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JOHNSON SPACE CENTER

The astronauts work diligently, despite their long time away from home. One calls Mission Control from the lunar module while the others retrieve geological samples of the moon. All seems to be normal, routine, even boring.

Suddenly a strange sight appears. The astronaut on the lunar module must be dreaming. There cannot be another living being out here. But then he sees another, and then a third. The beings ruthlessly kill the two astronauts who were taking the samples. The final astronaut panics and vainly attempts to leave the moon. It is too late. He and his spacecraft are destroyed.

In his distress, the astronaut called to Houston. Unfortunately for him, they were too far away to help. The three beings, the damage done, head to the nearby planet feeling like gods. They call the planet Houston, since that was the word used by the astronaut.

Thankfully, this is a work of fiction—*Superman II,* to be precise. Yet it provides an excellent and poignant example of the importance of Houston's Mission Control in NASA history, as well as in popular culture. For many people, Houston has become synonymous with spaceflight.

Since the creation of Project Mercury in the late 1950s, human spaceflight has been the most popular aspect of NASA's mission. As such, its Mission Control Center in Houston, Texas, has become the primary, or even the only, Mission Control in the public's eye. With human lives

at risk during each mission, NASA had to be sure to create a control center that principally protected those lives.

When NASA created the center in Houston in the early 1960s, NASA was able to construct a Mission Control from the ground up exactly as it wanted. The Mission Control Center therefore may be perceived as the perfect image of Mission Control in the space agency's eyes. Thus, it is essential to understand the construction process of this center to fully analyze the ground segment of America's human spaceflight program.

CENTER HISTORY

The roots of the Mission Control operations group reach back to the oldest of all the NASA facilities, Langley Research Center (1917) in Tidewater, Virginia. NASA established the original Space Task Group (STG) at Langley shortly after the agency's creation on 1 October 1958. The National Advisory Committee for Aeronautics (NACA), NASA's predecessor (dating back to 1915), put one of its veteran aeronautical engineers and flight test experts, Robert Gilruth, in charge of STG. His mission was to develop a human spaceflight program for the United States to rival the Soviet Union's. When the STG began work on 5 November 1958, it consisted of only fifty people: thirty-five from the Hampton, Virginia, facility, and fifteen from the Lewis Laboratory in Cleveland, Ohio. The STG was tasked with continuing to develop and fly rockets for the newly formed Project Mercury.[1]

Although based in Virginia, much of STG's work took place at the Mercury Control Center in Cape Canaveral, Florida. In Florida, a few members of the STG—most notably Christopher C. Kraft, the first flight director; Tecwyn Roberts from Wales; and John Hodge from England—were mainly responsible for designing the original Mercury Control. Much of the concept came directly from Kraft, Gilruth's protégé in high-speed flight testing, who visualized the control room manned by experts on the spacecraft systems and the various aspects of the mission. This idea arose out of Kraft's experience with test flights, when a flight-test engineer on the ground monitored the flight and provided suggestions to the pilot. Before building the room, he sought

the advice of various other experts, including test pilots and the new Mercury astronauts, especially Donald K. "Deke" Slayton. The idea of a control room came about largely due to the need to protect the astronauts. In the case of an emergency abort, for example, controllers on the ground would need to monitor various procedures quickly and relay them to the astronauts.[2] In this way, the engineers and experts on the ground could maintain a semblance of control over their spacecraft.

Crisis response also dictated the location of the original Mission Control. NASA chose Cape Canaveral as the site of its first Mission Control largely so that a controller on-site could monitor the rocket as it stood on the launchpad and during the critical first few moments of the launch. Because they could not always rely on the early radar and telemetry systems to provide accurate information, controllers watched the rocket through periscopes in case of an emergency and the need for abort arose. Early failed tests proved this to be shrewd foresight.

Technicians and STG controllers also manned remote stations around the world with equipment to communicate with the astronauts in space. These remote sites completed the majority of the actual monitoring of spacecraft. Certain kinds of decisions, however, had to be made by a central group of experts. Due to the limitations of the technology of the time, the remote sites could not send information and have it expeditiously processed at Mercury Control. Thus, Mercury Control was more of a hub, where controllers, the experts in their fields, made the most crucial decisions.

Of great importance, Mercury Control served as a significant training ground, a classroom of sorts, for many of the controllers who went on to work in Mission Control for future programs like Gemini and Apollo. Aside from Kraft, future flight directors Gene Kranz, John Hodge, and Glynn Lunney, among many others, initially worked in Mercury Control.[3]

The first mission controlled from Cape Canaveral was Mercury-Redstone 2, which included the first living being sent into space by NASA: Ham, a chimpanzee.[4] While some controllers had prior experience with test flights and rocketry, the space program was so new and different that it required a new set of procedures and expertise. Mercury Control essentially started from scratch, and the controllers

methodically developed their jobs along the way.[5] The technology available to them was relatively crude, including a mechanical plotting board toward the front of the room based on estimations of the spacecraft's location. Only two controllers had access to visuals through a television set, the capsule communicator (capcom) and the flight director. Others relied solely on instrumentation readings.[6] These limitations in the technology of Mercury Control may have influenced the development of the capcom and flight director positions as special within the control room. Even after visual technology expanded to be available for all controllers, only capcom and the flight director had substantial communications with the astronauts in space. Regardless, the room and its technology proved adequate for the six Mercury manned missions.

By the end of Project Mercury, NASA realized that they needed to replace Mercury Control. The constant shuttling of personnel between Langley and Cape Canaveral wore on the members of the STG. Also, the facilities in Langley and the Cape were unable to cope with the needs of NASA's human spaceflight program. As it moved on to the Gemini and Apollo programs, NASA confronted increasingly difficult procedures in space, like rendezvous and extravehicular activities. Mercury Control was not equipped with the technology to carry out such maneuvers.

The human spaceflight program continued to grow as well, and neither Langley nor Cape Canaveral could manage the number of employees required for such exploits. Eugene Kranz also argued that while, at first, NASA thought that the control center should be near the hardware, they evaluated and quickly realized that it was more important to be near "feeder universities," particularly as new controllers with knowledge of computers were brought in for the Gemini program.[7] Veteran controllers had little knowledge of computers, so as the machines became increasingly important for Mission Control, they relied more heavily on college graduates who did have training in computers. NASA also decided that the human spaceflight program required its own administrative center, as well as a new control center.

In late 1960, NASA initiated its search for a location for a new human spaceflight facility. Parameters set by a committee helped to narrow

down the list of possible locations. For instance, the site needed access to water transportation for large barges carrying rockets and rocket components, a moderate climate to avoid lengthy cessations of work, a nearby airport, an infrastructure of technical facilities and potential employees within a reasonable distance, an established infrastructure of higher education in close proximity, abundant electrical and water supplies, and at least one thousand acres of land at a reasonable price.[8] Even with such specific criteria, the site selection committee received dozens of applications. They soon narrowed down the search to twenty-three sites, including Jacksonville and Tampa, Florida; Baton Rouge, Shreveport, and Bogalusa, Louisiana; San Diego, San Francisco, Berkeley, Richmond, Palo Alto, and Moffett Field, California; four sites near St. Louis, Missouri; and Victoria, Corpus Christi, Liberty, Beaumont, Harlingen, and three separate sites in Houston, Texas. The selection quickly escalated into a political endeavor, with the congressmen and -women who represented the sites campaigning for their district. While the committee originally favored the site in Tampa, the Air Force decided not to close down the Strategic Air Command operations at MacDill Air Force Base for NASA's use. The committee, dismayed by this development, quickly decided on one of the Houston sites as the new primary choice.[9]

After an extensive search process, on 19 September 1961, NASA announced that the human spaceflight program would build a new Manned Spacecraft Center (MSC) for $60 million in Houston, Texas. The land, purchased from Rice University, included one thousand acres near Clear Lake, which feeds into Galveston Bay and the Gulf of Mexico.[10] Thus, large barges could easily navigate to and from the location. NASA also obtained the rights to work out of Ellington Field, an old air base from the world wars, only seven miles northwest of the MSC location. Nearby technical universities included Louisiana State University, the University of Texas, and Texas A&M University, among many others. Finally, the lack of harsh winter weather meant that operations would not be hindered. The location thus met each of the parameters established by the site committee.

Rice University officials were skeptical, understandably, about the prospects of human spaceflight. They included a clause in the purchase