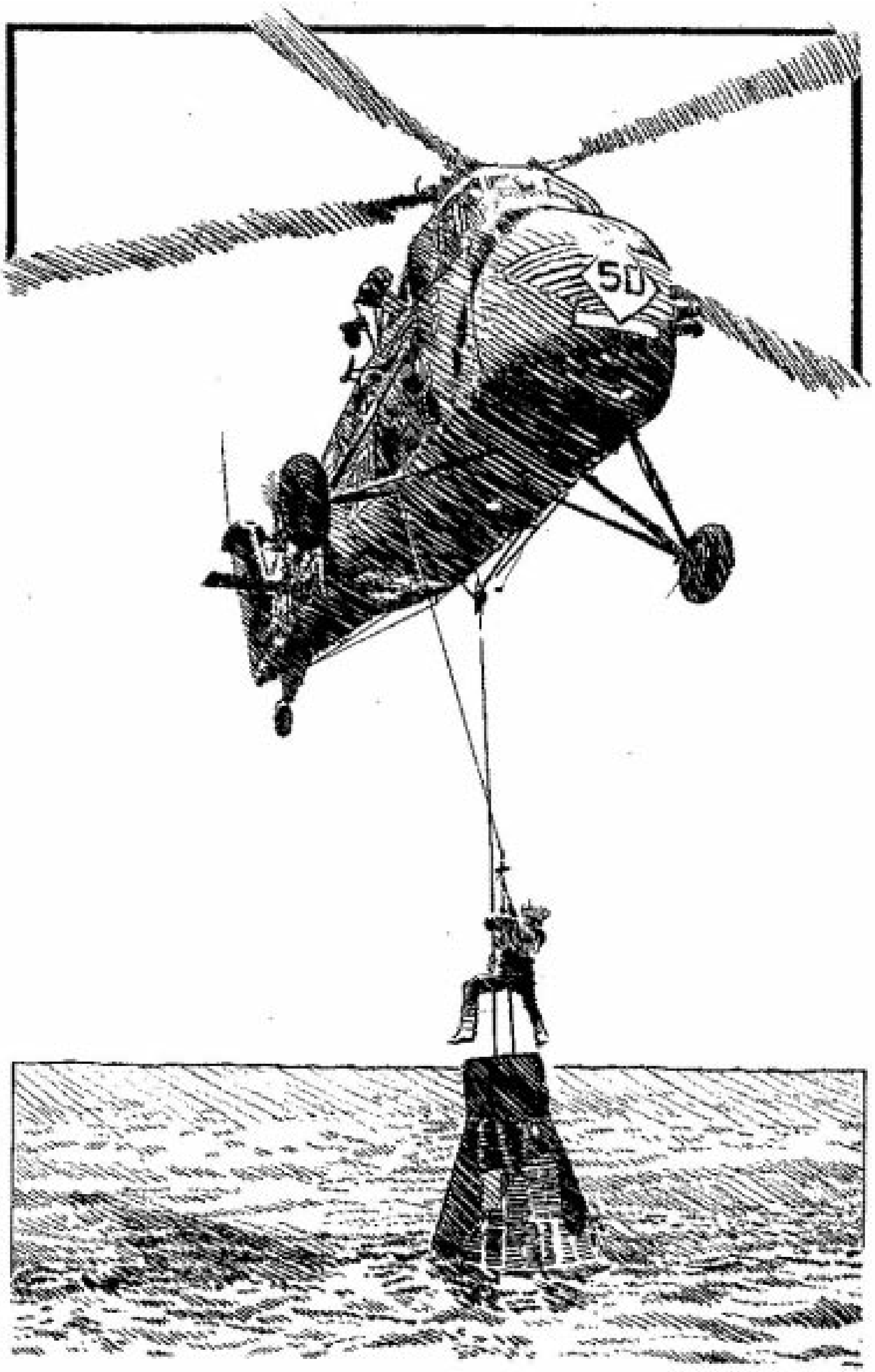
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# *CHAPTER 7: Precious Human Cargo*

"Spaceflight, like airplane flight," Michael Collins wrote in *Carrying the Fire*, "did kill." But it had never happened in the American space program before AS-204.

> Now this Apollo had destroyed three without even flying one; what was the pattern? Would one disaster follow another . . . ? How could NASA get going again? How many astronauts would decide they hadn't signed up to be incinerated and quit? How many wives would quit if hubby didn't?[1]

The answer, Collins pointed out, was that no one quit, "not husband or wife." Neither did NASA or the American public. Eighteen months later Collins, in orbit about the Moon aboard the Apollo 11 command module, heard Neil Armstrong's message from the lunar module to the Manned Spacecraft Center Mission Control: "Houston, Tranquility Base here, the *Eagle* has landed."[2]

From the very beginning, NASA's astronauts had been some of the most acclaimed and visible heroes America ever celebrated. Being an intensively and highly trained astronaut was difficult enough; being a celebrity compounded the work and the responsibility. Being an astronaut was no mundane or easy business. In the public's mind, the astronaut was what NASA and space were all about. Rarely did engineers, managers, centers, Headquarters, or even Congress and presidents intrude upon the public's space consciousness. That those astronauts were a part of MSC in Houston, and that their words and deeds became public through the center's Mission Control and its Public Affairs Office, gave the center a certain centrality in NASA's space programs in the mind of the public and in the estimation of those who worked there. It was a centrality, to be sure, not accepted by NASA Headquarters or by other NASA centers, but it was an element which helped define the character of MSC and its personnel.

MSC managed the engineering design, development, and construction of the spacecraft; supervised the selection and training of the astronauts who flew the craft; and directed spaceflight operations. In 1969, when Neil Armstrong and Edwin Aldrin stepped out of the *Eagle* onto the surface of the Moon, they were, with Mike Collins, 3 of the 73 individuals selected by NASA since April 1959 as astronauts. The 3 and 70 astronauts were the highly visible and in a sense final elements of that massive effort which thus far involved some $35 billion in public monies appropriated by Congress to NASA, and almost 250,000 employees (some 35,000 NASA civil service employees and the remainder employees of the firms providing contracted services to the space program).[3] Although one-half of NASA funds were involved in other than manned space programs, the astronaut came to represent in the public mind what the total NASA effort was all about. And, to be sure, the manned and unmanned programs were inextricable parts of the total NASA mission.

Although media attention and publications about space have understandably focused on the flights of the astronauts, the processes of their selection and training and the astronauts' relationships to MSC, to NASA, and to their public—the people on Earth—is a more meaningful story albeit a less dramatic one than is the story of the relatively brief flights through space. It is useful to reflect upon the selection and training of the astronauts through the Apollo era, to consider the organization of the Astronaut Office at MSC, and to contemplate some of the human dimensions of being a part of the astronaut corps. Those early years helped set the tone and style, not only of the astronaut corps but also of MSC and of NASA itself. Insight into the selection of the astronauts also contributes to an understanding of the "way NASA works."

There were no real answers in 1957 and 1958 to what an astronaut must do or be. No American flew in space until 1961. But some had come to the very edge of space, and that experience, and considerable speculation and extrapolation, suggested what might be reasonable criteria for being an astronaut. In February 1957, Dr. D.H. Beyer and S.B. Sells, Ph.D., with the School of Aviation Medicine at Randolph Air Force Base in Texas, published the results of their deliberations regarding the "Selection and Training of Personnel for Space Flight." The authors presumed that the return of a spacecraft into the atmosphere would require an extended glide and a conventional landing of a winged craft with a tricycle landing gear—a premise that perhaps fit the Shuttle but not the intervening Mercury, Gemini and Apollo spacecraft. They reasoned that training and experience in piloting jet and rocket aircraft, such as the X-15 then being developed, would be "most useful for transition to spacecraft."[4]

Current hypotheses for space launches, they said, citing Wernher von Braun among others, indicated an acceleration force of nine times the Earth's gravity on the passengers and a configuration approximating contemporary jet aircraft, but a much more complex instrumentation and control system. Given these parameters, the spacecraft pilot fit the mold of "experienced pilots of high performance aircraft." But the critical elements in the selection, they believed, related more to the psychological than to the physical aspects of spaceflight, for "by far the greatest problem involves the implications of a seemingly complete break from the Earth and the protective societal matrix in a small, isolated, closely confined container with few companions."[5]

An astronaut candidate, they believed, must "manifest intense motivation for the project," have a strong ability to cooperate to the point that they could place trust and confidence in associates and win the trust and confidence of those associates. They should have "positive interpersonal attitudes, mature character integration, and emotional stability involving an inner sense of duty, responsibility, self-control and restraint." And they had to be adventurous but not foolhardy.[6]

Although astronautical flight would not be drastically different from aeronautical flight, they admitted that the first space crews would be pioneers who would have to be "their own instructors," but they believed that astronauts would require academic training in "applied and theoretical mathematics, electronics, engineering, navigation, astronomy and astronavigation," as well as intensive courses on the design and construction of the spaceship, instruction in "basic spatial medicine," and training in simulators and near-space conditions. Years later Henry Cooper, Jr., author of *Before Lift Off*, which describes the training of a latter-day space shuttle crew, defined the astronaut as a "highly trained generalist," which seems to fit the early astronaut specifications.[7] The Beyer and Sells report intimated that the physical, psychological and mental demands on an astronaut would be very great indeed.

These theories quickly became confronted with realities. With the organization of NASA in 1958, selecting men for spaceflight became a pressing matter.

In November of that year, Administrator T. Keith Glennan appointed a team of "aeromedical consultants" from the military services for temporary assignment to NASA's Space Task Group. After a brief study requested by Glennan, Wesley Hjornevik urged that a biomedical office be permanently established. Six months after being organized as "consultants," the biomedical team became a permanent component of the Space Task Group. The initial group of medical advisors included Dr. Stanley C. White, described by John A. Pitts in his study of biomedicine in the manned space program as the nominal head of the team and a "specialist in human factors engineering and biotechnology." He worked closely with Robert Voas, Ph.D., a psychologist and a "Buck Rogers" devotee, whose first duty with the Navy involved pilot selection at its Pensacola, Florida, training base. Voas left there for an assignment to the medical laboratory at Bethesda, Maryland, and was attached by the Navy to NASA on its first day of existence, October 1, 1958. The third medical consultant, William S. Augerson, was an Army major, physician, and specialist in human physiology.[8] A fourth physician, Dr. Charles A. Berry, assisted the biomedical team for the Mercury astronaut selections from his position as Chief of Flight Medicine for the Air Force. He later became chief medical officer for NASA.

Dr. Berry, assistant and then chief (1958) of the School of Aviation Medicine at Randolph Air Force Base, provided a direct link between early Air Force space pilot criteria and NASA's astronaut selection. In 1959 he accepted the assignment with the Surgeon General of the Air Force as Chief of Flight Medicine, and in July 1962 joined MSC as Chief of Medical Operations Office. Berry was medical director for both the Gemini and Apollo programs.[9] In addition to NASA's biomedical team and the later appointment of Berry as chief medical officer for MSC, on October 27, 1958, Glennan appointed a non-NASA, independent Life Sciences Advisory Committee headed by Dr. W. Randolph Lovelace II to recommend programs and to assist in defining the qualifications and selection processes for the first astronauts to fly the Mercury vehicles.

Lovelace, who directed the Lovelace Clinic and Foundation in Albuquerque, New Mexico, had for some time been involved in special Air Force crew selection projects and conducted medical examinations for personnel involved in sensitive national security programs. A pioneer in high-altitude, near-space flight studies, Lovelace in 1943 investigated the effects of an extremely high-altitude parachute jump by personally bailing out at 36,000 feet. He speculated that the fall into denser atmosphere might create severe shocks on the human system. It did—and almost killed him—but the special equipment he had designed saved his life.[10]

The Life Sciences Committee produced a set of very broad specifications. The prospective astronaut must pass rigorous physical and psychological tests, have a degree in physical science or engineering, be under 40 years of age, and 5'11" in height. Using these criteria, NASA prepared a draft of a civil service notice for astronaut applicants at the GS-12 to GS-15 level (in 1958 scheduled at $8,330 to $12,770). At this point, President Eisenhower personally intervened to specify that astronauts must be selected from the rolls of current military test pilots. Bob Gilruth later remarked that this decision greatly improved the selection process and ruled out the "matadors, mountain climbers, scuba divers, and race drivers and gave us stable guys who had already been screened for security."[11]

In January 1959, Gilruth met with Charles J. Donlan, Dr. Stanley C. White, George Low, Dr. Lovelace, and Brigadier General Donald D. Flickinger (a member of the Life Sciences Committee and Surgeon and Assistant Deputy Commander for Research with the Air Research and Development Command in Washington) and condensed the rather elaborate specifications to a simplified list of seven. Astronaut candidates must:[12]

1) Have a degree or the equivalent in physical science or engineering
2) Be a graduate of a military test pilot school
3) Have at least 1500 hours flying time including a substantial amount in high-performance jets
4) Be younger than 40
5) Be no taller than 5'11"
6) Be in superb physical condition
7) Possess psychological attributes specified by the Life Sciences Committee

By these specifications the pool of candidates for the astronaut corps would be largely male by virtue of the heavily male-dominated fields of engineering and physical sciences, and by virtue of the prerequisite for test pilot experience. Leaving the pool would be an even smaller segment of men who not only had the academic background but as Tom Wolfe explained it, "The Right Stuff" as hypersonic, daring, high-speed addicts. While they may not have been "matadors, mountain climbers and scuba divers," they were birds of a feather. Although 13 women applied for the astronaut corps in 1960, and passed the grueling physical and psychological tests, none were admitted into the astronaut corps until 1978 when 5 women became astronauts.

Bob Gilruth, Donlan recalled, had been very uneasy about the broad specifications for an astronaut and was clearly relieved to have the President narrow the qualifications. Once the qualifications were established, Gilruth asked Donlan, whom he had recruited as his deputy for the Space Task Group in October 1958, to "drop everything" and give his full time to the selection of the Mercury astronauts. Donlan then recruited a Space Task Group team headed by Bob Voas to review the records of 473 military test pilots. Voas's group selected 110 pilots as potential candidates and divided those into 3 groups. Each group was then invited to the Pentagon in Washington, D.C., under orders marked "secret," for a preliminary briefing and personal interviews. The first two groups met separately in Washington on February 2 and 9. Abe Silverstein and George Low explained the nature of the program and invited those who were still interested to report to NASA Headquarters in civilian clothes (to heighten the "peaceful" intent of NASA programs) for further briefing and tests. Of the 63 interviewed in the first 2 groups, 80 percent indicated they were interested and would be available for more rigorous testing. After personal consultations and more interviews, the list of candidates was narrowed to 32 individuals, and the third interview group was canceled.[13]

Next, in five groups of six and one group of two, the astronaut candidates reported to the Lovelace Clinic, beginning on February 7, for a week of what Voas described in an understatement as an exhaustive series of examinations. Deke Slayton described the tests as medical experimentation rather than a physical examination. The astronauts were the rats being tested. Michael Collins, although he came through the tests several years later when the examination procedures had been somewhat moderated, luridly described the procedure and NASA later incorporated his description in the official record as an example of a "humanistic perspective of what all those tests were like":[14]

> Inconvenience is piled on top of uncertainty on top of indignity, as you are poked, prodded, pummeled, and pierced. No orifice is inviolate, no privacy respected. . . . Cold water is poured into one of your ears, causing your eyeballs to gyrate wildly as conflicting messages are relayed to your brain from one warm and one cold semicircular canal. Your body is taped with electrocardiogram sensors and you are ordered onto a treadmill, which maintains its inexorable pace up an imaginary mountain road. As the tilt becomes steeper, the heart rate increases, until it finally reaches 180 beats per minute . . . Your fanny is violated by the "steel eel," a painful and undignified process by which one foot of lower bowel can be examined . . .[15]

And the "shrinks," Collins said, take over where their compatriots leave off.

A psychological and stress evaluation of the astronaut candidate was conducted by the Air Force, with the assistance of Army and Navy specialists, at the Wright Air Development Center Aeromedical Laboratories at Wright-Patterson Air Force Base in Dayton, Ohio. One of the tests, Deke Slayton recalled, was to lock the candidate alone in a totally dark room for an extended time. "What are you supposed to do in a dark room?" he exclaimed many years later with some residual disgust. "Go to sleep!" And that's what he did. Collins admitted that when he came to the Rorschach (inkblot) tests, instead of describing a scene as he had the previous year as "nineteen polar bears fornicating on a snowbank," and thus incurring the displeasure of his examiner, because "I want to fly to the Moon, badly I want it, . . . I will describe that white card in any way that will please them." But he admitted that "second-guessing shrinks is not easy."[16] The first group of candidates began their 6 days of psychological evaluations on February 15.

*Astronaut Group I, selected in April 1959, included:* ***Front row****: (left to right) Walter M. Schirra, Jr.; Donald K. (Deke) Slayton; John H. Glenn, Jr.; and Scott M. Carpenter.* ***Back row****: (left to right) Alan B. Shepard, Jr.; Virgil I. Grissom; and L. Gordon Cooper, Jr.*

The final step in the selection process occurred at Langley Research Center where a group representing both the medical and technical fields evaluated the data from the Lovelace Clinic and Wright-Patterson Laboratories. Donlan, who presided, announced that each of the final candidates would be reviewed in alphabetical order. Those candidates, he said, met the basic physical and psychological requirements. The final decision, however, rested largely on the nontechnical evaluation of the person's resourcefulness, interest in the program, and "survivor" instincts. A good number of the prospective astronauts, however, earlier withdrew from consideration because they believed that the space program might be a very short-lived program, and because it did not seem to contribute to their promotion and career enhancement as military officers. Moreover, many pilots and the Experimental Test Pilots Association, he said, believed that the Mercury program required a "salmon in a can" rather than a real test pilot. In a 2-hour meeting, the review committee selected seven finalists.[17] Those seven were invited to NASA Headquarters where their names were publicly announced at a press conference on April 9. They were:

Lieutenant Malcolm S. Carpenter, U.S. Navy
Captain Leroy G. Cooper, Jr., U.S. Air Force
Lieutenant Colonel John H. Glenn, Jr., U.S. Marine Corps
Captain Virgil I. Grissom, U.S. Air Force
Lieutenant Commander Walter M. Schirra, U.S. Navy
Lieutenant Commander Alan B. Shepard, U.S. Navy
Captain Donald K. Slayton, U.S. Air Force

John Glenn described the press conference as "wild and woolly" and Slayton said it was a "shocker." The astronauts had moved from a very closed, protected environment onto center stage.[18] Few with NASA, unless it might have been Walter T. Bonney, the public information officer, anticipated the extent of the public reception of the astronauts or the continuing "media event" that became a part of the astronauts' lives.

Lieutenant Colonel John A. Powers, who came from the Air Force Ballistic Missile Division's lunar probe program to NASA, said he had some sense of the public's interest, but Bonney had a better feel for the situation. Walt Bonney, he said, came to the conclusion "there was going to be a scramble to get exclusives, inside personal stories, etc., out of these guys." Bonney wanted to allow the astronauts to sell their personal stories. After NASA approved the idea, Bonney contacted Leo D'Orsey, a prominent Washington, D.C., attorney, who agreed to represent the astronauts as their agent at no charge. The astronauts and their families agreed to combine, sell the rights to their personal stories on a single contract, and let D'Orsey handle the negotiations. After negotiations with *Saturday Evening Post*, *Look*, AP, UP, and several syndicates, D'Orsey accepted an offer from *Life* Magazine for $500,000, to be distributed equally among the astronauts.[19]

John Glenn described D'Orsey as "one of the best friends the astronauts had" who "gave us sage and wise counseling." He took care of contracting problems, helped with public relations, and served as a very good elder statesman. One problem that D'Orsey helped with was insurance, Glenn recalled. Although each had some coverage as test pilots, additional insurance coverage for the space program seemed unobtainable. D'Orsey finally got one company to agree to insure John Glenn for $100,000 for his (and America's) first orbital flight in space for a premium of $16,000 for the 5- or 6-hour flight. "Leo," Glenn said, "worried about this," and decided that he would not bet against Glenn and pay $16,000 from the astronaut's fund to the insurance company, but instead would personally write a check to Glenn's wife Annie for $100,000. D'Orsey did so, Glenn said, and gave the check to a third party to hold. When Glenn returned, Leo told Glenn "how glad he was to see him back down safely," because he could tear up the check.[20] Some insurance executives may still be regretting that they failed to issue Glenn a policy. It would have been the lowest priced, highest return on advertising ever. But few, inside or outside NASA foresaw the public's interest in astronauts and space.

Glenn reasoned that if the astronauts were to permit people to come into their homes and interview families and children and be part of their life, there should be some compensation for their loss of privacy. Although other members of the press criticized the *Life* contract arrangements as a use of the space program for private gain, the end result was, as Powers suggested, that the astronauts' privacy was protected more than it might have been by precluding "free" access to the astronauts. And most importantly, the astronauts were not thrown into competition with each other (as modern athletes might be) for media contracts and profit.[21]

The astronaut public relations problem continued to reappear in various forms. Tension between the astronauts and the Public Affairs Office at MSC was a continuous problem, Powers recalled. All seven astronauts, he said, really enjoyed the exposure, but as test pilots they instinctively rebelled at having to spend time talking to the media. Glenn, who was most adept at handling the media, commented that "life in the gold fish bowl did cause some problems. Everywhere we went, it seemed there had to be the press conference, the extensive press coverage and photography session, and while this helped support the program," he admitted, "sometimes it was carried to extremes." Eventually media pressures leveled off.[22]

Glenn recalled the enormous volume of mail directed to him and to the other astronauts. It came from heads of state and from ordinary people all over the world. Following his initial flight into space, Glenn received more than 350,000 pieces of mail. He didn't know what to do with it. Finally, NASA took it over, or more accurately, Steve Grillo in Administrative Services at NASA Headquarters assumed responsibility and established procedures to make sure that every letter was answered.[23] Every astronaut received dozens of invitations a week to speak, some from Congressmen and high officials who were difficult to ignore.

During the first 10 months of 1963, John Glenn received through official channels 1400 requests for appearances, while the other 6 astronauts, 4 of whom had not yet flown, had 700 requests. When George Mueller proposed that MSC release each astronaut for 2 weeks each year for public relations work, Gilruth responded that to do so would not only disrupt the training program, but once it became known that requests for astronaut appearances might be honored through political channels "most of the 300-plus per month requests will arrive at the Administrator's office and create quite a workload there."[24]

Tensions existed at every level between the desire on the one hand to accommodate the public's interests and the growing level of extra program activities required by the astronauts and NASA administrators. The astronauts' private lives did require protection. Publicity also flew in contradiction to the traditional government and Department of Defense security consciousness. The old NACA had little experience with public relations. Moreover, television was rapidly changing the management of public affairs. Government agencies, ranging from the White House to NASA to the specific NASA centers, such as MSC, held ambivalent and often contradictory ideas about dealing with the public and the media.

The White House, beginning with the Kennedy administration, became involved in the astronauts' public affairs problem on several levels. President Kennedy advised Administrator Webb to minimize the number of commitments by astronauts of a nonoperational nature. Jerome Weisner, President Kennedy's science advisor, prepared a brief memorandum in March 1961, prior to Shepard's historic flight in Freedom 7, for McGeorge Bundy, President Kennedy's national security advisor, expressing alarm about "pressures from the press" and that "press and TV for on-the-spot coverage of the first manned launch" could lead to the launch becoming "a Hollywood production," and might jeopardize the mission and have "catastrophic effect." Weisner advised that the press pressures must be met "with firmness" in order to promote the safety of the astronaut and a successful mission. But then he added, "It is my personal opinion that in the imagination of many, it will be viewed in the same category as Columbus' discovery of the new world. Thus, it is an extremely important venture and should be exploited properly by the administration."[25]

President Kennedy developed a rather close relationship with John Glenn and that too created problems. On one occasion, NASA's chief counsel Paul Dembling said, while water skiing with President and Mrs. Kennedy, John Glenn (on behalf of the astronauts) personally urged the President to fly yet one additional Mercury flight. Kennedy called Administrator Webb about the matter and Webb is supposed to have responded, "Who's running the Agency? If you want to run the Agency, appoint yourself a new administrator," or words to that effect. A series of White House meetings followed that conversation, Dembling said, and as a result the White House took a different approach to astronaut affairs.[26]

The line between wanting to help the astronauts and wanting to help oneself was often very thin and indeterminate. Frank Sharp, an enterprising real estate developer in Houston, for example, offered each of the first seven Mercury astronauts a new house in "Sharpstown" when the center moved to Houston in 1962. Powers got approval of NASA's general counsel, the astronauts, and D'Orsey, but when word was leaked to the press "a large unpleasant flap" followed. Powers admitted he probably exercised poor judgment, because "nobody gives you anything for nothing, and it was obvious Mr. Sharp certainly had plans for exploiting the fact that the seven astronauts lived in his development."[27] Although it was declined, the gesture by any standards was rather munificent.

NASA Headquarters began to feel that MSC tended to be excessively permissive in matters relating to the astronauts' outside activities and their business and financial arrangements. Robert C. Seamans finally sent a memorandum drafted by Paul Dembling and Walter Sohier in the General Counsel's Office requiring Headquarters' concurrence on any outside astronaut activities, including business arrangements and public engagements.[28]

Life in the fish bowl worked both ways. In answer to questions about the toughest part of their flights, some of the astronauts responded that it was the press conference. Gus Grissom built a house near Houston with no windows on the side facing the street. "He simply did not want people peering in his windows." After his first flight, John Glenn's home in Arlington, Virginia, had to be guarded by county and state police to ward off the curious and literally to protect his property.[29] For some, such as John Glenn, life in the gold fish bowl proved very rewarding. Glenn won election to the U.S. Senate in 1974. Others, however, found their postflight experiences difficult.

In part, for their own protection and to exercise greater control over both their professional life and their home life, the astronauts organized their own office or division within MSC. Their first several years with MSC were organizationally unstructured. Bob Voas, involved in the initial selection process as a Navy psychologist, was assigned to develop training programs and to a lesser extent look after the astronauts' administrative needs. Eugene Horton, who worked with "Shorty" Powers in the Public Affairs Office, served variously as the astronauts' "Executive Officer" and press secretary. Voas, with the assistance of Joseph Loftus, Raymond Zedekar and others, developed a training regimen, but Slayton said that basically "we were doing training on our own."[30] That soon changed.

During their first years with NASA, the astronauts reported individually to Bob Gilruth. Gilruth told them, when they first reported for duty, John Glenn recalled, that they were chosen because they were experienced engineers and test pilots, and they could apply that experience to the new area of testing spacecraft. "If there was anything at anytime in the program that we didn't like," Gilruth told them, "we had free access to him with our complaints." Gilruth promised that they would be happy with the spacecraft before it flew and that no one would push them into anything. Moreover, Gilruth told them, anytime anyone became dissatisfied or wanted out they were free to go back to their parent services.[31] Gilruth maintained personal contact and a personal interest in those whom he referred to as his "precious human cargo."

As the astronauts grew closer they began to develop their own informal structures and associations, and as time passed these often became institutionalized. Each of the first seven astronauts, for example, assumed responsibility for reviewing specific design aspects of the mission. Slayton, for example, became responsible for escape systems; when Gemini came on line, Gus Grissom became the astronauts' liaison with Gemini. Astronauts visited all of the contractor facilities, and worked closely with MSC managing engineers. In doing so they strengthened the cooperation between the contractor and MSC. Slayton became an unappointed group leader who attended the weekly staff meetings with Gilruth. As new astronauts joined and the programs developed, first the Astronaut Office and then the Flight Crew Operations Division became formal parts of MSC. That is not to say that organizational systems and the training programs were ad hoc arrangements, rather they emerged and developed as the understanding of the requirements of spaceflight grew and as training systems and equipment caught up with the needs. One aspect of astronaut training throughout the Mercury, Gemini, and Apollo programs was that changes in the equipment constantly necessitated changes in training procedures. Moreover, the production of training equipment quite often lagged behind the basic equipment design changes. Thus, despite every effort, there were aspects of "make-do" in the astronaut training regimen.

Bob Voas completed an initial outline of an astronaut training program about the time the first seven astronauts came on board in late April 1959. The program essentially involved a "ground school" phase and a flight test phase. Conveniently, the ground school occupied the remainder of 1959, while Mercury capsules and components were being built. For the first 3 months, the astronauts met with various engineers involved in the design and construction of equipment, including the capsule, booster, range, tracking, and recovery systems; onboard equipment; computers; environmental control systems; and navigational systems. They attended seminars and courses relating to basic sciences such as astronomy, meteorology, and aviation physiology. They visited contractor assembly plants and other NASA installations. Voas devised a rather tightly constructed training calendar which included 7 hours per week of leisure time to be devoted to flight training and physical exercise.[32]

Voas advised establishing a training committee including himself as the training advisor, Douglas to serve as flight surgeon and direct life support training, Harold I. Johnson to handle simulators, George Guthrie to produce a pilot's handbook and monitor program arrangements, and Raymond Zedekar to provide flight and overall program coordination. The committee would meet each Friday morning and complete and approve the training schedule for the following week, with a report to the Chief of the Operations Division (Charles W. Mathews). Every Friday afternoon the committee reviewed and discussed the agenda for the following week with the astronauts.[33]

Training hardware to be developed included a Missions Procedures Simulator, a Mercury capsule mockup with instruments and displays linked to an instructor-trainer console. An Environmental Controls Trainer would be a pressure capsule used to train in life support and emergency systems. Another Escape and Recovery Trainer would be a non-pressurized boilerplate mockup used to train for landing and recovery operations. An Air-Lubricated Free-Attitude Trainer (ALFA, designed and developed at MSC) trained astronauts in manual control skills while undergoing extreme roll, pitch and yaw changes. A Multi-Axis Spin-Test Inertia Facility Trainer (MASTIF), developed by engineers at Lewis Research Center, came on line in February 1960 and gave astronauts experience at tumbling at 30 rpm along three possible axes. Couches, flight instruments, computers and lesser components completed the list of training devices.[34]

One of the great difficulties in training for spaceflight was that nothing on Earth could quite simulate a space environment; moreover, no one really knew what that environment might be like. Developments in training clearly had to await new information anticipated from flight experiences. Acceleration forces and weightlessness were known factors. Training at the Aviation Medical Acceleration Laboratory centrifuge in Johnsville, Pennsylvania, and flights aboard the Air Force's C131, the Navy's F9F-2 or later in an Air Force KC-135 aircraft provided limited experience (60 seconds) with weightlessness.[35]

Voas prepared a Mercury project training summary in 1963 which concluded that overall the training program appeared to have been successful, but that it had been a learning experience for everyone. The training devices were simple and rudimentary, simulation for spaceflight was in its infancy, and the training program was on an accelerated schedule.[36] Over the next few years, new and improved laboratories and training facilities came on line at MSC and the training regimen became more intense and sophisticated.

With the conception of the Apollo Moon-landing program, training began to shift in emphasis and purpose. Almost concurrently, insofar as the astronauts were concerned, Gemini came on line as a training program for Apollo. Slayton said they were trying to make a "fighter plane" out of the Gemini craft, and pilot training became more critical. Longer duration flights required more emphasis on celestial navigation, science applications, environmental adaptations, and survival training. Astronauts spent extensive time in pressure suits underwater as a simulation for EVA in a weightless environment. Communications, computer, and control systems changed markedly with Gemini and even more as Apollo systems were designed and produced, all requiring new training programs and apparatus.[37] As they progressed from Mercury through Gemini and the Apollo vehicles to the Shuttle, American spacecraft, by design, became eminently more flyable.

Because of the rapid pace of the design, construction, and launch of Gemini systems, training for each Gemini flight depended to a major degree on the preceding flight. In its latter phases, NASA launched a Gemini mission about every 2 months. As missions evolved, training plans were formulated in concert with the crews. For Gemini, astronaut Edwin Aldrin said, "there was a lot more crew participation" in setting mission profiles.[38] Apollo mission planning, on the other hand, and its training regimen were more carefully structured before they reached the Astronaut Office. Both Gemini and Apollo training differed sharply from Mercury training in that flight involved crews of two and three persons, each having far more flight-related and nonflight-related tasks to complete.

Training activities for the Apollo missions were structured so that the training for one was a building block for the following mission. Apollo crews did, however, exercise some influence and independence in doing things their own way, and this caused some conflicts with mission specifications. On the more subjective flight decisions, such as how to go about performing specific tasks (such as undocking), when or how to perform inflight inspections, or whether to fly "heads up or heads down," the crew and its commander generally made the decisions.[39]

More frequent flights and accelerated programs meant that additional astronauts were needed. Congressman Olin Teague and others began to talk about organizing an "astronaut academy" similar to the Nation's military academies. MSC administrators, more realistically, began to discuss recruiting more astronauts and organizing the astronauts into a regular branch or division.

According to Deke Slayton, recently grounded from Mercury flights because of a suspected heart condition, Wally Shirra, Gus Grissom, and Alan Shepard decided that, "hell, if we're going to have a boss, why bring somebody in from the outside and superimpose him on us?" They decided they wanted Slayton to be their boss, so Slayton got Gilruth's approval and "we organized the astronaut office," he said. In addition, Gilruth appointed Warren J. North, then with NASA Headquarters staff and formerly a test pilot for the Lewis Research Center, as head of a new Flight Crew Support Division in the spring of 1962, which became the Flight Crew Directorate a year later. Slayton thereafter recommended flight crew assignments to the center director. Gilruth independently made those assignments through Mercury 7. Slayton selected crews for Gemini, Apollo, and Skylab. He, Warren North, and Alan Shepard comprised the selection board for the second group of astronaut candidates.[40]

Specifications for the second field of astronaut candidates changed slightly, but significantly. The age limit was lowered from 40 to 35, educational qualifications were broadened to include degrees in biological sciences, and while flight experience required "experience as a jet test pilot," that experience could be achieved through the aircraft industry or NASA or by having graduated from a military test pilot school. Thus, the second astronaut draft opened the door to civilians and to persons with scientific as well as engineering credentials (table 3).[41]

In 1963, for the third recruiting effort, flight requirements were lowered to 1000 hours, non-test pilots were qualified, and the age limit was lowered to 34. Instead of prospective candidates being prescreened by NASA or by the military services, the call extended to

## *TABLE 3. NASA Astronaut Selections, 1959 to 1969*

***Group I****/April 9, 1959 (7 Selected)*

Scott Carpenter (USN)
Gordon Cooper, Jr. (USAF)
John Glenn, Jr. (USMC)
Virgil "Gus" Grissom (USAF)
Walter Schirra, Jr. (USN)
Alan Shepard (USN)
Donald "Deke" Slayton (USAF)

***Group II****/September 17, 1962 (9 Selected)*

Neil Armstrong (civilian)
Elliot See (civilian)
Frank Borman (USAF)
James McDivitt (USAF)
Thomas Stafford (USAF)
Edward White, II (USAF)
Charles "Pete" Conrad (USN)
James Lovell (USN)
John Young (USN)

***Group III****/October 8, 1963 (14 Selected)*

Edwin "Buzz" Aldrin, Jr. (USAF, Ph.D. astronautics)
William Anders (USAF, M.S. engineering)
Charles Bassett, II (USAF, B.S. engineering)
Alan Bean (USN, B.S. engineering)
Eugene Cernan (USN, M.S. engineering)
Roger Chaffee (USN, B.S. Engineering)
Michael Collins (USAF, B.S., U.S. Military Academy)
R. Walter Cunningham (USMC, M.S. physics)
Donn Eisele (USAF, M.S. astronautics)
Theodore Freeman (USAF, M.S. engineering)
Richard Gordon (USN, B.S. chemistry)
Russell Schweickart, (civilian, M.S. astronautics)
Clifton Williams, Jr. (USMC, B.S. engineering)

***Group IV****/June 28, 1965 (6 Selected)*

Owen Garriott (Ph.D., engineering)
Edward Gibson (Ph.D., engineering)
Dr. Duane Graveline (M.D., medicine)
Dr. Joseph Kerwin (USN, M.D., medicine)
F. Curtis Michel (Ph.D., physics)
Harrison "Jack" Schmitt (Ph.D., geology)

***Group V****/April 4, 1966 (19 Selected)*

Vance Brand, (civilian, B.S. engineering)
John Bull (USN, B.S. engineering)
Gerald Carr (USMC, M.S. engineering)
Charles Duke (USAF, B.S. engineering)
Joe Engle (USAF, B.S. engineering)
Ronald Evans (USN, M.S. engineering)
Edward Givens, Jr. (USAF, B.S. Naval Academy)
Fred Haise, Jr. (civilian, B.S. engineering)
James Irwin (USAF, M.S. engineering)
Don Lind (civilian, Ph.D. physics)
Jack Lousma (USMC, M.S. engineering)
Thomas Mattingly, II (USN, B.S. engineering)
Bruce McCandless, II (USN, M.S. engineering)
Edgar Mitchell (USN, Ph.D. aeronautics and astronautics)
William Pogue (USAF, M.S. mathematics)
Stuart Roosa (USAF, B.S. engineering)
John Swigert, Jr. (civilian, M.S. aerospace science)
Paul Weitz (USN, M.S. engineering)
Alfred Worden (USAF, M.S. engineering)

***Group VI****/August 4, 1967 (11 Selected)*

Joseph Allen, (Ph.D., physics)
Philip Chapman (Ph.D., instrumentation)
Anthony England (M.S. physics)
Karl Henize (Ph.D. astronomy)
Donald Holmquest (M.D.)
William Lenoir (Ph.D. engineering)
John Llewellyn (Ph.D. chemistry)
F. Story Musgrave (M.D.)
Brian O'Leary (Ph.D. astronomy)
Robert Parker (Ph.D. astronomy)
William Thornton (M.D.)

***Group VII****/August 14, 1969 (7 Selected)*

Karol Bobko (USAF, B.S. Air Force Academy)
Robert Crippen (USN, B.S. engineering)
Charles Fullerton (USAF, M.S. engineering)
Henry Hartsfield (USAF, B.S. physics)
Robert Overmyer (USMC, M.S. astronautics)
Donald Peterson (USAF, M.S. engineering)
Richard Truly (USN, B.S. engineering)

volunteers from industry, professional groups, and other organizations. There was more emphasis on academic credentials, but most of the astronauts for the first three groups (24 of 30) still came from the military.[42] The fourth group was different. Its selection followed several years of discussion and some controversy relating to the perceived need for astronauts with strong scientific training for the lunar missions.

The Space Sciences Board of the National Academy of Sciences conducted a preliminary study of space research needs in 1962, and in 1963 a special ad hoc committee, retained by NASA and chaired by Dr. C.P. Sonett, submitted a report on "Apollo Experiments and Training on the Scientific Aspects of the Apollo Program." As a result of this work, NASA decided that astronaut selection should be based on both scientific and operational criteria, but that "because of the complex and difficult operational requirements and crew safety, whenever conflict exists between operational and scientific requirements, flight safety considerations demand that the scientific requirements be subordinate to the operational requirements."[43]

Subsequently, the NASA Office of Space Science and Applications cooperated with the National Academy of Sciences in defining specific scientific qualifications desired for the scientist-astronauts to be trained for lunar expeditions. The Office of Manned Space Flight defined the other-than-scientific requirements, notices for applicants were published and distributed in October, November, and December of 1964, and applications were due by January 1, 1965, to MSC. Flight experience or training was not required of these candidates. The applicants were then reviewed by the National Academy of Sciences which ranked the top 50 applicants on the basis of their scientific qualifications. Finally, on June 28, 1965, NASA selected six finalists from the Academy list. The finalists all had M.D. or Ph.D. degrees, two were medical doctors, two were engineers, one a physicist, and one a geologist. All but one, Lieutenant Commander Joseph Kerwin, USN (medicine), were civilians.[44]

The fifth group, selected in 1966, met the requirements established for Group III, but the age limit was raised from 34 to 36. NASA selected 19 astronauts, 4 of whom were civilians, in this round. The next year, 1967, the National Academy of Sciences again screened candidates as in 1965, and NASA selected 11 finalists, all of whom had Ph.D. or M.D. degrees, all of whom were civilians, and all of whom were required to attend jet pilot school for a year before beginning their regular training program at MSC.[45]

A seventh group of astronauts joined MSC in 1969, as transfers from the Manned Orbiting Laboratory Program being canceled by the Department of Defense. Seven transfers were accepted on the basis of their Air Force program qualifications, and by virtue of the fact that they were under 36 years of age.[46] One of these transfers, Lieutenant Commander Richard Truly, became NASA's Administrator in 1988. Nine years passed before NASA recruited any additional astronauts for spaceflight programs. Therein lies another story.

During the 10-year time frame in which the Mercury, Gemini, and Apollo astronauts came on board, "life systems" engineering and astronaut training changed to reflect the experiences and growing body of knowledge about spaceflight. Over time NASA engineers, such as Aleck C. Bond who assisted in the design and planning of the training and testing laboratory facilities at the Houston center and managed the Systems Test and Evaluation Program of the MSC's Engineering and Development Directorate from 1963 through 1967, heightened their senses and their skills in "man-rating" the design and operation of equipment used by astronauts. This process relates, Bond says, to designing equipment to accommodate human use and making it safe.[47] Before NASA, man-rating for conventional aircraft components was largely intuitive and unstructured. NASA engineers refined the concept as a technical engineering tool and a reliability and quality assurance measure.

Bond explained that the Mercury and Gemini programs used military boosters (Redstone, Atlas and Titan II) as launch vehicles. These missiles were designed to provide moderate reliability for a reasonable cost. "This," he said, "was not acceptable for manned spaceflight and thus very aggressive and definitive man-rating programs had to be undertaken to provide the desired safety and reliability of the launch vehicles and also of the spacecraft." General design criteria for launch vehicles and for manned spacecraft required conservative design approaches, redundancy in all critical systems, the use of "off-the-shelf" proven components to the fullest extent possible, and the use of standard design practices. A general design philosophy included the guidelines that no single mechanical failure would cause a mission to abort, and no single failure would result in the loss of life of the crew.[48]

Man-rated design criteria were supported by both standard engineering design reviews and by formal flight safety review panels which included representatives from engineering, operations, flight safety, and the astronauts. Prior to launch, a final mission review included key management personnel who certified the "total vehicle's readiness for launch."[49]

Man-rating criteria also changed between programs. The greater understanding of man's capabilities in space derived from Mercury resulted in Gemini design giving greater reliance on the astronaut for redundancy or backup systems. Piloting successes with Gemini resulted in the Apollo astronaut having more control. The debate over human versus automated control systems waned as the human became more of a system's manager integrated into the electronic controls. The Apollo program was the first to use launch vehicles specifically designed for manned flight; and Apollo, unlike Mercury and Gemini, relied heavily on alternative design approaches and extensive testing of subsystems.[50]

The test facilities of MSC in Houston sought both to test equipment and to train astronauts for living and working in the unearthly environment of space. While the Flight Crew Operations Division and the Mission Operations Division of MSC generally supervised astronaut training, every division of MSC participated, to some extent, in training and in testing materials and equipment. Astronauts, for example, spent many of their thousands of training hours in the laboratories and facilities operated by the Crew Systems Division, Structures and Mechanics Division, and other units of the Engineering Directorate.

The Crew Systems Division validated the "physiological design parameters for manned spaceflight"; that is, it had responsibility to design and test life support systems including space suits, atmospheric instrumentation, and food, water, and waste systems, and to train astronauts in their use. Testing and training were conducted in the laboratories specially designed and built at MSC to simulate space conditions on Earth, albeit in piecemeal portions. Thus the two altitude chambers (a 20-foot chamber and an 8-foot chamber) could replicate air pressures at 225,000 feet and 150,000 feet, respectively. A liquid nitrogen cold-trap associated with the 8-foot chamber could test the characteristics of solids and liquids and heat exchange characteristics. The envirotron chamber associated with the 8-foot altitude chamber could subject an equipped astronaut to a near-vacuum and temperature ranges of –100 degrees F to +400 degrees F.[51]

A separate crew performance laboratory allowed physiological and biomedical tests of astronauts in pressure suits. A flight acceleration facility or centrifuge was a primary training and testing device used to evaluate astronaut tolerance to acceleration and spaceflight stresses. Weightlessness, first reproduced for brief moments by zooming an aircraft, was better simulated by placing the suited astronaut underwater. Later a special tank, called the Weightless Environment Training Facility (WETF), was used to simulate spacewalks or EVA.[52]

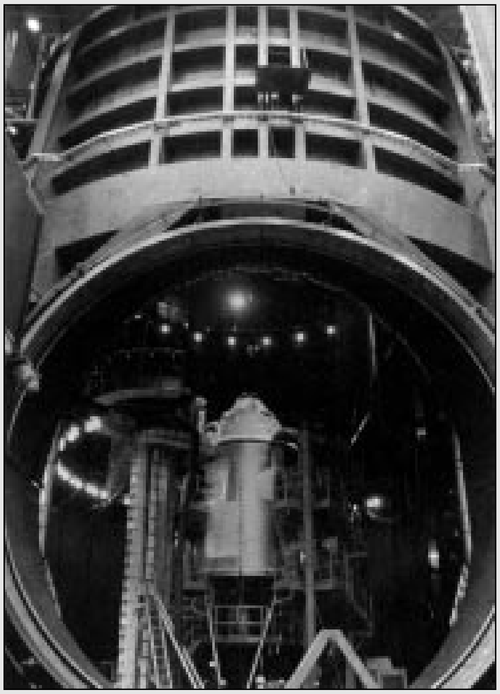
Supporting laboratories included a chemistry laboratory used to evaluate "expendables" (carbon dioxide, water, etc.) produced during simulations and spaceflight. The waste management laboratory designed and tested spacecraft waste and water management systems. The crew performance laboratory examined the performance of astronauts within pressure suits. A microbiology laboratory checked bacterial contents of food, water, wastes and blood specimens. A clinical biochemistry laboratory analyzed urine samples, performed hormone analyses, and examined the effects of space-like conditions on the human body. Life support systems, crew provisions and equipment, space suit, and nutrition laboratories studied and tested the performance of the astronaut in space and provided input into the training regimen of the astronauts.[53]

One of the most important devices used in the training of Apollo astronauts was "SESL," the Space Environment Simulation Laboratory operated by the Structures and Mechanics Division of the Engineering Directorate. The offices and corridors of the laboratory, located in Building 32, are lined with photographs of the astronauts who spent so much of their training time in Chambers A and B.

Those chambers can simulate the vacuum of space, the wide ranges in temperature bearing on objects in space, the light and darkness, and varying degrees of radiation intensity. Astronauts, before entering a chamber, are given a full preflight physical examination, enter into a bioinstrumentation area where body sensors are applied, then are outfitted in pressure suits, spend several hours in a special denitrogenation area—and only then enter SESL to begin their tests or training regimen—after which they must go through an equally elaborate and time-consuming exit procedure. During an exercise emergency, repressurization systems can restore chamber pressure from 0 to 6.0 psia in 30 seconds (with oxygen at 4 psia) and can achieve a normal atmosphere within 90 seconds. Each component of SESL, such as the compressed air systems, emergency power systems, solar simulation (carbon-arc lights), vacuum panels, cryogenic panels, control room, electronic equipment, measuring devices, liquid nitrogen, and gaseous helium systems, requires teams of technicians and engineers working in tandem for prolonged and critical simulation tests.[54] SESL was only one of the elaborate test and training facilities intrinsic to the mission.

Mission operations training sought to replicate as closely as possible the flight plan and required the coordination and training of all elements that would be involved in an actual flight. Mockups or boilerplate models of spacecraft, linked to Mission Control, gave the astronaut a hands-on simulation and absorbed countless hours of training. Each program and each mission required a unique flight plan and specialized training. Very special training equipment sometimes had to be designed for each mission. It was very difficult to simulate equipment that was itself still being designed. Over time the astronaut graduated, as technology improved, from a mechanical Link-type pilot training device to a highly sophisticated Shuttle Mission Trainer which could simulate most of the flight possibilities that

## The Space Environment Simulation Laboratory



*Exhaustive tests were run on manned and unmanned Apollo spacecraft. This is a view of Apollo 8 in Chamber A of the SESL at MSC.*

With the advent of the space age came the need for new testing and development facilities. In 1961 an ad hoc group of Space Task Group engineers began designing and drawing the specifications for test facilities to be built at MSC.

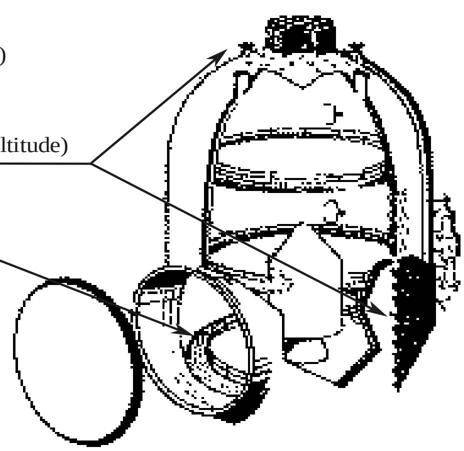
Space could not be duplicated on Earth, but many of its characteristics including weightlessness, audio and radio wave qualities, temperatures, and vacuum could be replicated. The Space Environment Simulation Laboratory [SESL] proved as essential to the design and testing of space vehicles as was the wind tunnel for aircraft.

The two chambers were completed in 1965. The external measurements of chamber A, 65 feet in diameter and 120 feet in height, made it unique. Chamber B was 45 by 43 feet. The two chambers were also unique because they were man-rated and had high vacuum performance and solar simulation fidelity.

The first tests in SESL took place in January 1966 in chamber B for the qualification of Gemini suits and associated EVA life support systems—as used by Edward H. White during his EVA during Gemini 4. The initial tests in Chamber A occurred later in 1966, on the Apollo Block I spacecraft for the purpose of demonstrating its adequacy for manned Earth-orbital missions. The tests revealed several design flaws and procedural and process errors that were corrected before the first Apollo flight. Later tests in 1968 to certify equipment for lunar flight conditions revealed several design anomalies and procedural errors that were corrected before subsequent lunar flight.

**Capability and description**

| | |
|---|---|
| Outside dimensions | 65 ft. (dia.) x 120 ft. (ht.) |
| Inside clear dimensions | 55 ft. (dia.) x 90 ft. (ht.) |
| Maximum vehicle size | 25 ft. (dia.) x 75 ft. (ht.) |
| Maximum vehicle weight | 150,000 lbs. |
| Pressure level | 1 x $10^{-6}$ torr (130-mile altitude) |
| Solar simulation source | Carbon arc units |
| Temperature interior chamber walls | -280¼ F |
| Lunar plane | Rotates ±180¼ |



a pilot might encounter during a mission.[55] Training and testing were constants in the spaceflight business and consumed a major part of the energies of MSC personnel, but the public and the press rarely ventured into these deeper recesses. What the public saw and heard were the astronauts who, willingly or not, became celebrities.

The growing numbers of astronauts, accelerated training and missions coupled with the Gemini and Apollo programs, and the enormous increase in public interest created more and more stress in the area of public relations. Through the Mercury program and in the early stages of the Gemini flights, public affairs people at NASA Headquarters had an almost incidental relationship to the operating NASA centers. Public information for the manned spaceflights was derived from MSC and the Cape (Kennedy Space Center). There was, according to Julian Scheer who joined the Headquarters information staff in 1962, "little coordination, little cooperation" and a lot of frustration between public affairs people at Headquarters and those in the centers. Field people were not getting proper direction or supervision from Headquarters, he said; rather, the field centers were the "tail wagging the Headquarters dog." When George Mueller became Director of Manned Space Flight, Scheer was named Deputy Assistant Administrator for Public Affairs (circa March 1963). Subsequently, to develop a more coordinated and centralized public affairs policy, Scheer sent Paul Haney to MSC to relieve John "Shorty" Powers, who had functioned effectively but very independently.[56]

Alfred Alibrando became the public affairs officer at NASA Headquarters, working under Julian Scheer, and Headquarters strengthened its functional supervision over public relations, but never wholly displaced the independence of the center offices, particularly the independence of MSC which generated 80 percent of NASA's media releases. Haney, Scheer said, worked well with Bob Gilruth and George Low at MSC, and a coordinated and effective public affairs program developed over time. Houston established public affairs personnel assignments for the missions and submitted them to Headquarters for approval. Press releases were initiated in Houston and sent to Headquarters for approval and production. Live commentary for flights was a Houston responsibility.[57]

Scheer credited the Houston center for developing very strong public affairs programs including exhibits, public tours of space equipment and paraphernalia (such as Gordon Cooper's Mercury capsule), public programs (as in the Teague theater), and astronaut public speaking engagements. Some of the astronauts accepted foreign speaking engagements. Gordon Cooper and Charles Conrad, for example, went to Europe and Africa, Richard Gordon and Neil Armstrong spoke in South American engagements, and Walter Schirra and Frank Borman went to the Far East. Edwin Aldrin, who flew Gemini XII and the Apollo 11 lunar landing mission said, "Being in the public eye continually without any particular isolation was not a situation I relished in Gemini, and I certainly didn't look forward to an intensification after the lunar landing." Aldrin felt that public relations activities of MSC and Headquarters were not well coordinated and that each astronaut often became his own public relations resource.[58] The astronauts, despite tremendous workloads and little private time, generated widespread public goodwill and support for NASA programs.

Because of the affiliation of the astronauts with MSC and to some extent because of the linkage provided by the Mission Control Center to the astronauts in flight, MSC, and to a lesser extent the Kennedy Space Center from which the missions were launched, achieved a greater identification in the media and the public mind as being the essence of NASA and the American space program. This undoubtedly contributed to some friction between the various elements of the NASA community, but it also resulted in MSC, in cooperation with the Headquarters Public Affairs Office, developing unusual proficiency in the area of public relations.

The open door, visitor-oriented public exhibit policies adopted by MSC produced some operating inconveniences, but large dividends in goodwill. The Educational Programs and Services Branch of the center's Public Affairs Office, established by Paul Haney and directed by Eugene Horton, brought legislators, teachers, students, and the general public to the center's "campus" for information, orientation, and a sense of public participation in the space adventures of NASA. Horton stressed the benefits of spaceflights to Americans. "Where else," he told audiences, "could one buy a decade of technological and economic growth, national pride, and wholesome family entertainment for the price of four cinema tickets a year per family?" America's investment in space, he explained in 1970, was less than one-half of one percent of the gross national product. Space technology, he emphasized, not only resulted in sharper X-ray pictures, longer lasting paint, faster dentist drills, smaller TV cameras, weather detection and tracking satellites, communication satellites, new medical instruments and fire protective materials and devices, but it has been most important as a successful management approach to solving overwhelmingly complex problems. And he stressed, as NASA has stressed, that this has been done "within full view of the whole world."[59]

Despite the competition of worries at home and wars abroad, the American public and people throughout the world became drawn with fascination to the flights of Apollo following the enormously successful mission of Apollo 4, the first flight test of the Saturn three-stage launch vehicle, launched on November 9, 1967. As the authors of (NASA's) *Chariots for Apollo* (1979) explained:

> Technically, managerially, and psychologically, Apollo 4 was an important and successful mission. . . . The fact that everything worked so well and with so little trouble gave NASA a confident feeling, as [Sam] Phillips phrased it, that "Apollo [was] on the way to the Moon."[60]

Bob Gilruth congratulated center personnel for their achievement. The successful launch of the Saturn V and the perfect performance of the Apollo spacecraft in flight and during reentry at lunar return speeds," he said, "make Apollo 4 a major milestone for the entire program." Despite the problems of the past year, he said, "Our goal continues to be a lunar landing in this decade. With the continued dedication and personal commitment of our entire staff, this goal can be met."[61] Rejuvenated, the entire NASA organization, with the cooperation of the contractors, redoubled efforts to put a man on the Moon within the decade.

On January 22, 1968, a second Saturn IB test flight, this carrying the first unmanned lunar module with an unmanned command and service module, lifted off from the pad at Cape Kennedy. Production delays on the lunar module (LM-1) resulted in its delivery to Kennedy Space Center 7 months after originally scheduled, and the investigations and systems reevaluations that followed the AS-204 fire further delayed a test of the module. Now it flew. The LM separated successfully from the S-IVB stage, and after two independent revolutions, ground control fired the descent engines for a programmed 38-second burst. Four seconds later the engines stopped, under an automatic impulse which signaled that the vehicle was not accelerating fast enough. Mission control evaluated the situation (as would happen under a manned flight situation), and an alternate flight program was implemented. The descent engine was fired twice successfully under the new program, and the mission was determined to be a success. In February, the LM reentered the atmosphere and its "fiery remains" plunged into the Pacific southwest of Guam.[62]

Apollo 6 fared less well, but despite countdown delays, engine failures aboard the second stage of the Saturn, and an emergency burn by the third stage which lifted the unmanned command module and LM into a much lower orbit than planned, the command module was retrieved and the mission objectives achieved.[63] Despite the problems with the mission, Apollo 6 was largely ignored by the media and the public. Launching unmanned vehicles into space did not tickle the public fancy nearly so much as manned flights—and there were more pressing concerns.

Americans were deflected from their recent interest in space launches by the growing and more difficult involvement of American military forces in southeast Asia and by the heightened racial confrontations at home. Rising federal expenditures on war and welfare began to affect NASA budgets. President Lyndon B. Johnson announced a few days before the launch of Apollo 6 that he would not seek reelection; and on the day of the launch, Martin Luther King, Jr., a leader in the civil rights movement, was assassinated in Memphis, Tennessee.[64]

Nevertheless, the resumption of manned spaceflights beginning with the launch of Apollo 7 in October 1968, and the subsequent lunar expeditions, rekindled an excitement at MSC, within the NASA community, and throughout the United States that has rarely been duplicated. The "space race" against time, against money, against technology and human frailty, and against the Russians was being won many Americans believed. Americans needed heroes and a victory, and that victory, if not in southeast Asia or along the Iron Curtain, could well be in space. The astronauts became something greater than life, and space became for a time the "opiate of the masses" and the media.

The flights of Apollo, however, were far more important than a media event. NASA and the American space program had already invoked changes in life on Earth, changes still largely imperceptible to the casual observer. Astronauts were flying in machines that a decade earlier had not existed. They were being trained and tested in laboratories designed and constructed to simulate conditions not of this Earth. The men and women who built and operated the machines were as indispensable as the spacecraft that carried them into space. Ten years before there had been no astronauts. Only now, in the mid-1960's did aerospace begin to replace aeronautics in the American lexicon. The technology upon which spaceflight depended ranged the gamut of human knowledge and experience. The contractors and subcontractors who built the machines in which the astronauts trained and which they flew into space covered a broad spectrum of American technology and industry. Almost unwittingly, and sometimes unwillingly, NASA and the space programs were putting Americans and people of the world on a new learning curve. The atomic age with its more defined technology that emerged in war began to yield to the more broadly conceived technology of space dedicated to peace.