An American in Orbit

Glenn was awakened once again at 2:20 a.m. on February 20. After showering, he sat down to a breakfast of steak, scrambled eggs, toast, orange juice, and coffee. At 3:05 the astronauts' flight surgeon, William Douglas, gave him a brief physical examination.

Douglas, Glenn, and his suit technician, Joe W. Schmitt, were only three of a multitude hard at work on the cloudy February morning. In the Mercury Control Center procedures log, the flight control team noted at 3:40 that they were "up and at it." The team immediately conducted a radar check, and although ionospheric conditions made the results poor the controllers believed the situation would improve soon. So they went on to check booster telemetry and the Control Center's voice intercom system, both of which were in good order. Shortly thereafter they found a faulty communication link that was supposed to be obtaining information about the capsule's oxygen system, but within minutes they had corrected the problem.[27]

At 4:27 a.m. Christopher Kraft, sitting before his flight director's console, received word that the global tracking network had been checked out and was ready. In Hangar S, Douglas placed the biosensors on Glenn, and Joe Schmitt began helping the astronaut don his 20-pound pressure suit. At 5:01 the Mercury Control Center learned that the astronaut was in the van and on his [423] way to the launch pad. The van moved slowly and arrived at 5:17, 20 minutes behind schedule. But the delay was of little consequence, for at 5:25 (T minus 120 minutes) trouble had cropped up in the booster's guidance system. Since this came during the built-in 90-minute hold part of the countdown for the astronaut insertion activity, the delay was not likely to halt the readying procedures for very long. The installation of a spare unit and an additional 45 minutes required for its checkout, however, made a total of 135 minutes lost.[28]

Because of overcast weather and the guidance problem in the Atlas, Glenn relaxed comfortably in the van until 5:58, when the sky began to clear. The capsule and booster validation checks were progressing normally as he emerged from the van, saluted the onlookers, and boarded the gantry elevator. At 6:03, the operations team noted in its procedures log, the astronaut "put a foot into the spacecraft." Once inside *Friendship 7*, Glenn noticed that the respiration sensor - a thermistor attached to the astronaut's microphone in the air stream of his breath - had shifted from where it had been fixed during the simulated flight. Stanley C. White pointed out to Williams that a correction could only be made by opening the suit, a very tricky operation atop the gantry. So the two officials decided to disregard the slipped thermistor, even though faulty data would result. White advised the range to ignore all respiratory transmissions.[29]

At last the technicians began to bolt the hatch onto the spacecraft, but at 7:10, with the countdown proceeding and most of the 70 bolts secured, a broken bolt was discovered. Although Grissom had flown in MR—4 with a broken hatch bolt, Williams, taking no chances this time, ordered removal and repair. Taking the hatch off and rebolting would require about 40 minutes, so the operations team took this opportunity to run still another check of the guidance system on Atlas 109-D. Glenn evidently maintained his composure during this hold, with his pulse ranging between 60 and 80 beats per minute. When a little more than half of the bolts had been secured, he peered through the periscope and remarked to Scott Carpenter and Alan Shepard in the Control Center, "Looks like the weather is breaking up."[30]

Minutes later the hatch installation was completed and the cabin purge was started. A check of the cabin oxygen leakage rate indicated 500 cubic centimeters per minute, well within design specifications. At 8:05, T minus 60 minutes, the countdown continued, but after 15 minutes a hold was called to add about 10 gallons of propellant to the booster's tanks. Glenn had been busily going over his capsule systems checklist. As the holds continued, he occupied his time and relieved the pressure at various points on his cramped body by pulling on the bungee-cord exercising device in front of his head in the capsule. The countdown resumed while the liquid oxygen was being pumped aboard the Atlas, but at T minus 22 minutes, 8:58, a fuel pump outlet valve stuck, causing still another hold.[31]

At that point in the countdown, Glenn, the blockhouse and Control Center crews, and workers scurrying around and

climbing on the gantry were joined by some 100 million people watching television sets in about 40 million homes [426] throughout the United States. Countless others huddled around radios in their homes or places of business and about 50,000 "bird watchers" stood on the beaches near Cape Canaveral, squinting toward the erect rocket gleaming in the distance. Some of the more hearty and sun-tanned spectators had been at the Cape since mid–January and had organized trailer towns, complete with "mayors." Mission announcer Powers, popularly known as "the voice of Mercury Control," who had been at his post in the Control Center since 5 o'clock that morning, went on the air to advise the waiting public of the status of the countdown and the cause for the present hold.

With the stuck valve cleared, the count picked up at 9:25, but another suspenseful moment came at 6 1/2 minutes before launch time, when the Bermuda tracking station experienced an electrical power failure. Although the breakdown was brief, it took several more minutes to steady the Bermuda computer.

At 9:47, after two hours and 17 minutes of holds and three hours and 44 minutes after Glenn entered his "office," *Friendship 7* was launched on its orbital journey. The Atlas, supported by its tail of fire, lifted off its pad, and Powers made the announcement that this country had waited three long years to hear: "Glenn reports all spacecraft systems go! Mercury Control is go!" As Atlas 109-D lunged spaceward, Glenn's pulse rate climbed to 110, as expected. The Atlas and its control systems telemetered signals that they were functioning perfectly.[32]

Half a minute after liftoff the General Electric-Burroughs guidance system locked onto a radio transponder in the booster to guide the vehicle until it was through the orbital insertion "window." The vibration at liftoff hardly bothered Glenn, but a hundred seconds later at max-q he reported, "It's a little bumpy about here." After the rocket plunged through the max-q region, the flight smoothed out; then two minutes and 14 seconds after launch, the outboard booster engines cut off and dropped away. Glenn saw a wisp of smoke and fleetingly thought the escape tower had jettisoned early, but that event occurred exactly on time, 20 seconds later.[33]

When the tower separated, the vehicle combination pitched over still further, giving Glenn his first view of the horizon, which he described as "a beautiful sight, looking eastward across the Atlantic." Vibration increased as the fuel supply spewed out the sustainer engine nozzle, then abruptly stopped when the sustainer shut down. The sustainer had accelerated the capsule to a velocity only seven feet per second below nominal and had put the Atlas into an orbital trajectory only .05 of a degree low. Joyously the operations team noted in the log, "9:52- - -We are through the gates." Glenn received word that he could make at least seven orbits with the orbital conditions MA-6 had achieved. To Goddard's computers in Maryland the orbital insertion conditions appeared good enough for almost 100 orbits.[34]

Although the posigrade rockets kicked the capsule loose from the booster at the correct instant, the five-second rate-damping operation started two and a half seconds late. This brief lapse caused a substantial initial roll error just as the [427] capsule began its turnaround. The attitude control system managed the deviation very well, but it was some 38 seconds before *Friendship 7* dropped into its proper orbital attitude. Turnaround spent 5.4 pounds of fuel from a total supply of 60.4 pounds (36 for automatic and 24.4 for manual control). Despite his slow automatic positioning maneuver, Glenn made his control checks with such ease that it seemed, he said, as if he were sitting in the procedures trainer. As Voas had asked him to do, the astronaut peered through the window at the tumbling Atlas tankage. It had come into view exactly as Ben F. McCreary of MSC had predicted it would. He could see the spent vehicle turning end over end, and he called out estimates of distances between the separating vehicles: "One hundred yards, two hundred yards." At one point Glenn's estimate matched the telemetry signal exactly. He visually tracked the sustainer intermittently for about eight minutes.[35]

Glenn, noticing the onset of weightlessness, settled into orbital free flight with an inertial velocity of 17,544 miles per hour and reported that zero g was wholly pleasant. Although he could move well and see much through his trapezoidal window, he wanted to see even more. "I guess I'd like a glass capsule," he later quipped. Weightlessness also helped him as he used the hand-held camera. When his attention was drawn to a panel switch or readout, he simply left the "weightless" camera suspended and reached for the switch. Dutifully carrying out all of the head and body movements requested by Voas, he experienced none of the sensations reported by Gherman Titov. While any Glenn-Titov comparison might be ruled invalid since Titov reportedly became nauseated on his sixth orbit and Glenn flew only three orbits, MA-6 at least was to demonstrate to the American medical community that there were no discernible

adverse physiological effects from over four hours of weightlessness.

The first orbit of *Friendship 7* began ticking off like clockwork with the Canary Islands reporting all capsule systems in perfect working order. Looking at the African coastline, and later the interior over Kano, Nigeria, Glenn told the tracking station team that he could see a dust storm. Kano flight communicators replied that the winds had been quite heavy for the past week.[37]

Glenn, completing his spacecraft systems checks over the Canaries, had commented that he was getting a little behind in his schedule but that all systems still were "go." Then, over Kano, he had commenced his own first major yaw adjustment, involving a complete turnaround of the capsule until he was facing his flight path. Glenn noted that the attitude indicators disagreed with what he could see were true spacecraft attitudes. Despite the incorrect panel readouts, he was pleased to be facing the direction his spacecraft was going.[38]

Over the Indian Ocean on his first orbit, Glenn became the first American to witness the sunset from above 100 miles. Awed but not poetically inclined, the astronaut described the moment of twilight simply as "beautiful." Space sky was very black, he said, with a thin band of blue along the horizon. He could see the cloud strata below, but the clouds in turn prevented his seeing a mortar flare fired by the Indian Ocean tracking ship. Glenn described the remarkable sunset: [428] the sun went down fast but not quite as quickly as he had expected; for five or six minutes there was a slow but continuous reduction in light intensity; and brilliant orange and blue layers spread out 45 to 60 degrees on either side of the sun, tapering gradually toward the horizon.

On the nightside of Earth, nearing the Australian coastline, Glenn made his planned star, weather, and landmark observations. He failed to see the dim light phenomenon of the heavens called the zodiacal light; he thought his eyes had not had sufficient time to adapt to the darkness. Within voice radio range of the Muchea, Australia, tracking station, Glenn and Gordon Cooper began a long space-to-Earth conversation. The astronaut reported that he felt fine, that he had no problems, and that he could see a very bright light and what appeared to be the outline of a city. Cooper answered that he probably saw the lights of Perth and Rockingham. Glenn also said that he could see stars as he looked down toward the "real" horizon - as distinguished from the haze layer he estimated to be about seven or eight degrees above the horizon on the nightside - and clouds reflecting the moonlight. "That sure was a short day," he excitedly told Cooper. "That was about the shortest day I've ever run into."[39]

Moving onward above the Pacific over Canton Island, Glenn experienced an even shorter 45-minute night and prepared his periscope for viewing his first sunrise in orbit. As the day dawned over the island, he saw literally thousands of "little specks, brilliant specks, floating around outside the capsule." Glenn's first impression was that the spacecraft was tumbling or that he was looking into a star field, but a quick hard look out of the capsule window corrected this momentary illusion. He definitely thought the luminescent "fireflies," as he dubbed the specks, were streaming past his spacecraft from ahead. They seemed to flow leisurely but not to be originating from any part of the capsule. As *Friendship 7* sped over the Pacific expanse into brighter sunlight, the "fireflies" disappeared.[40]

The global circuit was proceeding without any major problems, and Glenn still was enjoying his extended encounter with zero g. He ran into some bothersome interference on his broadband HF radio when he tried to talk with the Hawaiian site at Kauai. An aircraft from the Pacific Missile Range tried unsuccessfully to locate the noise source. Other than the mystery of the "fireflies" and the intermittent HF interference, the mission was going fine, with the capsule attitude control system performing perfectly.

Then the tracking station at Guaymas, Mexico, informed the control center in Florida that a yaw reaction jet was giving Glenn an attitude control problem that, as he later recalled, "was to stick with me for the rest of the flight." This was disheartening news for those in the operations team, who remembered that a sticking fuel valve discovered during the second orbital pass of the chimpanzee Enos had caused the early termination of MA-5. If Glenn could overcome this control problem he would furnish confirmation for Williams' and others' contention that man was an essential element in the loop. If the psychologists' [429] failure task analyses were correct, the flexibility of man should now demonstrate the way to augment the reliability of the machine.

Glenn first noticed the control trouble when the automatic stabilization and control system allowed the spacecraft to

drift about a degree and a half per second to the right, much like an automobile with its front wheels well out of alignment. This drift initiated a signal in the system that called for a one-pound yaw-left thrust, but there was no rate response. Glenn immediately switched to his manual-proportional control mode and eased *Friendship 7* back to orbital attitude. Then, switching from mode to mode, he sought to determine how to maintain the correct attitude position with the least cost in fuel. He reported that fly-by-wire seemed most effective and economical. Mercury Control Center recommended that he stay with this control system. After about 20 minutes the malfunctioning thruster mysteriously began working again, and with the exception of a few weak responses it seemed to be working well by the time Glenn was over Texas. After only about a minute of automated flight, however, the opposing yaw-right thruster ceased to function. When similar trials and waiting did not restore the yaw-right jet, Glenn realized that he would have to live with the problem and become a full-time pilot responsible for his own well-being.[41]

To the operations team at the Cape and to the crews at the tracking sites, Glenn appeared to be coping with his attitude control problem well, even though he had to omit many of his observational assignments. But a still more serious problem bothered the Cape monitors as *Friendship 7* moved over them. An engineer at the telemetry control console, William Saunders, noted that "segment 51," an instrument providing data on the spacecraft landing system, was presenting a strange reading. According to the signal, the spacecraft heatshield and the compressed landing bag were no longer locked in position. If this was really the case, the all-important heatshield was being held on the capsule only by the straps of the retropackage. Almost immediately the Mercury Control Center ordered all tracking sites to monitor the instrumentation segment closely and, in their conversations with the pilot, to mention that the landing-bag deploy switch should be in the "off" position. Although Glenn was not immediately aware of his potential danger, he became suspicious when site after site consecutively asked him to make sure that the deploy switch was off. Meanwhile the operations team had to decide how to get the capsule and the astronaut back through the atmosphere with a loose heatshield. After huddling for several minutes, they decided that after retrofire the spent retropackage should be retained to keep the shield secure during reentry. William M. Bland, Jr., in the control center, hurriedly telephoned Maxime A. Faget, the chief designer of the Mercury spacecraft, in Houston, to ask if there were any special considerations they needed to know or to watch. Faget replied that everything should be all right, providing all the retrorockets fired. If they did not, the retropack would have to be jettisoned, because any unburned solid propellant would ignite during reentry. [430] The operations team concluded that retaining the retropack was the only possible way of holding the shield in place and protecting Glenn during the early portion of his return to the dense atmosphere. The men in Mercury Control realized that the metallic retropack would burn away, but they felt that by the time it did, aerodynamic pressures would be strong enough to keep the shield in place. The decision once made, the members of the operations team fought off a gnawing uneasiness throughout the rest of the flight.[42] This uneasiness was transmitted to the TV and radio audience before actual retrofire.

Meanwhile *Friendship 7* was vaulting the Atlantic on its second orbital pass, and Glenn was busy keeping his capsule's attitude correct and trying to accomplish as many of the flight plan tasks as possible. He had advised Virgil Grissom at Bermuda that the oculogyric test, involving visually following a light spot, had just been completed. Near the Canary Islands the sun, streaming through his window, made Glenn a little warm, but he refused to adjust the water coolant control on his suit circuit. This time around he observed that evidently the "fireflies" outside the spacecraft had no connection with the gas from the reaction control jets. Glenn skillfully positioned his ship to take some photographs of the cloud masses and Earth spinning past beneath him. As he mused over a small bolt floating around inside the capsule, the Kano and Zanzibar sites monitoring the capsule suddenly noted a 12 percent drop in the secondary oxygen supply.[43]

Meanwhile the Indian Ocean tracking ship was preparing for the second pass observation experiment. Battened down for heavy weather, the Mercury support crew decided that releasing balloons for Glenn to try to see was out of the question and instead they fired star-shell parachute flares. Glenn, however, was able to observe only lightning flashes in the storm clouds below.

Over the Indian Ocean, Glenn finally decided to adjust the water coolant flow in the suit circuit to improve on a condition he described as "comfortably warm." By the time he was over Woomera, Australia, the light signal warning of excess cabin water told him that the humidity level was rising. From then on throughout the rest of the flight he had to balance his suit cooling carefully against the cabin humidity, but the temperature inside his suit was never more than

moderately uncomfortable. Another warning light appeared over Australia, indicating that the hydrogen peroxide fuel supply for the automatic system was down to 62 percent. Mercury Control Center recommended letting the capsule drift in orbit to conserve fuel. Glenn also complained that the roll horizon scanner did not seem to be working too well on the nightside of Earth and that it was difficult for him to obtain a visual reference to check the situation. To get a better view of Earth's horizon he pitched the spacecraft slightly downward, which helped some.

For the remainder of the second orbit and while going on into the third pass, *Friendship 7* encountered no new troubles. Glenn continued to control his attitude without allowing too much drift, and consequently consumed considerably more fuel than the automatic system would have used had the control system been working normally. He had used six pounds from the automatic tank and 11.8 pounds [431] from the manual on the second orbit, or almost 30 percent of his total supply. While he had to pay close attention to the control system to hold the fuel expenditure as low as possible, he still had opportunities for making observations, photographing the constellation Orion, and executing a third 180-degree yaw maneuver.

On the last orbital circuit of *Friendship 7*, the Indian Ocean tracking ship gave up on the release of objects for pilot observation; cloud coverage was still too thick. There was still time enough for a little joking between Cooper, at Muchea, and Glenn. The pilot quite formally requested the "down under" communicator to tell General David Shoup, Commandant of the Marine Corps, that three orbits should suffice for his minimal monthly requirement of four hours' flying time. Glenn asked that he be certified as eligible for his regular flight pay increment.

Now that *Friendship 7* was halfway through its last orbit, Williams and Kraft decided to try once more to find out all they could about the heatshield before Glenn and his ship plunged through the searing reentry zone. At Kraft's order, the Hawaiian tracking site told Glenn to place the landing bag deploy switch in the automatic position. Then, if a light came on, he should enter with the retropack in place. Coupling this with past queries about this switch, Glenn thoroughly deduced his situation. He ran the test, reported that no light appeared, and added that he could hear no loose bumping noises when the spacecraft's attitude changed. The ground crew leaders differed regarding the best possible procedure to follow: Capsule systems monitors in the Control Center thought that the retropack should be jettisoned, while the data reduction crew urged that it be retained. This left the final decision up to Kraft and Williams. They weighed the information they had received and decided it would be safer to keep the retropack. Walter Schirra, the California communicator, passed the order to Glenn to retain the retropack until he was over the Texas tracking station.[44]

Meanwhile Glenn was preparing for reentry. Keeping the retrorocket package on meant that he had to retract the periscope manually and activate the .05-g sequence by pushing the override switch. Then, while nearing the California coastline, a little more than four hours and 33 minutes after launch, the spacecraft assumed its critical retrofire attitude alignment and the first retrorocket fired. "Boy, feels like I'm going halfway back to Hawaii," Glenn reported. Seconds later, in orderly succession, the two remaining rockets executed the braking process. The attitude controls maintained spacecraft position exactly throughout the retrofire sequence; about six minutes after the first retrorocket fired, Glenn carefully pitched the conical end of the spacecraft up to the correct, 14-degree negative pitch attitude for its downward plunge through the atmosphere.

Now came one of the most dramatic and critical moments in all of Project Mercury. In the Mercury Control Center, at the tracking stations, and on the recovery ships ringing the globe, engineers, technicians, physicians, recovery personnel, and fellow astronauts stood nervously, stared at their consoles, and listened to the communications circuits. Was the segment 51 reading on the landing bag and heatshield correct? [432] If so, would the straps on the retropack keep the heatshield in place long enough during reentry? And even if they did, was the thermal protection designed and developed into the Mercury spacecraft truly adequate? Would this, America's first manned orbital flight, end in the incineration of the astronaut? The whole Mercury team felt itself on trial and awaited its verdict.

Glenn and *Friendship 7* slowed down during their long reentry glide over the continental United States toward the hoped-for splashdown in the Atlantic. The Corpus Christi station told Glenn to retain the retropack until the g meter before him read 1.5. Busily involved with his control problems, Glenn reported over the Cape that he had been handling the capsule manually and would use the fly-by–wire control mode as a backup. Mercury Control then gave him the .05-g mark, and the pilot punched the override button, saying later that he seemed to be in the fringes of the g

field before he pushed. Almost immediately Glenn heard noises that sounded like "small things brushing against the capsule." "That's a real fireball outside," he radioed the Cape, with a trace of anxiety perhaps evident in his tone. Then a strap from the retropackage swung around and fluttered over the window, and he saw smoke as the whole apparatus was consumed. Although his control system seemed to be holding well, his manual fuel supply was down to 15 percent, with the deceleration peak still to come. So he switched to fly-by-wire and the automatic tank supply.[45]

Friendship 7 came now to the most fearful and fateful point of its voyage. The terrific frictional heat of reentry enveloped the capsule, and Glenn experienced his worst emotional stress of the flight. "I thought the retropack had jettisoned and saw chunks coming off and flying by the window," he said later. He feared that the chunks were pieces of his ablation protection, that the heatshield might be disintegrating, but he knew there was nothing to gain from stopping work.[46]

Shortly after passing the peak g region, the spacecraft began oscillating so severely that Glenn could not control the ship manually. *Friendship 7* swung far past the "tolerable" 10 degrees on both sides of the zero-degree point. "I felt like a falling leaf," Glenn would recall. So he cut in the auxiliary damping system, which helped to stabilize the large yaw and roll rates to a more comfortable level. Fuel in the automatic tanks, however, was getting low. Obviously the heatshield had stayed in place; Glenn was still alive. But now he wondered whether his capsule would remain stable down to an altitude at which the drogue parachute could be deployed safely.

The pilot's fears proved real when both fuel supplies ran dry. Automatic fuel gave out at 111 seconds, and manual fuel depleted at 51 seconds, before the drogue deployment. The oscillations rapidly resumed, and at about 35,000 feet Glenn decided he had better try to deploy the drogue manually lest the spacecraft flip over into an antenna-downward instead of a heatshield-downward position. But just as he lifted his hand toward the switch, the drogue automatically shot out at 28,000 feet instead of the nominal 21,000. Suddenly the spacecraft straightened out and, as Glenn reported, "everything was in good shape."[47]

[433] All systems in *Friendship 7* worked with precision for the remainder of the flight. At about 17,000 feet the periscope opened again for the pilot's use. Glenn, instead, glanced out the window, but it was coated with so much smoke and film that he could see very little. The spacecraft stabilized in its descent; the antenna section jettisoned; and Glenn, with immense relief, watched the main chute stream out, reef, and blossom. The Florida control center reminded Glenn to deploy the landing bag. He flipped the switch, saw the green light confirmation, and felt a comforting "clunk" as the shield and impact bag dropped into position four feet below the capsule. Glenn watched the ocean coming up to meet him and braced as the gap closed. Jolted by an impact that was more reassuring than stunning, he bobbed in the water, checked his watertight integrity, and relayed his elation that a successful MA-6 mission seemed assured.[48]

Friendship 7 had splashed into the Atlantic about 40 miles short of the predicted area, as retrofire calculations had not taken into account the spacecraft's weight loss in consumables. The *Noa*, a destroyer code-named Steelhead, had spotted the spacecraft during its descent. From a distance of about six miles the destroyer radioed Glenn that it could reach him shortly. Seventeen minutes later, the *Noa* cruised alongside; a sailor smartly cleared the spacecraft antenna; and Boatswain's Mate David Bell deftly attached a davit line for pickup. During the hoist upward the spacecraft bumped solidly against the side of the destroyer. Once *Friendship 7* was lowered to the mattress pallet, Glenn began removing paneling, intending to leave the capsule through the upper hatch. But it was too hot, and the operation was too slow for the already long day. So he told the ship's crew to stand clear, carefully removed the hatch detonator, and hit the plunger with the back of his hand. The plunger recoiled, cutting Glenn's knuckles slightly through his glove and giving him the only injury he received during the whole mission. A loud report indicated that the hatch was off. Eager hands pulled out the smiling astronaut, whose first words were "It was hot in there."

Lieutenant Commander Robert Mulin of the Navy and Captain Gene McIver of the Army, physicians assigned to the Mercury recovery team, described Glenn as being hot, sweating profusely, and fatigued. He was lucid but not loquacious, thirsty but not hungry. After drinking a glass of water and showering, he became more talkative. Asked if he felt any "stomach uneasiness" either during the flight or while he lolled the 17 minutes in the floating spacecraft waiting for pickup, Glenn admitted only to some "stomach awareness," beginning after he was down on the water. But

there was no nausea, and the examining physicians assured themselves that Glenn's condition was caused by heat, humidity, and some dehydration. He had lost five pounds, five ounces from his preflight weight of 171 pounds, seven ounces. He had consumed the equivalent of only 94 cubic centimeters of water, in the form of applesauce puree, during the flight, while his urine output was 800 cubic centimeters. He also had perspired profusely while awaiting pickup.

Glenn's temperature an hour after landing was 99.2 degrees, or only a degree [434] higher than his preflight reading, and by midnight he recorded a normal temperature. His blood pressure registered only a fraction higher than the preflight readings. The condition of his heart and lungs was normal before and after the mission, and there was nothing unusual about his skin except the superficial abrasions on the knuckles, caused by opening the hatch. By the time President Kennedy called his personal congratulations by radio telephone to Glenn aboard the *Noa*, the "wonderful trip–almost unbelievable" was over, Glenn was safe and sound, and 100 million American television viewers had happily ceased their vigil.

After recording on tape a "self-debriefing" aboard the *Noa*, Glenn was transferred to the carrier *Randolph*, where his chest was x-rayed, an electrocardiogram was made, and the initial phase of the technical debriefing was started. From there the astronaut was transported to Grand Turk Island, where a much more thorough physical began about 9:30 p.m., under the direction of Carmault B. Jackson, assistant to Flight Surgeon Douglas. February 20, 1962, proved to be "a long day at the office" for Glenn. After exhaustive tests and observations the attending physicians could find no adverse effects from Glenn's threefold circumnavigation in space. Technical debriefings continued for two days on the island and then moved to the Cape for another day's session.

The postflight analysis of Glenn's use of the three-axis handcontroller during reentry showed that about half of the thrust pulses he initiated opposed the direction of spacecraft motion, as they were supposed to. But the other half of the handcontroller movements either reinforced oscillating motions or had no net damping effect. The issue of "pilot-induced error" was picked up by some newsmen and reported as a controversy rather than a problem.

Now that the primary objectives of Project Mercury had been achieved at last in grand style, the drive for perfection in performance, so indispensable to manned space flight, still did not slow down.[49]

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[27] "Postlaunch Memorandum Report for MA-6"; "Procedures Log," Mercury Control Center, Feb. 20, 1962; *Space News Roundup*, I (Feb. 21, 1962).

[28] *Ibid*.; Kranz memo; memo, Stanley C. White to Kraft, "Summary Report on Test 5460 (MA-6)," Feb. 22, 1962.

[29] "Procedures Log"; White memo.

[30] On launch day cloud masses continued to hover over the launch area, causing many of the newsmen present to bet "no liftoff today." A little after 7 a.m. one of the Cape weather men, Harlan G. Higgins, noticed that the wind was shifting to drive the clouds away and that the temperature was becoming cooler. He quickly phoned Ernest A. Amman, the weather support man in Mercury Control, and told him that the chances for launch now looked promising.

[31] "Procedures Log"; White memo; "Postlaunch Memorandum Report for MA-6."

[32] *Ibid*.; "Transcript of Public Address Announcements by Col. John Powers Beginning at T Minus 22 Minutes, Describing MA-6 Launch," Feb. 20, 1962. For the story of the people on the beaches, see *New York Times*, Feb. 20, 1962. The impatience of some of the news personnel was understandable. A *New York Times* correspondent reported in mid–February that the often-postponed Glenn flight had already cost the broadcasters $2 million and that each day of delay cost them another $50,000. Newspaper and magazine costs were estimated at about a third of those figures. *New York Times*, Feb. 17, 1962. Also see "Liftoff! for John Glenn and His Family," *Life*, LII (March 2, 1962); "Liftoff and Uplift for the U.S.," *Life*, LII (March 2, 1962); "He Hit That Keyhole in the Sky," *Life*, LII (March 2, 1962); "At School All Systems Are Go," *Life*, LII (March 9, 1962); D. J. Hamblin, "Applause, Tears and Laughter and the

Emotions of a Long-Ago Fourth of July," *Life*, LII (March 9, 1962); "Hero's Words to Cherish," *Life*, LII (March 9, 1962); John Glenn, Jr., "If You're Shook Up You Shouldn't Be There," *Life*, LII (March 9, 1962).

[33] White memo; "Postlaunch Memorandum Report for MA—6." The General Electric–Burroughs booster-guidance system performed an interesting operation. Aboard the Atlas were three small black boxes, two of them similar to two-way radios. A radar on the ground automatically tracked signals emanating from these boxes, determining range and position. The operation for the MA - 6 mission progressed along the following pattern: A few minutes before launch time Michael Michela, the GE rate console operator, flipped a switch that pointed the rate antennas in the same directions as the precise tracking radar. This was to obtain velocity data. Thomas Waid, the track console operator, pushed a button to place the guidance system in automatic operation. Guidance system signals were aimed on a "cube in space" several hundred feet above the booster. It was simply a matter of waiting until the booster passed through this area, when the signals locked onto a radio transponder and the system began steering the launch vehicle after staging. This condition was maintained until orbital conditions were attained. The system had operated some 8000 hours before MA-6, and some members of the guidance team, consisting of Rodney Borum, John Savarie, Donald Wood, Waid, Robert Stanton, and Michela, had participated in as many as 121 launches. (News release, "Radio Guidance Functions of Mercury-Atlas 6," Defense Electronics Div., General Electric Co., undated; News release, no title, Defense Electronics Div., General Electric Co., undated.) During the powered phase of the flight, Kraft was notified that signals from a foreign C-band radar transmitter had been intercepted, but the operations team was unable to identify the source. ("Procedures Log.") The guidance equations were developed by C. L. Pitman, Robert Page, and Duncan McPherson of the Space Technology Laboratories. John P. Mayer, comments, Sept. 8, 1965.

[34] "Postlaunch Memorandum Report for MA-6"; "Procedures Log." At sustainer cutoff Glenn was not only aware of weightlessness but felt as though he were tumbling. Shepard and Grissom reported the same sensation. The apogee of Glenn's flight was 162 miles; the perigee, 100 miles.

[35] "Postlaunch Memorandum Report for MA-6"; "Continuation of MA-6 Debriefing." Glenn felt no angular acceleration during turnaround.

[36] *Ibid*.

[37] "Test 5460, Composite Message Summary," Mercury Control Center, Feb. 20, 1962. Over the Kano area on the first pass, Glenn opened his faceplate and ate a xylose (sugar) pill and his tube of applesauce without difficulty. (*Results of the First United States Manned Orbital Space Flight*, 153.) In the Zanzibar area Glenn worked out briefly with his exerciser, and the tracking station noted a temporary increase in his pulse rate to 140.

[38] The engineers later stated that these disagreements were inherent and would crop up whenever major yaw or roll attitudes deviated from zero degrees for an extended period of time. In other words, the gyro "readouts" on the panel, which were reporting an attitude change of about four degrees per minute, were considerably behind Glenn's quickly slewing yaw maneuver. Consequently the best procedure when executing such an operation was to stop the revolving gyroscopes, an action called "caging."

[39] "Postlaunch Memorandum Report for MA-6"; "Test 5460, Composite Message Summary"; "Transcript of Announcements by John Powers"; "Continuation of MA-6 Debriefing." Upon meeting the mayor of Perth later, Glenn remarked facetiously that he had half-expected the mayor to hand him an electric bill. An attempt to observe the airport lights at Woomera had failed because of cloudiness. As for the height of the haze layer, Jocelyn R. Gill of NASA Headquarters said this distance was later measured and found to be about 2 1/2 degrees above the horizon. For other comments on Glenn's observations while in orbit see "National Aeronautics and Space Administration," *Astronomical Journal*, 67, No. 9, Nov. 1962, 655.

[40] "Procedures Log"; "Continuation of MA–6 Debriefing." The particles appeared to be about 1/16 inch in diameter and to be traveling at about the same speed as the spacecraft.

[41] "Postlaunch Memorandum Report for MA-6." On Feb. 26, 1962, postflight inspectors disassembled the thrust

chamber systems and found some loose particles upstream of the fuel-metering orifices. These were found to be pieces of the dutch-weave fuel-distribution screens. Fuel consumption during the first orbit was 4.2 pounds from the automatic tanks and .6 pound from the manual tanks. Those figures were nominal; control trouble did not develop until the flight had been in progress for an hour and 29 minutes.

[42] *Ibid*.; *Space News Roundup*, I (Feb. 21, 1962); William Hines, "Segment 51," Washington *Evening Star*, March 16, 1962; Maxime A. Faget, interview, Houston, April 19, 1962.

[43] Postflight inspectors were unable to explain the secondary oxygen supply drop. For a report on Glenn's observational efforts, see John H. Glenn, Jr., "Summary Results of the First United States Manned Orbital Space Fight," in *Life Sciences and Space Research*, "A Session of the Third International Space Science Symposium," Washington, D.C., April 30–May 9, 1962 (North Holland Publishing Company, Amsterdam, Netherlands, 1962), 173–183.

[44] "Procedures Log."

[45] *Ibid*.; "Postlaunch Memorandum Report for MA-6"; "Test 5460, Composite Message Summary"; *Results of the First United States Manned Orbital Space Flight*, 190; "Continuation of MA-6 Debriefing."

[46] *Ibid*.

[47] "Postlaunch Memorandum Report for MA-6."

[48] "Postlaunch Memorandum Report for MA-6." At the moment of Glenn's splashdown, the Post Office issued a special 4-cent stamp commemorating the MA-6 mission ("Transcript of Announcements by John Powers"). For a popular account of the MA-6 mission, with excellent illustrations, see Robert B. Voas, "John Glenn's Three Orbits in *Friendship 7*," *National Geographic*, reprinted from the June 1962 magazine.

[49] *Ibid*.; *Astronautics*, VII (May 1962). In a debriefing session a few days after the MA-6 flight, Glenn said he wished he had known of the supposed heatshield and landing bag problem, so that he could have been listening for sound clues. He seemed to be making the point that the pilot, as the thinking part of the man-machine team, should be allowed to participate in decision making. Scott Crossfield, one of the X-15 pilots, expressed this view well in the immediate post-MA-6 period: "Where else would you get a non-linear computer weighing only 160 pounds, having a billion binary decision elements, that can be mass-produced by unskilled labor?" "Continuation of MA-6 Debriefing"; *Aviation Week*, LXXVI (March 5, 1962).