1965 calls for one flight each quarter, barring difficulties which may be a result of natural or technical causes or both. An example of this previous statement might best be presented by the story of GT-2, which was originally scheduled to have been flown during the third quarter of 1964.

The Gemini launch vehicle used in GT-2 was shipped to Cape Kennedy July 10, 1964, following inspection and acceptance at Martin Company's Balti-



GEMINI 2 is shown split seconds after liftoff from Pad 19 at Cape Kennedy, Florida, January 19, 1965.

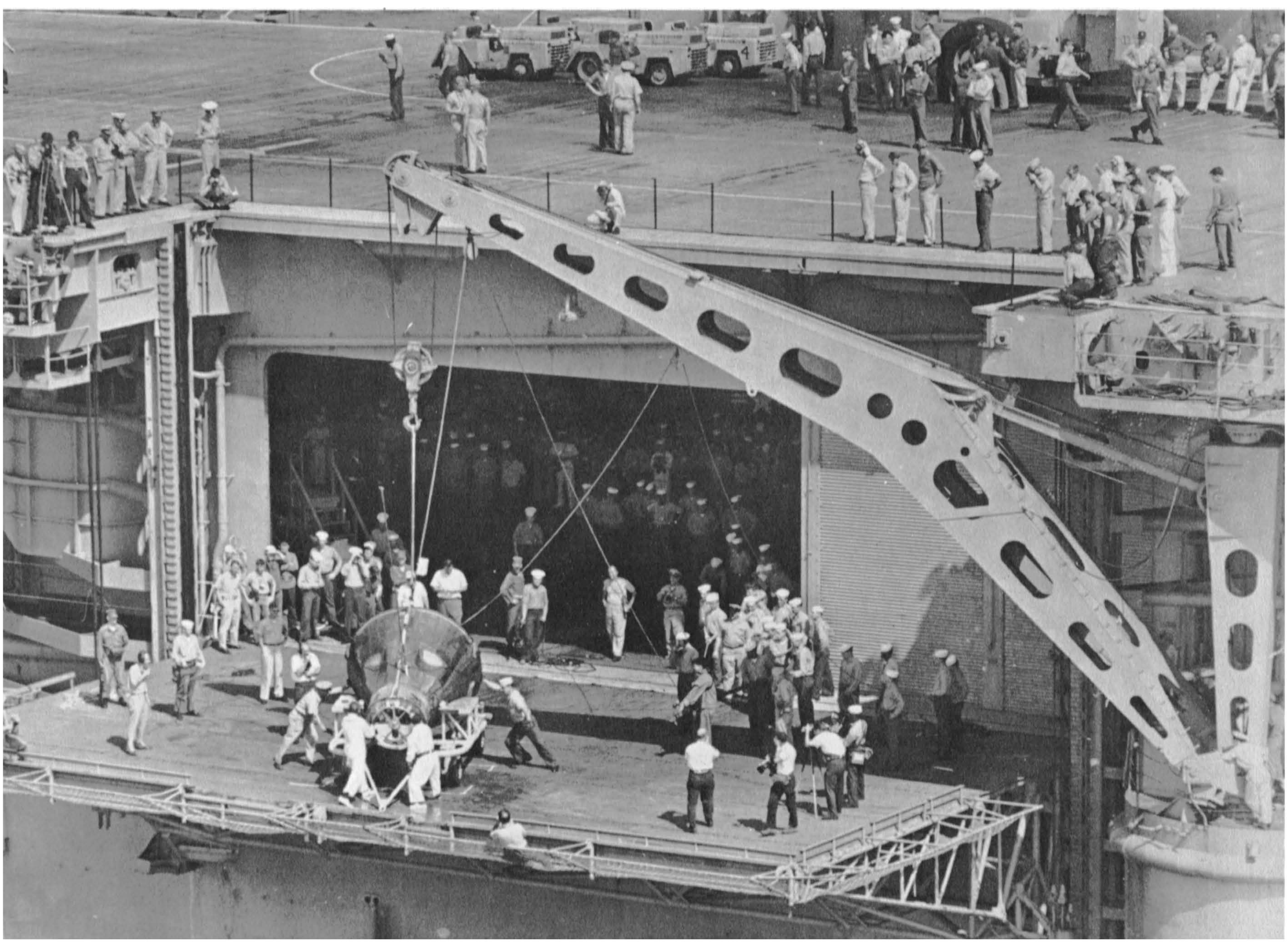
more, Maryland plant, and its erection at the Cape's Pad 19 complex was completed July 14. On August 17, the launch vehicle was exposed to lightning strikes near the Pad area, causing a delay while necessary repairs were made and systems revalidated. Late in August, it was determined necessary to de-erect the second stage of the launch vehicle as Hurricane Cleo battered the Florida Coastline. Another hurricane, Dora, hit the area in September and this time both stages were de-erected.

Three days later the launch vehicle was re-erected for the last time and work started toward completing necessary work to make it ready for the launch. On November 5, the Gemini spacecraft was mated to the launch vehicle and it seemed that, finally, the second and last of the planned unmanned Gemini tests would be completed early in December. With the launch finally set for December 9, the countdown progressed normally and, when the countdown reached zero the stage one engines were ignited. The Malfunction Detection System detected technical troubles due to a loss of hydraulic pressure and shut down the engines about T plus 1 second. After an inspection of the vehicle by NASA, Air Force and associated contractor officials to determine the cause of the difficulty, it was decided to re-schedule the GT-2 launch for January 1965.

GT-2 was launched from Pad 19 on January 19, 1965, at about 9:04 a.m., EST. The mission, a suborbital flight, lasted a little more than 19 minutes. The primary objective of the flight, last of the unmanned tests scheduled in the Gemini Program, was to flight-qualify the total spacecraft as an integrated system for manned space flight.

A major item under careful observation was the reentry module's heat protection equipment during the maximum heating rate reentry situation planned.

Other requirements identified as primary mission objective were the satisfactory performance of the following spacecraft systems — reentry control, retrograde rocket, parachute recovery, pyrotechnics, communications, electrical, sequential, environmental control, spacecraft displays, orbital attitude and maneuver and associated electronics, inertial measuring unit (during the launch and reentry phases), inertial guidance (during turn-around and retro maneuvers),



THE GEMINI 2 SPACECRAFT is shown as it was lowered to the deck of the aircraft carrier Lake Champlain after its 19-minute journey and subsequent pick-up by the carrier.

spacecraft recovery aids, tracking and data transmission, check-out and launch procedures, and backup guidance steering signals throughout the launch phase.

During the flight the maximum altitude attained was about 99 statute miles, and the maximum earth-fixed velocity was 16,709 miles per hour. Other major events followed the planned pattern closely. For instance, the planned exit g-force was estimated at 7.57 and the actual g-force during that phase was indicated at 7.5; the reentry g-force was estimated at 9.576 and the data recorded indicated it was 9.6.

The GT-2 spacecraft was lifted out of the water at 10:45 a.m., EST, by the aircraft carrier Lake Champlain, the same carrier which retrieved Astronaut Alan B. Shepard Jr., the first American to go into space.

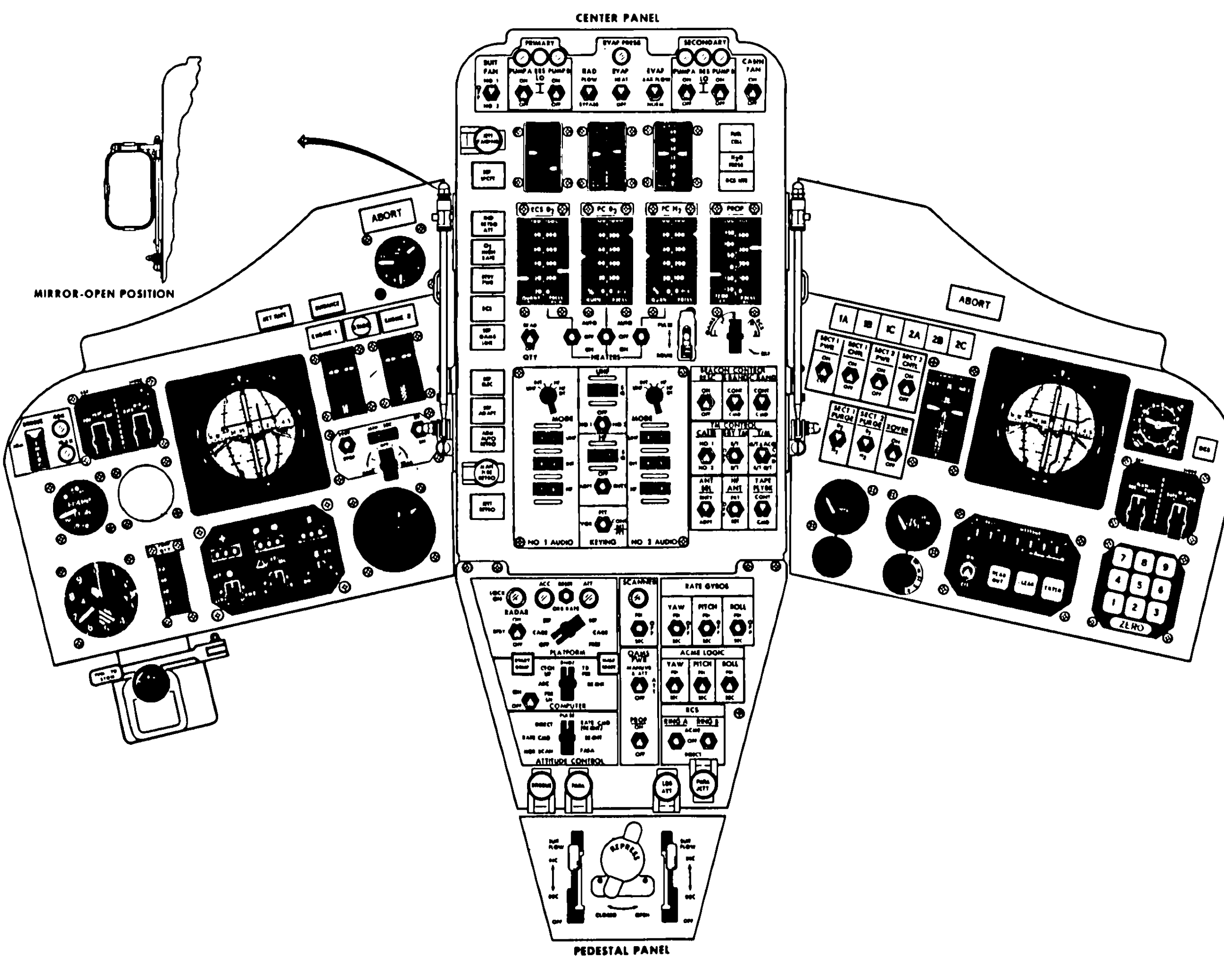
FLIGHT CREWS

Flight crews for the manned Gemini mission are named well in advance of the scheduled flight times. Since NASA originally planned the first manned Gemini flight for late 1964, the crew was selected on April 13. Astronauts Virgil I. Grissom and John W. Young were named prime crew command pilot and pilot, respectively, with Astronauts Walter M. Schirra, Jr., and Thomas P. Stafford as the back-up crew in the same positions.

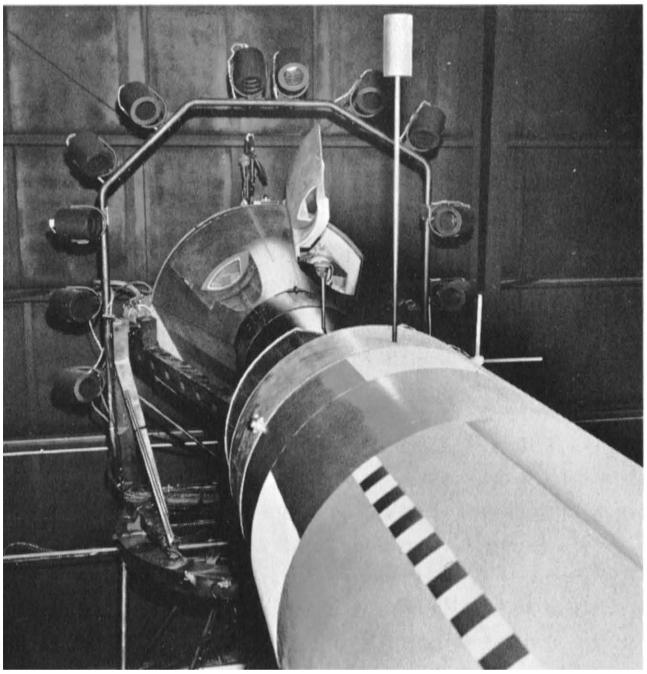
On July 27, 1964, the crew members for the second manned Gemini mission were named. They are Astronauts James A. McDivitt and Edward H. White II, as the prime command pilot and pilot, respectively, and Frank Borman and James A. Lovell as the back-up crew.

From the time these crews are named they practically "live" with the spacecraft assigned to their particular mission. They spend much time at the McDonnell Aircraft Corporation plant in St. Louis, Missouri, where the spacecraft is assembled and keep an almost continuous check on it as well as participate in the spacecraft testing during all phases of assembly.

Additionally, they are at the Cape for the mating of the spacecraft and the launch vehicle and participate in many simulations and tests prior to and following that mating procedure. The crews spend literally hundreds of hours training for their mission. A major part



THE INSTRUMENT PANEL OF THE Gemini spacecraft is pictured above. The center panel is located between the two astronauts, the panel at the left is in front of the command pilot, and the panel at the right in front of the pilot.



THE GEMINI translation and docking simulator is shown in use above with Astronaut Richard F. Gordon Jr. at the controls, at the left. This simulator is used by all the astronauts to gain experience for rendezvous and docking maneuvers in space with a target vehicle. Below is a picture of the Gemini Mission Simulator at Manned Spacecraft Center at Clear Lake. This is one of two such training devices built for NASA by the McDonnell Aircraft Corporation. The other such simulator is located in the Mission Control Center at Cape Kennedy, Florida. The crew station of the simulator is shown at the left, and the instructor's console's and related equipment take the remainder of the space. By use of this simulator, assigned flight crews run through many simulations of their missions and the instructors are able to "insert" various systems failures and other unexpected events in the flight simulation sequences in order that the pilots might gain experience in reacting to such situations. The simulators are also capable of being used in testing the Manned Spaceflight Network prior to actual missions by running the various mission simulations through the computer while tied into the network. In addition to providing flight training for the astronauts, this training device is able to provide almost every contingency and flight condition with the exception of zero gravity.

of this time is spent in simulated mission runs in the Gemini Mission Simulator at Cape Kennedy, with each astronaut spending more than 100 hours in this type training. Other refresher training for the selected crews includes such areas as abort training, egress activities, star identification and familiarization with the constellation above the planned orbital path, parachute landings, centrifuge, restraint system procedures and controls and displays. All this training is accomplished to assure that the crews are at a peak of efficiency at flight time. The many hours in simulated missions also provides them with the opportunity of working with flight controllers, network personnel, and other personnel who support them on the ground during the missions.

TYPICAL MISSION PROFILES

There are two typical mission profiles for Gemini manned flights. It might be more true to say there is one flight profile which pertains to all flights and an additional profile for the rendezvous missions.

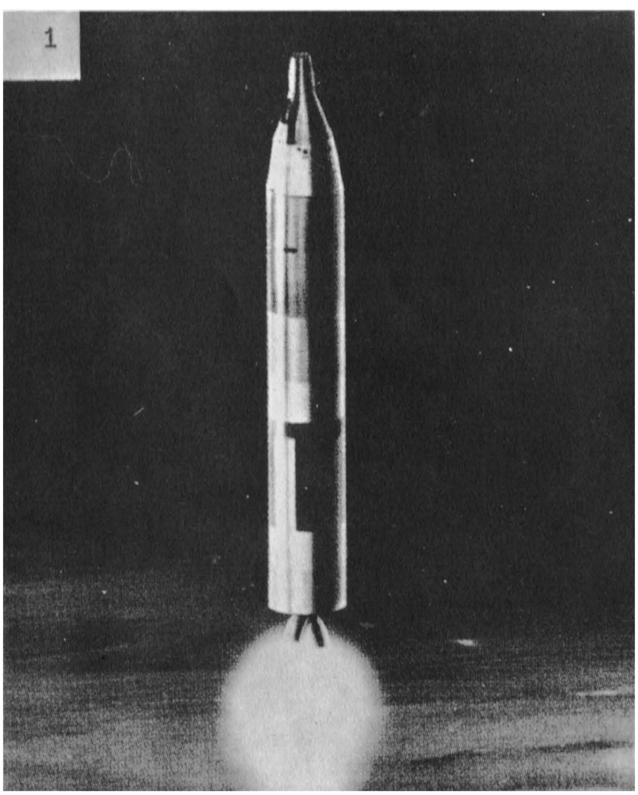
First, let us consider the non-rendezvous type missions which will start with three orbits and then graduate to longer flights later in the program with some flights being up to a 14-day duration.

Gemini flights really consist of a number of phases—prelaunch, launch, orbit, retrograde, reentry, landing, and recovery.

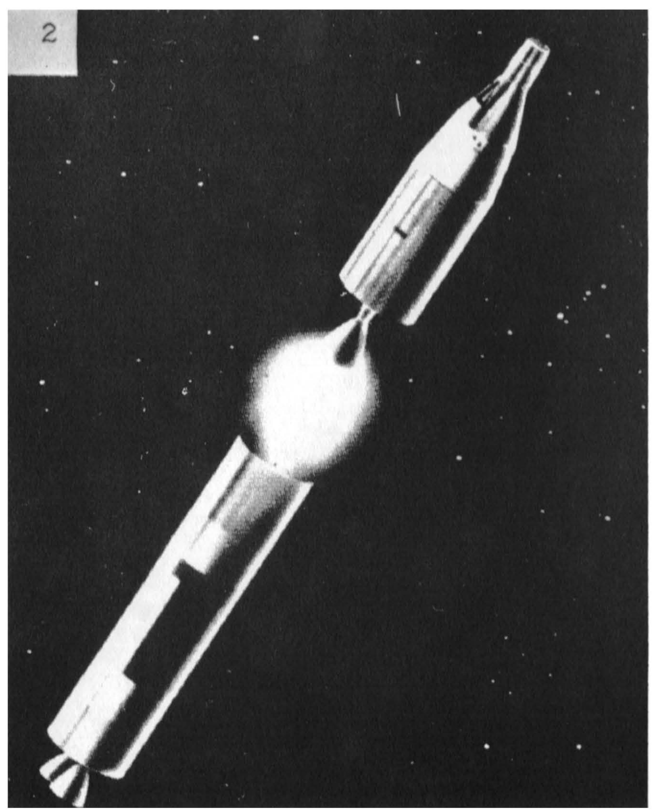
The prelaunch phase begins with the arrival of the launch vehicle and the spacecraft at Cape Kennedy. This is followed by the launch vehicle erection; continuing checks of both launch vehicle and spacecraft systems; physical mating of the launch vehicle and spacecraft; simulations to give further assurance that everything is in working order; and finally, the countdown on launch day.

When the Gemini configuration lifts off the pad, the launch phase starts and continues through the point when the spacecraft is separated from the launch vehicle's second stage approximately six minutes after liftoff. During this phase of the mission, many vital actions are required for a successful mission to take place. The roll program is completed (this is necessary to reach proper altitude for orbital insertion); the stage one engines are shut down about 2½-minutes following launch at an altitude of about 230,000 feet; the stage two engine is ignited and following this ignition, stages one and two are separated. When the orbital insertion point is approached, the astronauts cut off the second stage engine and fire explosive charges which separate the spacecraft from the launch vehicle.

When these actions are completed, the orbital phase of the flight begins, and the activities from that point on depend upon the specific flight plan, and the planned length of the mission. Typical actions during the orbital phase of flight include a continuous check



The following series of 14 photos are the artist's concept of various important activities during a Gemini mission. In Picture 1, above, the liftoff phase is shown with the launch vehicle's 430,000 pounds of thrust pushing the total Gemini configuration skyward.



Picture 2 shows the separation of the second stage of the launch vehicle and the spacecraft from the first stage following first stage burnout and ignition of the second stage.

of spacecraft systems, translational and out-of-plane orbital maneuvering, completion of experiments assigned to the mission, possible egress of one of the astronauts while in space, taping comments at specified times, communications with network stations, updating information in the computer, and performing other required pilot functions.

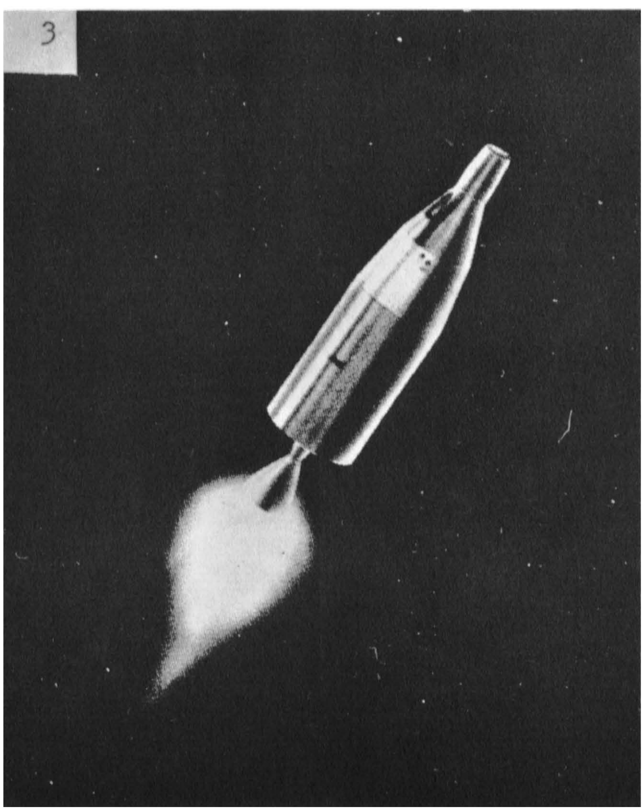
At a specific point in the orbital phase of flight, the astronauts will turn their spacecraft around so that the large end is forward in flight in the proper reentry attitude. They will then jettison the equipment section of the adapter module, thereby exposing the four retrograde rockets. Meanwhile, ground tracking stations will transmit data indicating orbital position and track which the pilot will insert into the on-board computer. The computer will then determine when the planned landing point is within range of the spacecraft and indicate the time the astronauts should fire the retrorockets to reach that point. The retrorockets will sufficiently slow the spacecraft's orbital velocity to a point where it will gradually drop from its orbit. The retrograde section is jettisoned following retrofire, and the spacecraft starts the reentry phase.

During reentry, the computer continues to assess the flight path; directs the crew to roll the spacecraft with attitude control jets to position it properly to take advantage of its lift capability and to fly right or left or to lengthen or shorten the descent as necessary to fly to the planned landing point. The Gemini spacecraft can be "flown" in this manner to a point within a 10-mile circle in a 28,000 square mile area. When the spacecraft reaches a point where a non-lifting trajectory will carry it to the landing area, the computer will direct the crew to establish a continuous roll to eliminate the lift effect on the spacecraft path. Aerodynamic drag then ultimately slows the spacecraft to near sonic speed.

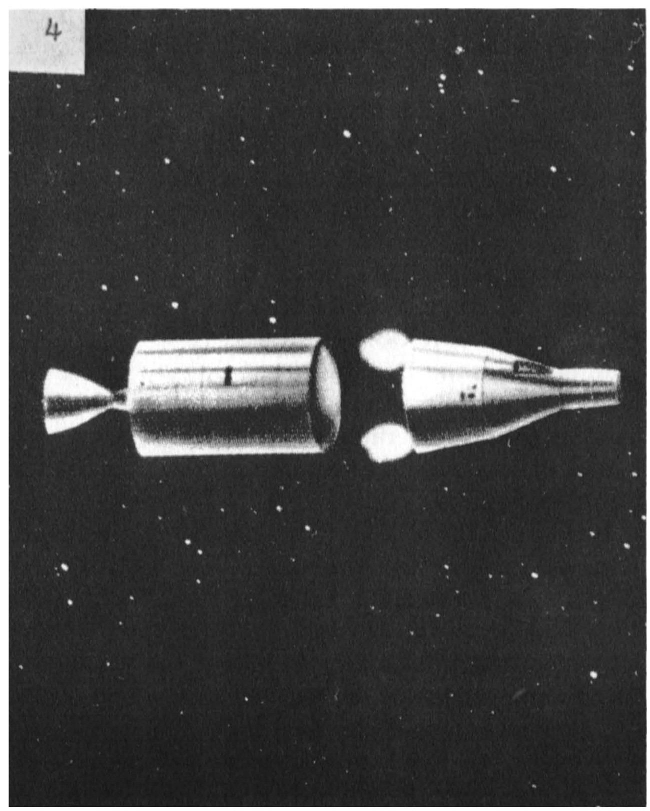
At approximately 60,000 feet, the astronauts will deploy a drogue chute which will further slow their descent and stabilize the spacecraft. At approximately 10,000 feet, a large ring-sail parachute will be deployed and the spacecraft will make a water landing.

The Department of Defense plays a major role in the recovery phase of the mission. Ships, aircraft, and personnel are deployed to many parts of the world to insure as rapid a recovery as possible following either a planned or contingency landing.

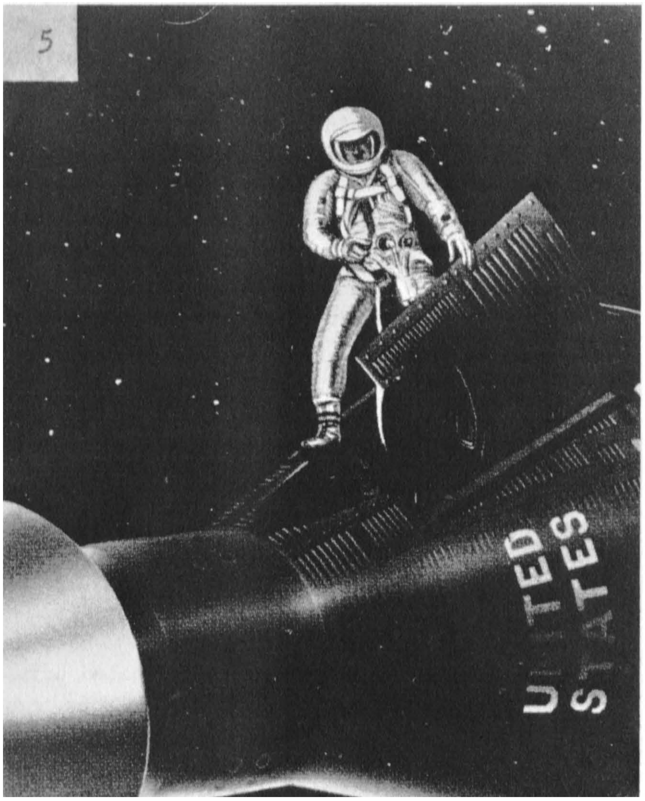
The bulk of the recovery forces are located across the Atlantic Ocean, along the planned orbital insertion path in the event of a high-altitude abort situation and in the primary planned landing areas such as in the case of a three-orbit mission, are located at the end of the first, second and third orbits. In this case several destroyers are located in the area at the end of the first



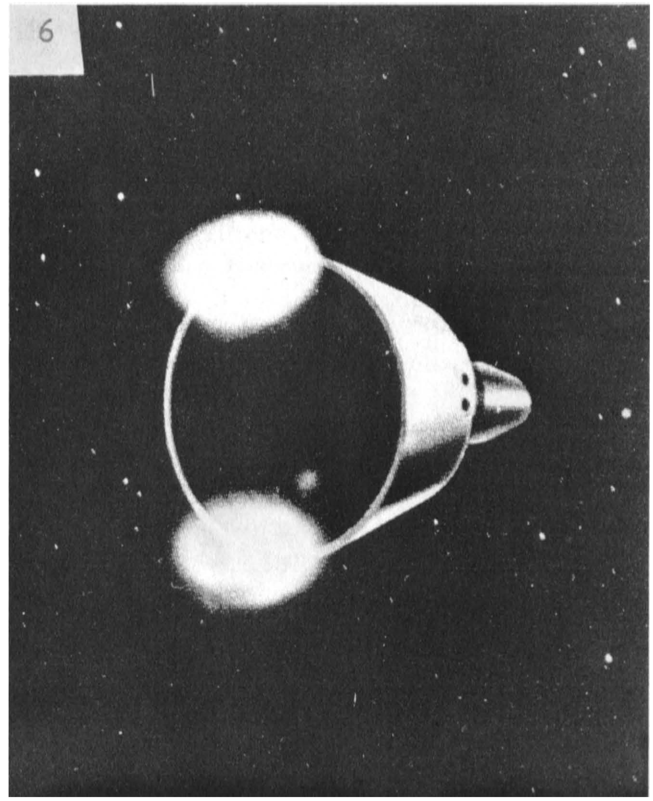
Picture 3 in the series shows the second stage and the spacecraft as it nears the orbital insertion point and just prior to the shutdown of the second stage engine.



Picture 4 shows the separation of the spacecraft from the second stage of the launch vehicle after the astronauts have fired an explosive charge to initiate such action.



Picture 5 shows an astronaut stepping out into space during a flight prior to attempting some extra-vehicular activities.



Picture 6 shows the astronauts using thrust maneuvering rockets to close in on the target vehicle during the rendezvous mission.

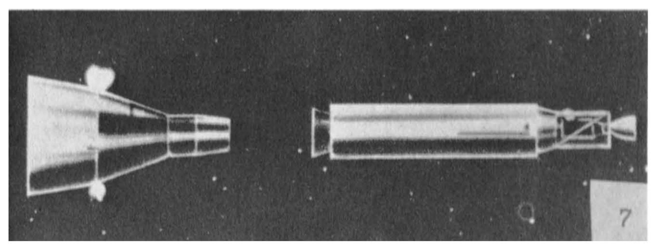
and second orbits and an aircraft carrier (the prime recovery vessel) and a destroyer in the area planned for landing at the end of a nominal three-orbit flight.

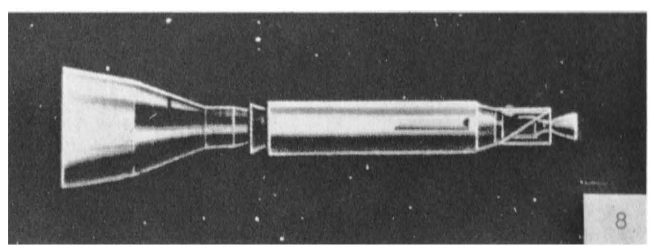
During other missions, there will be prime landing areas in both the Atlantic and Pacific Oceans as well as preferred contingency landing areas. This will require additional Department of Defense support, particularly in the number of Navy ships required to support the particular mission. However, in all cases, the bulk of the recovery forces will still be located across the Atlantic Ocean.

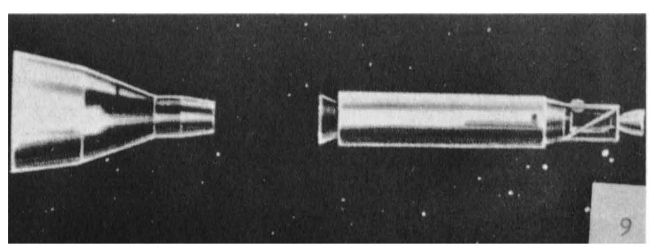
In addition, the Department of Defense has several ships and aircraft with special equipment which are used in tracking operations and these ships are capable, as well, of certain communication capabilities with the spacecraft.

Following the spacecraft landing and the exact location determined by aircraft, pararescue men are dropped from aircraft or helicopters and install a flotation collar around the spacecraft to aid in keeping it afloat until a ship with special retrieval equipment arrives and completes the recovery operation.

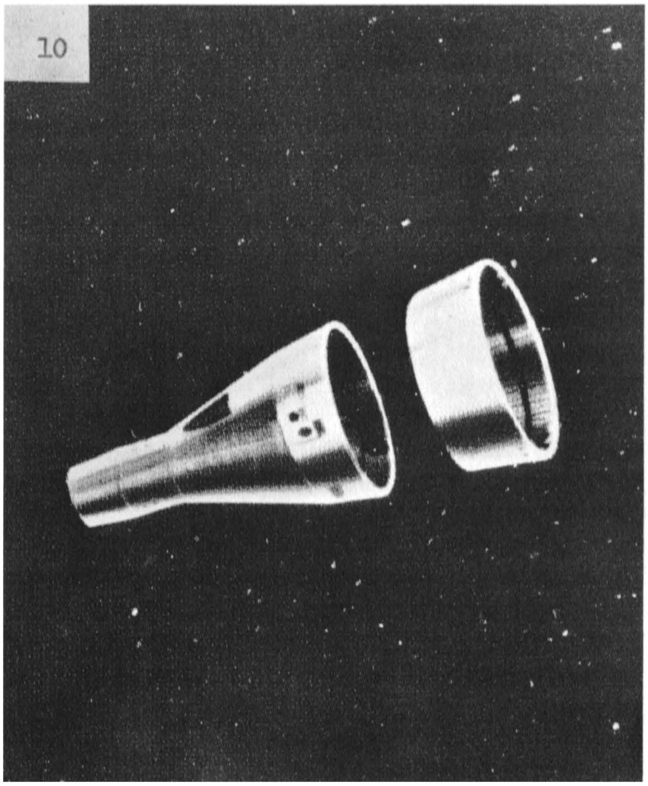
The flight profile of the spacecraft is much the same for rendezvous missions with some differences — the orbital plane may be adjusted slightly by varying the azimuth in order to place the spacecraft into an orbital path which will most nearly compare to the path of the Agena D target vehicle launched at an earlier time.







Pictures 7, 8 and 9 show the approach of the spacecraft just prior to docking with the target vehicle, the two vehicles in the docked configuration, and the spacecraft backing away from the target vehicle after completing their desired maneuvers.



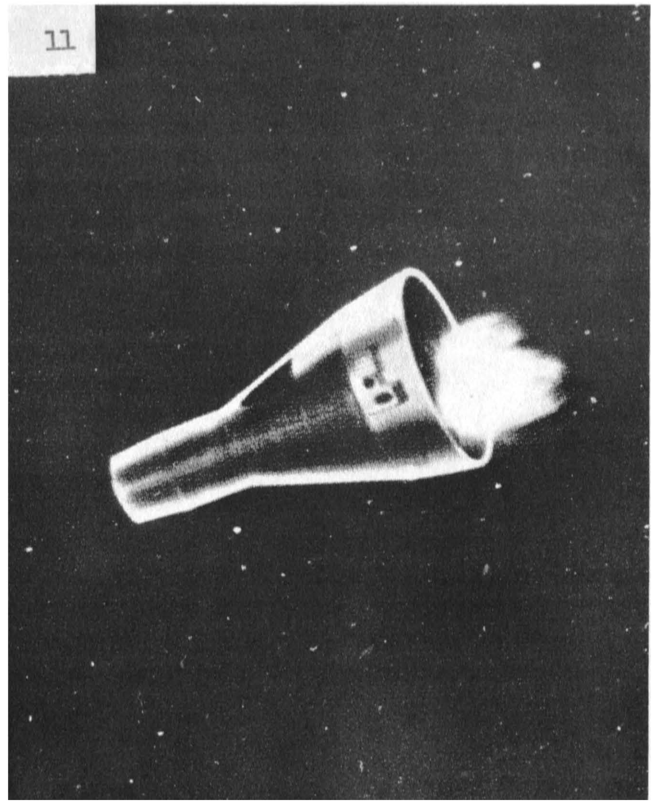
Picture 10 shows the equipment section of the adapter module being jettisoned to expose the retrograde rockets prior to the start of the reentry phase of the mission.

The Agena is boosted toward a nearly circular orbit at approximately 181 statute miles altitude. After tracking stations determine the target has reached the proper orbit, its engines are shut down by ground command to conserve fuel for additional maneuvers as desired at a later time.

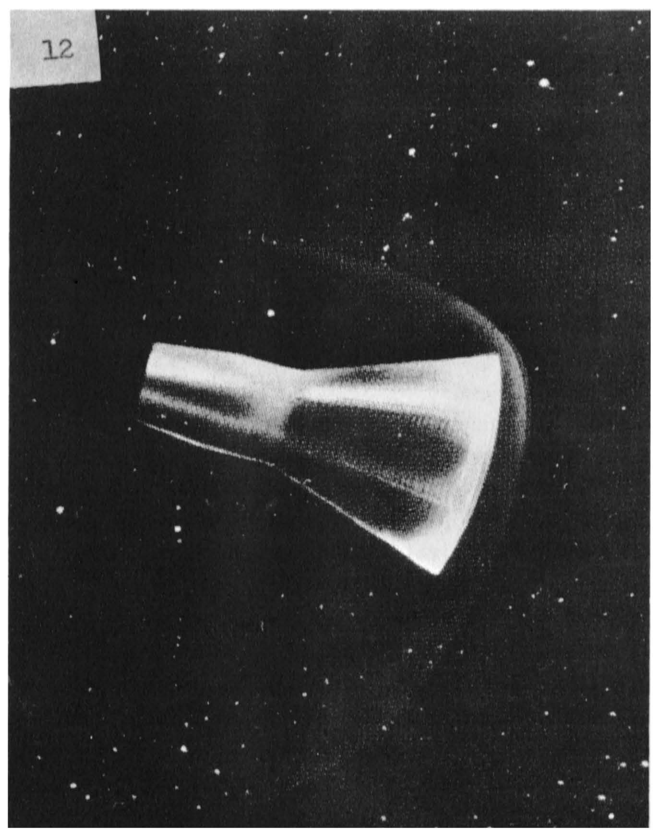
This is followed by the launch of the Gemini during a period in which the spacecraft will require a minimum time to effect the rendezvous. This time period is termed a "launch window" and if climactic or other conditions preclude the launch of the Gemini at this time, the Gemini launch is delayed until favorable "launch window" conditions prevail. The Gemini will be inserted into an elliptical orbit with a low point of about 101 statute miles and a high point of about 181 statute miles. This results in the Gemini requiring less time to complete an orbit and permits it to gradually "catch up" to the Agena.

When the Gemini is within 250 miles of the Agena and near the high point of its orbit the astronauts will use their maneuvering capabilities to circularize their orbit. At that distance the radar equipment at the front end of the spacecraft will acquire the Agena and the onboard computer will begin to provide the astronauts with bearing, range, closing rate and other maneuvering information.

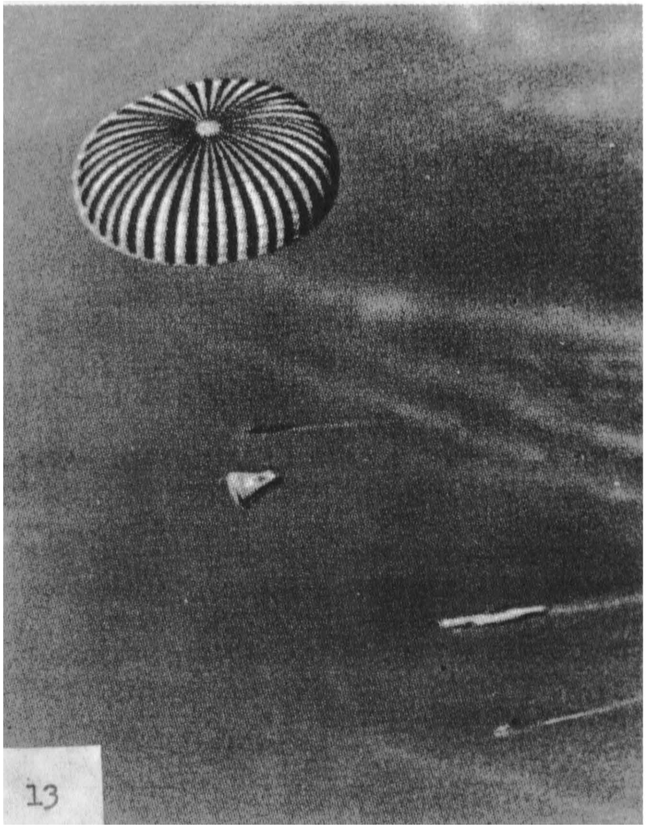
This small computer, occupying only a cubic foot of space, is a key computer in the complex inertial guid-



Picture 11 shows the retrorockets being fired. This slows down the spacecraft sufficiently to allow it to reenter the earth's atmosphere.



Picture 12 shows the spacecraft during the reentry with control jets being used to move the spacecraft to the right or left or to lengthen or shorten the descent as necessary to fly to the selected landing area.



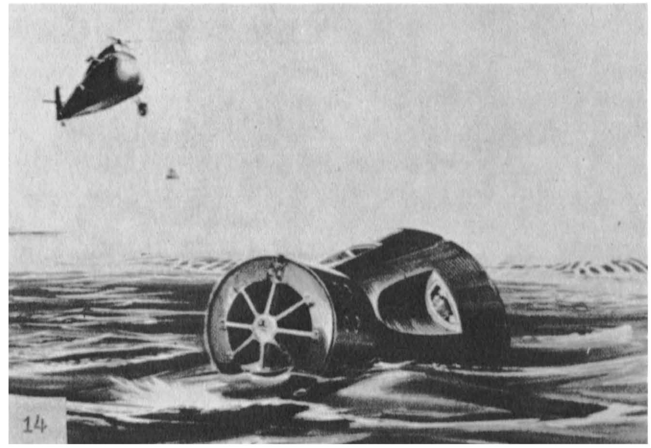
Picture 13 shows the spacecraft in the final descent phase after the large ring-sail parachute is deployed at about 10,000 feet.

ance system. It is one of the major sub-systems which has been incorporated in the Gemini program, both to aid in the rendezvous and docking missions and for the reentry phase of all missions.

When the spacecraft closes to within 20 miles of the Agena, the astronauts will be able to see a high intensity flashing light to help guide them in their rendezvous procedure. Using 100 pound thrust-maneuvering rockets, the astronauts will visually and manually guide their spacecraft into the final docking position and direct the index bar on the Gemini into a V-notch on the docking collar of the Agena. When this maneuver is successfully accomplished, clamps inside the docking collar will firmly lock the two vehicles together and hardline electrical connectors aboard the two spacecraft will mate, thus providing the astronauts with full control of the combined Gemini-Agena spacecraft.

Although this docking will occur with both vehicles rushing through space at about 17,500 miles per hour, their relative speeds will only be a mile or two different, thus simplifying the operation. In the event the first docking attempt is unsuccessful, the pilots will use small pulse jets to position the spacecraft for another docking attempt.

A valuable aid to the astronauts during this period will be a lighted display panel mounted on the Agena and visible to the pilots. This panel will provide them with information concerning the status of the Agena such as amount of fuel, presure, electrical power, etc., which is available for use during the "docked" maneuvers.



Picture 14 shows the spacecraft after the water landing with a helicopter approaching. Pararescue personnel are then dropped into the water by the helicopter and attach a flotation collar around the spacecraft to aid in keeping it afloat until the retrieval ship arrives.

When this phase of the mission has been completed, the astronauts will unlatch their spacecraft from the target by firing reverse thrust maneuvering rockets, and will prepare for retrograde, reentry and landing operations.

EXPERIMENTS

While the principle objectives were listed earlier, other major advances are expected during Gemini through the experiments which will be conducted. Although these are not fully determined yet for all flights, preliminary planning places these experiments in four general categories — medical, engineering, defense, and scientific. Medically planned experiments include such studies as biochemical analysis of body fluid, cardiovascular reflexes, etc. In the field of engineering it is planned to study optical communications and experiment with ultra-violet reflections from the lunar surface. Some planned experiments for the Department of Defense will concern radiation, navigation, polarization, and light levels, and extravehicular activities utilizing portable individual propulsion units. Scientific experiments are expected to include nuclear emulsion tests, micrometeorite collection, and experiments with astronomical camera equipment.

PRESSURE SUIT

A new pressure suit has been developed for the Gemini program in order to provide more freedom of movement. The cabin environmental control system provides a 100 percent oxygen environment, control pressurization and humidity, and removes unpleasant odors. The oxygen supply, purification, and suit cooling are all on a single circuit. The suits are connected in parallel to this circuit and fitted with individual regulators so that each astronaut can select the oxygen flow rate he desires.

Oxygen enters the suit just below the chest and is routed directly to the face area, the arm areas, the leg areas, then out an exhaust line to be purified for reuse.

ELECTRICAL SYSTEM

The major components of the primary electrical power system consist of two fuel cells, five silver zinc batteries, utilization of ground power prior to liftoff, and necessary switches and controls for distribution of A-C and D-C power. On some flights batteries may be used as the primary electrical power system.

Astronaut John Young, pilot of the Gemini 3 mission, models the Gemini space suit.

Gemini is the first space vehicle to utilize the fuel cell as a primary source of electrical power. From launch through orbital phases, until the equipment section is jettisoned these cells will be used as a primary power source. Through the chemical reaction of oxygen and hydrogen, each cell will also produce a pint of pure drinking water for the crew each kilowatt hour of operation. This is a valuable by-product since it drastically cuts down the total water supply onboard at launch time, and weight in Gemini as in all space programs is a prime consideration.

CONTROL AND TRACKING

Although the Gemini spacecraft will be controlled by the pilots throughout the flight, there are a number of decisions which are made by flight controllers which direct the actions of the flight crew. The flight controllers are stationed in the Mission Control Center and this team of specialists continually monitors the various systems of both the launch vehicle and the spacecraft throughout all phases of the flight.

The Mission Control Center at Cape Kennedy has been used for the unmanned Gemini flights and will continue there through the early manned missions. Another Mission Control Center is being completed at the Manned Spacecraft Center at Houston, Texas, and probably, starting with the third manned Gemini flight, control following liftoff will be shifted to that facility for the remainder of the Gemini missions and all Apollo missions.

Prior to launch date, a mission readiness review is held and all aspects of the launch vehicle, spacecraft, crew, manned spaceflight communications network, and the weather are thoroughly reviewed as to their flight readiness. At the conclusion of this review the Gemini Operations Director makes a Go/No Go decision based upon the reports submitted.

The flight date and time is established by the Operations Director and, barring serious problems which might develop in any of the aforementioned areas during the interim period, the schedule is followed. Although many hardware tests and simulated flights as well as flight-readiness tests of both the spacecraft and launch vehicle are held prior to the mission review, there is always the possibility that, in such a complex operation, troubles might crop up during the final countdown which might necessitate "holding" the mission for minutes or even days, depending on the trouble area and the length of time required for corrective action. Such trouble areas might, for example, be in major launch vehicle or spacecraft systems, status of a downrange network station, or weather conditions.

The flight director in Mission Control Center has complete responsibility for the mission from liftoff through recovery. Based upon information furnished him by his group of flight controllers concerning the various systems and the nominal parameters for such systems, he must decide whether to permit the mission to continue as planned in case of any serious systems deficiencies or to terminate the mission. It is anticipated that during Gemini the crew members may be able to make most necessary corrective actions.

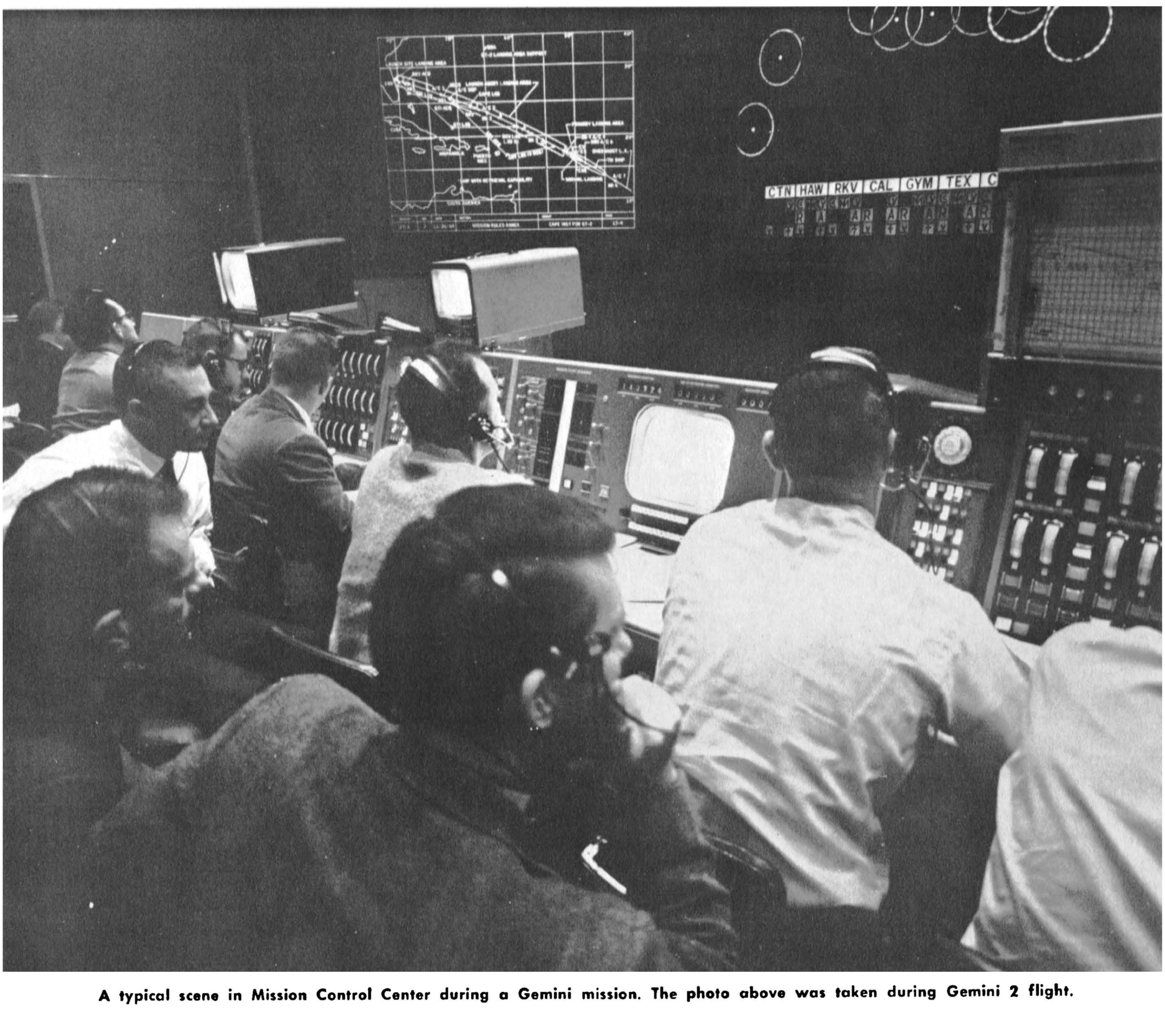
The manned spaceflight communications network plays a vital role in all missions, both in tracking the spacecraft and in relaying information from the spacecraft to Mission Control Center and from Mission Control Center to the spacecraft.

The network presently consists of tracking stations located at Cape Kennedy; Grand Bahama Island; Grand Turk Island; Ascension Island; Bermuda; Grand Canary Island; Kano; Nigeria, Tananarive, Malagasy; Indian Ocean Ship; Carnarvon, Australia; Canton Island; Kauai, Hawaii; two Pacific Ocean ships; Point Arguello, California; Guaymas, Mexico; White Sands, New Mexico; and Corpus Christi, Texas. In addition to the three ships which have been specially modified for the tracking duties, the Department of Defense has also converted several aircraft to provide additional tracking capability.

Two MISTRAM (missle tracking measurement) stations, Eleuthera and Valkaria, may be used during the powered phase of flight to obtain additional trajectory data.

The Mission Control Center uses both digital command and tone command systems and can remote these commands through some of the network stations.

High speed data is provided through the Ground Operational Support Systems Network through a combination of submarine cable, land lines and radio. Until control is shifted to the Mission Control Center (MCC) at Houston, all this data is processed at Goddard Space Flight Center, Greenbelt, Maryland, then transmitted to the Cape. After control has been

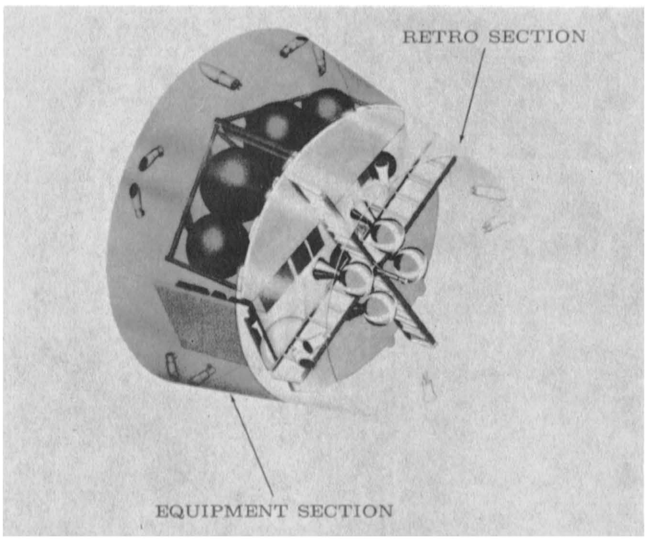


A typical scene in Mission Control Center during a Gemini mission. The photo above was taken during Gemini 2 flight.

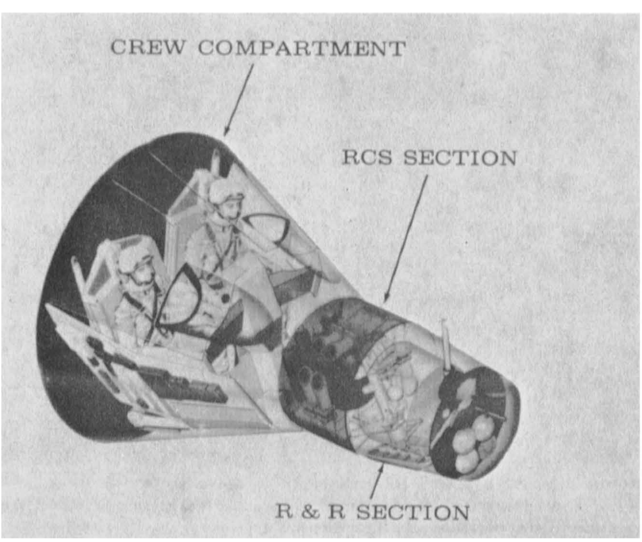
switched to the Houston MCC much of the information will be relayed through the Goddard facility in raw form and will be processed at Houston. This will result in a money-saving since the existing communications network is established and will require only extending the lines from Goddard to Houston.

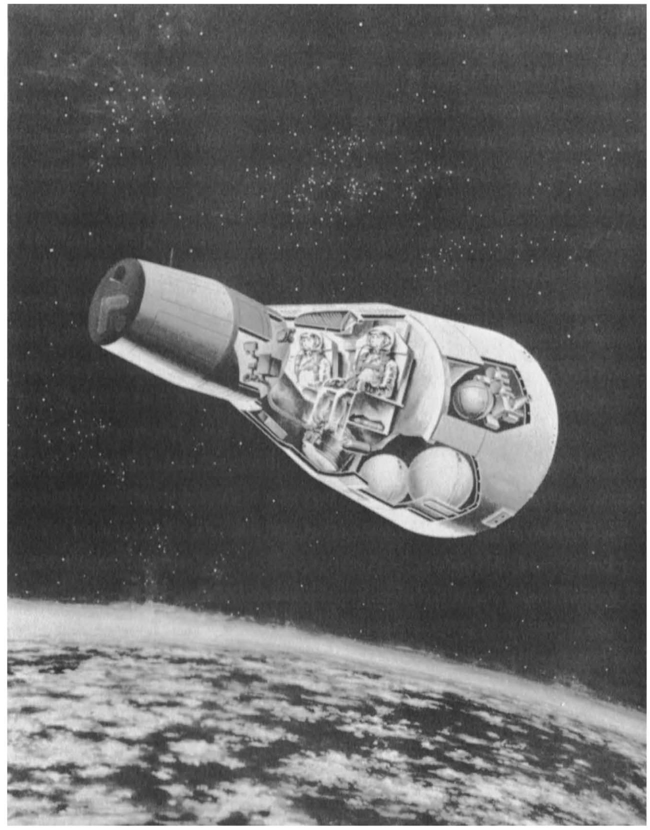
Data received via the network and data originating at the Control Center for transmission to the spacecraft is processed and displayed in real-time, that is within several seconds of the time of transmission. Through this exceptional communications system both the flight controllers and the astronauts have vital information concerning the systems which is updated on a continuing basis.

Following each flight, all of the data recorded is thoroughly reviewed and a comprehensive report prepared. The information gathered from these reports is used by the engineers in the development of plans for future spaceflight missions.

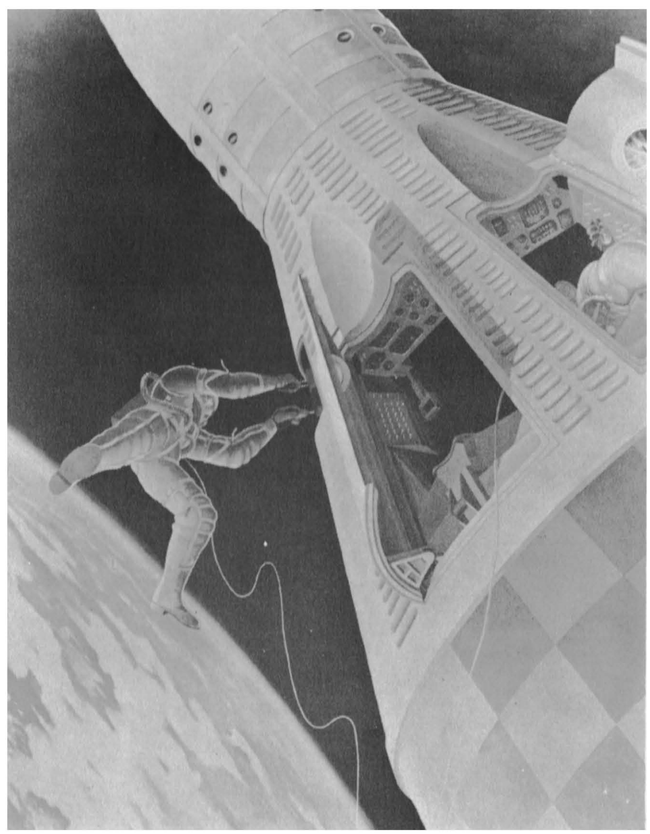


The picture above shows a cutaway impression of the sections of the Gemini adapter module and the picture below shows a similar impression of the sections of the reentry module.

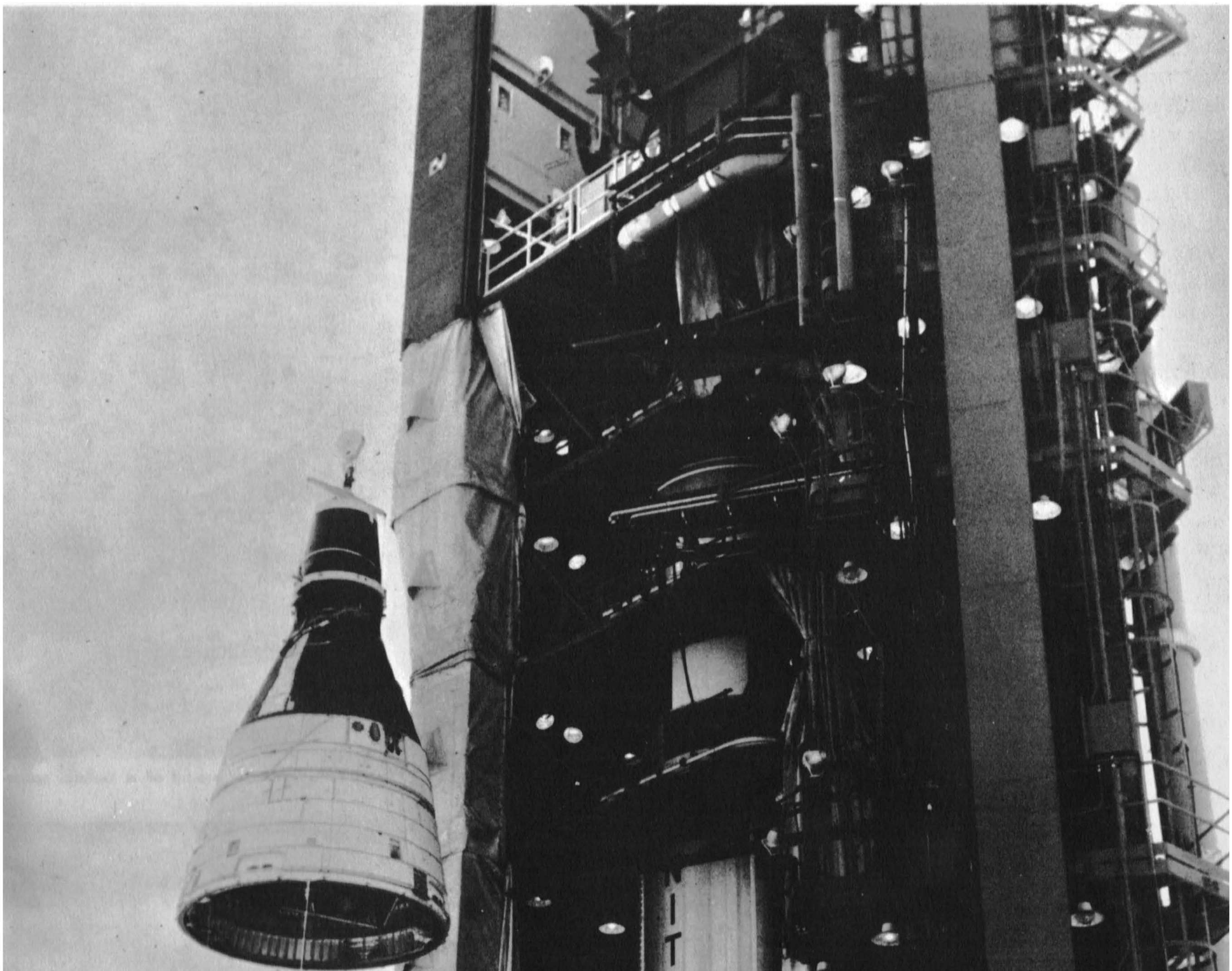




AN ARTIST'S CONCEPTION of a cutaway model of a Gemini spacecraft in flight.



AN ARTIST'S conception of an astronaut egressing from the spacecraft during a Gemini flight and attempting extra-vehicular experiments with specially designed tools.



A GEMINI SPACECRAFT is shown at Pad 19 at Cape Kennedy as it is lifted to the top of the gantry prior to being mated with its launch vehicle. This activity takes place after static firing of both stages of the launch vehicle and subsequent checks of all systems of the spacecraft and the launch vehicle. Many other tests and simulations are conducted following the mating procedure before the flight is made.

MSC 1953-66