John Aaron: Oklahoma's Legendary Steely-Eyed Missile Man

*By Andrew L. Warren**

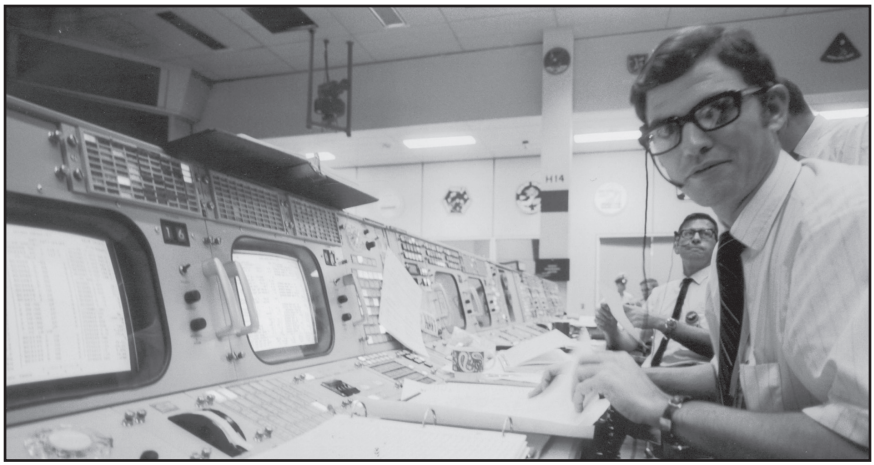
On the morning of Friday, November 14, 1969, John Aaron, a graduate of Vinson High School and Southwestern Oklahoma State University, became a National Aeronautics and Space Administration (NASA) legend.[1] Astronauts Pete Conrad, Alan Bean, and Richard Gordon reclined in their Apollo command module atop a massive Saturn V booster preparing to launch Apollo XII on mankind's second voyage to the explore the moon's surface. The weather was grumpy; the sky would clear, and then cloud over and rain again.[2] But weather reports indicated no lightning, and NASA flight directors decided to launch.[3] Aaron was at his console near Houston in the Johnson Space Center serving as Launch EECOM—the flight controller responsible for the command module's electrical, environmental controls, and communications systems. Flight directors wanted Aaron on duty during the launch phase of spaceflight and soon the reason became apparent.[4]

The most powerful rocket ever to propel humans into space, the Saturn V lifted off with 7.5 million pounds of thrust, more than 6.5 million parts, and more than 1.5 million "systems, subsystems, and assemblies."[5] This massive collection of parts and systems accelerated toward the 17,500 miles per hour necessary to achieve orbit. As the thirty-six story rocket ascended, astronaut Richard Gordon, aboard the Saturn V, advised Mission Control that the sky was getting lighter. But, shortly thereafter, Mission Commander Pete Conrad saw a white light, and heard a long burst of static over the radio. Conrad blurted, "What the hell was that?"[6]

In the command module the spacecraft's master alarm sounded and "almost every light that had anything to do with the electrical system" lit up, warning of countless electrical problems and failures.[7] Along with all of the electrical problems the guidance and navigation system became useless, leaving the monster rocket and three crew members unable to tell where they were going or even to control their flight.[8] Astronaut Alan Bean, veteran of countless fiendish NASA simulations saw "more lights than I had ever seen—ever—in the simulator" and Bean "didn't have any idea what to do."[9] Conrad said, "We had so many lights we couldn't read them all."[10] It appeared that the electrical system failed and the entire spacecraft was running entirely on badly overloaded batteries in a severe "brown-out" condition.[11]

That morning's flight director, Gerry Griffin, had, as did all flight directors, the last word on any matter affecting mission success or safety.[12] He needed to make a quick decision. Apollo XIII Mission Commander James Lovell said of Apollo XII, "When six million pounds of fully fueled, freshly launched Saturn V begins flying out of control . . . . You light the escape rocket at the tip of the booster, accelerate the capsule away from the Saturn, and blow up the whole wayward missile over the empty Atlantic."[13] Faced with the apparently inevitable decision to follow Lovell's dictum and abort the mission, Griffin turned to John Aaron and asked, "What do you see?"[14] Those batteries were all that powered information transmissions from the spacecraft; information controllers absolutely needed to know whether the mission could proceed or whether an immediate abort of the mission was necessary. The information they were getting, however, was no good.

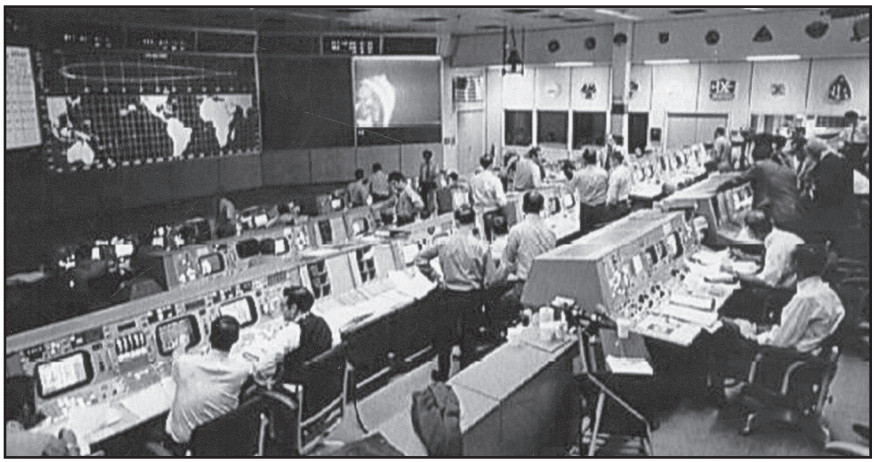
The console in front of Aaron ordinarily displayed data transmitted from the spacecraft. At this time Aaron described the data he saw as "nonsensical." But he had seen the nonsensical pattern before.[15] And his natural curiosity and his desire to understand how things work came to bear on the rapidly developing disaster.



John Aaron at the Electrical Environmental Communications Officer (EECOM) console in Mission Control (photograph courtesy of John Aaron).

One night, about a year earlier, Aaron watched from his console in the Johnson Space Center in Houston as a third-shift team of NASA employees at the Kennedy Space Center in Florida administered a routine test to a command module. Errors at Kennedy Space Center resulted in the malfunctioning of the electrical system in the command module. The system switched to the same type of reentry batteries contained in the command module on Apollo XII—those same batteries with only two hours of electricity that were now overloaded and trying to support the severe brown-out in the flying spacecraft. The data displayed on Aaron's console in Houston during this test was totally "squirrely" and not indicative of the type of readouts expected for the power failure experienced. Aaron assisted the Kennedy Space Center crew in returning the command module to normal operation, but he was unable to let go of the illogical and nonsensical nature of the data he observed during the drop in electrical power. The data piqued Aaron's curiosity and as he drove home that night he thought about it further.[16]

Aaron, who describes one of the qualities of a good flight controller as an almost irresistible urge to understand how things work, decided completely on his own that he would find out what was behind the nonsensical data pattern he saw that night.[17] The next morning Aaron sat down with a member of the command module team from manufacturer North American Rockwell and—just to satisfy his curiosity about how things work—traced the illegible and unintelligible data back through the electrical system, ultimately finding the solution in the soon-to-be-



John Aaron served at the EECOM console from Gemini III to Gemini VII, and then on Apollo VII to Apollo XVII (photograph courtesy of John Aaron).

famous signal conditioning electronics (SCE) switch. Flight Director Gene Kranz, himself a legend around NASA and one of the less than half-dozen men to merit the informal title "steely-eyed missile man," later described this switch as "a small, redundant power supply that provided voltage to forty-six critical instrumentation points in the electrical, booster, control, fuel cell, and cryogenic systems. If the normal power supply fails, an auxiliary power supply can be switched on."[18]

So, on that morning when Apollo XII screamed skyward with a badly malfunctioning electrical system, no navigation equipment, and a very high likelihood of a mission abort, Aaron coolly and confidently told flight director Griffin to "have the crew take the SCE to Aux [Signal Conditioning Electronics to auxiliary]."[19] Nobody knew what Aaron was talking about and Griffin replied, "Say again, SCE to Aux?" Aaron repeated the instruction to Griffin.[20]

Gerry Carr, himself an astronaut, was responsible for relaying all information from Mission Control to the astronauts in Apollo XII, which continued streaking toward space. But Carr did not know what Aaron and Griffin were talking about. He relayed the instruction to the crew in spite of his confusion.[21]

When Mission Commander Pete Conrad, atop the massive Saturn V rocket now exceeding the speed of a rifle bullet, heard the radioed instruction to switch SCE to auxiliary he asked, "What the hell is that?" Ultimately Carr had to repeat the instruction three times. Crewmember Alan Bean, who admittedly had no idea what to do about the cri-

sis, at least knew where the switch was and flipped it to auxiliary as instructed.[22]

Valid transmission to Mission Control returned. Aaron recognized that all three fuel cells supplying electrical power to the spacecraft were knocked offline. He requested the fuel cells switches be reset. The fuel cells came back online ending the spacecraft brown-out and the overload condition on the reentry batteries. Instrument readings returned to normal, warning lights blinked off, the navigation and guidance system returned to full function, and the flight proceeded into orbit.[23] Conrad nervously laughed all the way into space and opined that Apollo XII had been struck by lightning, which eventually proved correct.[24] Three days later Apollo XII, instead of being aborted during the launch phase, made a pinpoint landing on the moon.

Out of more than 1.5 million "systems, subsystems, and assemblies" required to take the spacecraft to the moon, John Aaron alone knew on which one to focus. As a result of his knowledge and split-second performance that saved Apollo XII from imminent abort, Aaron gained "to both the delight and envy of his fellow controllers" status as a "steely-eyed missile man" and became, according to Apollo XIII hero James Lovell, a NASA legend.[25]

Aaron attributes his elevation to the very rare status of steely-eyed missile man to chance. He contends that, to some extent, luck dictated his presence at his console the morning Apollo XII launched.[26] Luck or not, the result of another controller unfamiliar with the nonsensical data pattern or its remedy making the call during Apollo XII's launch is a matter for grim speculation. But, in fact, it was not chance that dictated Aaron's presence at the EECOM's control console. What Aaron did not know was that flight directors had deemed that his presence in the control room during the launch phase of nearly half the Gemini and Apollo missions was necessary. Because it was the most time-critical phase of the mission, Aaron's knowledge and ability to coach flight directors made him nearly indispensable at launch.[27] This was neither the first nor the last of Aaron's control room masterpieces.

Aaron's humble, hardscrabble Oklahoma teenaged years foreshadowed neither the title steely-eyed missile man nor legendary status within the twentieth century's greatest institution of applied science. Aaron's life is, in fact, a classic American success story and a tale worthy of Horatio Alger.

The year the Aarons settled in Greer County, Texas, is not certain, but an 1895 Rand McNally atlas shows the town of Aaron a few miles west-southwest of Altus.[28] In 1896 the US Supreme Court resolved a dispute between the United States and Texas, awarding then Greer

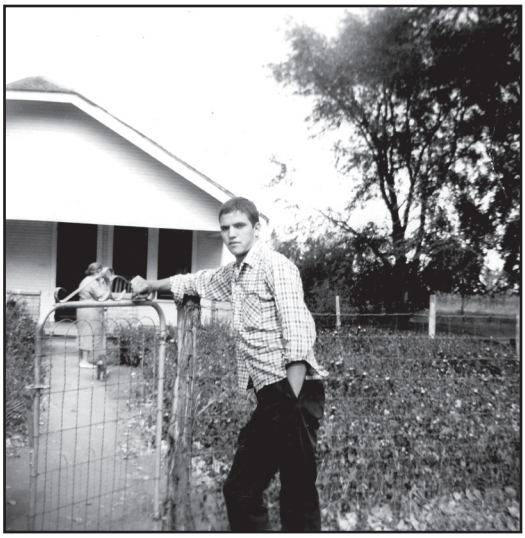
County, Texas, to the United States. This made Greer County the extreme southwestern corner of Oklahoma Territory.[29] Ten years later, the Oklahoma State Constitutional Convention divided Greer County and placed the land then occupied by the Aarons into present-day Jackson County.[30] Among the counties that adjoined the original Greer County was Collingsworth County, Texas, where John Aaron was born in 1942.

Aaron's paternal great-grandfather was a circuit riding Methodist minister who built a small schoolhouse near the now-extinct town of Aaron. He, in turn, gave birth to Aaron's grandfather, who also eventually became a Methodist preacher. Aaron's father, a cotton farmer and cattle trader also named John William Aaron, was born near Altus in 1894, and eventually fathered eight children by Aaron's mother.[31] At the time of Aaron's birth his father sharecropped various plots in Collingsworth County to provide for Aaron's six older sisters.[32] He was forty-seven when Aaron was born. Aaron's father was committed to and driven by his faith.[33]

Aaron's mother, Malicia Agnes Eversole, was a housewife at the time of Aaron's birth.[34] Her life—an Oklahoma story that itself merits telling in full—began in 1904 on a farm in a log cabin near Gonzales, Texas. Agnes, as she was known, had a grandfather who fought in the Texas Revolution and received, as a result, the two hundred acres in Gonzales County where Agnes was born. Her father never attended school and was illiterate. Her mother, however, had eight years of education and continued pursuing knowledge her entire life.[35] Like his Methodist father, Aaron's Baptist mother Agnes was deeply religious and "professed . . . faith in Christ publicly" at the age of twelve. She considered becoming a Christian the most important thing that ever happened to her. The Bible was frequently read aloud in her childhood home and was her earliest reading material.[36]

Aaron's father and uncle left the southwest Oklahoma–Texas Panhandle region, where the family had lived for many years, seeking work in south Texas. There, in 1920, Aaron's father met his mother and they began dating, interrupted by his father's periodic returns to the Texas Panhandle area. In 1922 they were married in Beeville, Texas, shortly after his mother graduated from high school. Aaron's parents spent five peripatetic years in south and central Texas while his father farmed and worked in oil fields and lumberyards until 1927 when the then family of four moved to the Texas Panhandle, where much of the Aaron family was reunited.[37]

Aaron's parents began sharecropping dry-land around Wellington and weathered the hard years of low prices and the Dust Bowl when so



John Aaron and his mother on the Aaron farm near Reed, Okahoma (photograph courtesy of John Aaron).

many left. They endured a tornado that struck their home. Some years the family barely raised enough to eat but, in spite of being dirt farmers, the Aarons were hardy and cheerful souls and made do without taking government relief. Singing, revivals, regular Sunday church, and church offices and activities provided what little entertainment time allowed. The seventh Aaron child and first son, John William, was born in September 1942. He quickly earned the nickname Bud, by which he remains known to his family today.[38]

Things improved and by 1944 Aaron's sharecropping father scraped together the money to buy 160 acres near Quail, Texas. By 1948 Aaron's father's cattle trading and the family's hard work on the farm paid off with the purchase of a better place near Wellington. By this time the older children, who so indulged their only brother Bud, began leaving the nest. The Aarons remained very active in church.[39]

During elementary school years in Collingsworth County, Texas, Aaron was at best an indifferent student. An older sister remembered that he "hated" school because he was so bored and the schools were so bad. Some years he attended only six months of school and sometimes his father physically forced him to attend class, until his father finally just gave up in frustration.[40] But young Aaron, smart enough to "fumble through" and encouraged by the example of his sisters, got by. In the seventh grade, however, he ran into a teacher named Ted Parker who scared Aaron enough that he buckled down and caught up for the first six years he had "blown off."[41] After his seventh-grade year

John Aaron graduated from Vinson High School, Southwestern State College in Weatherford, and began working for NASA in 1964 (photograph courtesy of John Aaron).

with Parker, he reverted to form and admittedly ran with a crowd that almost always "took the easy way out." His education again suffered.[42]

Despite Aaron's casual attitude toward his education, he showed exceptional responsibility to the family farm. While his father traded cattle, Aaron often had full responsibility for the farm as early as age twelve, with his father's full confidence.

Aaron's responsibility and exceptional mechanical acuity became visible at an early age. By the sixth grade he dissected clocks and radios to the annoyance of other family members. His father often relied on him to keep farm and ranch equipment running, even at the age of ten.[43] At twelve he virtually farmed the place, allowing his father to trade cattle. At fourteen he rebuilt the family's farm tractor, again with the confidence of his father who depended on the youth to repair and rebuild the machinery, cars, and trucks.[44] The family's poverty ensured that they only could afford poor and broken down equipment that the teenaged Aaron kept functioning.[45] In fact, Aaron's love for figuring out things mechanical was often the reason for his absence from school. He preferred the farm to class. His sister remembered him frequently checking out books from the library to solve mechanical challenges. He was patient and persistent, and did not get frustrated by obstacles or challenges to his repairs.[46] He just kept at it until he solved them.[47]

In 1956 Aaron's mother was invited to preach at the Nazarene Church in Vinson, Oklahoma. She immediately accepted.[48] During a visit to Vinson, Aaron's father spotted the land known as Booger Hol-

low, thought it perfect for his ambitions, and asked young John what he thought. Young John agreed. With money raised from the sale of the place near Wellington, Texas, John the father was able to purchase Booger Hollow and in January 1957 the Aarons moved there.[49] Aaron felt that the move to Booger Hollow was positive because it separated him from the loafing crowd with whom he associated in Texas.

Not surprisingly, Christianity played a central role, perhaps the central role, in the Aaron family's life. Attendance at revivals provided entertainment. Christian principles were subtly imbued in the children by example from parents of deep faith. Aaron's mother worked on sermons while tending family gardens during the week and they were taken seriously by the children.[50] He never missed church while living in Vinson.[51]

Still indifferent toward attendance Aaron, nevertheless, did well in high school. His future wife, two years behind him in school, hardly knew him because he was so rarely at the tiny school.[52] Family members and friends thought the exceptionally bright Aaron inadequately challenged by school and too bored to attend.[53] Although Aaron graduated with the highest grades in his class of nine, school administration denied him status as valedictorian because of excessive absences.[54] Then, during an emotional postgraduation conversation with his mother, the normally stoic Aaron committed himself to a college education and more serious application of himself. Aaron's mother encouraged him to let bygones be bygones and give it his best shot.[55] His promise was not empty.

Aaron first attended Bethany Nazarene College (now Southern Nazarene University). His ultimate goal was ranching, but he needed money and figured that math and science teachers were in demand everywhere. He planned to teach at a rural school until he could build up a herd of cattle. A counselor at Bethany, aware of Aaron's shortage of either science or math courses at very humble Vinson High School tried to prevent him from pursuing a double major in those subjects.[56] But Aaron was insistent and went forward. He loved and excelled in both subjects at Bethany.[57]

After his first year at Bethany Aaron transferred to Southwestern Oklahoma State College at Weatherford (now Southwestern Oklahoma State University). The $10 an hour tuition reduction at Southwestern attracted him, and he needed to save the money.[58] He also was closer to home where he regularly drove on weekends to help his father on the ranch and earn a little money for his own survival and education.[59] At Southwestern he came under the influence of Professor J. R. Pratt, who encouraged Aaron and advised him to take every math and phys-

ics class he could.[60] Then came a letter from Southwestern graduate James Bates, who had been Aaron's physics lab instructor and with whom Aaron enjoyed a reputation as a straight A student and a good guy.[61]

James Bates went to work for NASA upon graduation, just two years earlier. In a letter to Professor Pratt, Bates advised of job opportunities at NASA and encouraged Southwestern graduates to apply.[62] Aaron and his new wife Cheryl decided it might be a way to generate money to buy a cattle herd. Aaron, a 1964 graduate of Southwestern, applied to NASA, hoping for an interview. Instead he got a job offer for an annual salary of $6,770, which after discussion he took.[63]

Neither NASA nor Aaron wasted any of his time. By 1965 he was the backup EECOM on Gemini III. Even more remarkably, barely five months later, at age twenty-three, he was the lead EECOM on Gemini V.[64] Obviously Aaron's ability and rapid learning skills brought him to the attention of flight control supervisors. Flight Director Kranz was "damn happy" to have Aaron on his shift on Gemini V and it was then that he first helped salvage a mission headed for an early abort.[65]

An overall view of the mission operations control room in the Mission Control Center in Houston, Texas, on June 3, 1965 (22311.S.65.22240, Jerry Elliott Collection, OHS Research Division).

Astronaut Edward H. White II used this device during the first extravehicular activity by an American astronaut outside the Gemini IV spacecraft in June 1965 (22311.S.65.19597, Jerry Elliott Collection, OHS Research Division).

Fuel cells were in their infancy in 1965 and were barely understood. But the "fresh college graduate" of little Southwestern Oklahoma State understood them about as well as anybody.[66] Adequate batteries able to sustain the increasingly long flights were just too heavy. The experimental fuel cells, then, were the heart of the spacecraft. They combined oxygen and hydrogen to produce water, electricity, and heat. These three elements were the lifeblood of the craft. The astronauts could not survive without the water, would die of exposure without the heat, and could not operate the spacecraft without the electricity the fuel cells produced.

Gemini V was the first American spacecraft dependent on fuel cells as the primary energy source for what NASA planned to be the longest manned spaceflight ever at eight days.[67] But as Gemini V reached orbit, instruments indicated that pressure in the fuel cells' oxygen tank was dropping, causing the cells to quit working well before the mission was over. The spacecraft would run out of the electricity, without which it could not fly, and the astronauts in it could not live.[68]

Decisions had to be made quickly. At the time of Gemini V communications were primitive and rapid communications with the capsule only were available during limited portions of limited orbits. Significant portions of some orbits were over unfriendly or hostile nations

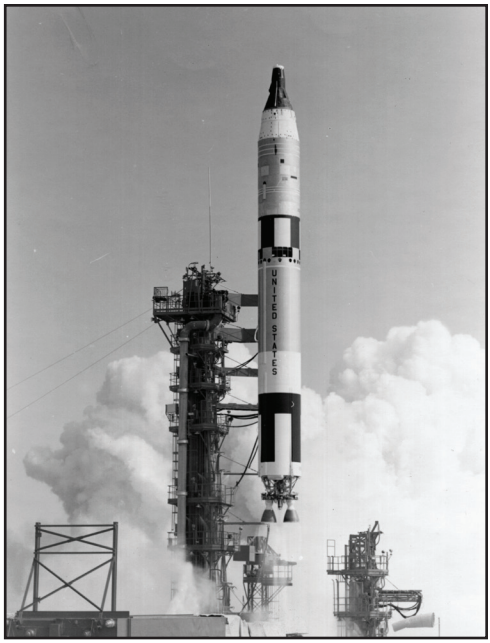
and often far from American forces that could recover the spacecraft. So the orbits in which the mission could be comfortably aborted and the spacecraft brought back to earth came along only sporadically. The decision had to be made quickly or the spacecraft would have to reenter in a random location, on limited battery power, and possibly out of communication with NASA.[69]

Aaron quickly went to work to estimate whether the fuel cells could continue to produce enough electricity to power the spacecraft, whether reduced electrical consumption would be adequate to continue with falling electrical output, or whether a mission abort was necessary.[70] He and engineers at the spacecraft's manufacturer independently concluded that the fuel cells would keep producing electricity but reduced consumption also was necessary. The manufacturer's engineers, however, were slow to commit. Aaron was not. He went to work cutting every system in the spacecraft not necessary to human survival.[71]

Based on his calculations, estimations, and knowledge of the principles of fuel cells Aaron felt that even at pressures well below those theoretically necessary for the cells to continue producing electricity the pressures eventually would rise, at least enough to provide sufficient electricity to continue the mission with cuts in electricity demand.[72] Out on a limb, he gave flight directors Christopher Kraft and Gene Kranz his opinion.[73] They took his advice and, not for the last time under similar pressure, he was right. Gemini V went on to be the longest manned spaceflight in history to that point.[74]

Aaron's darkest day at NASA, however, came a little more than two years later, the evening of January 27, 1967. It was the Apollo I fire, or as it is universally known throughout NASA, "the Fire." He was serving as chief EECOM; the head of Electrical, Environmental, and Communications Officers that would manage the Apollo module. Others just like it would be the first to take humans to the moon. Aaron sat at his console in Houston monitoring manned testing with the new Apollo I spacecraft while it sat on the launchpad at Cape Kennedy. It was a Friday night. Aaron and others were just listening, monitoring, learning what they could as tests went forward.[75]

It was a routine test. But it was, as always, in the explosive environment of pure oxygen. The first audible word that informed everyone that something had gone wrong in the Apollo I Command Module sounded like "fire."[76] The cause remains in question today. What resulted is starkly, tragically clear. A flash fire killed astronauts Roger Chaffee, Ed White, and Gus Grissom before they could be removed. Aaron heard it all over his headset: "We've got a fire in the cockpit! . . . 'We've got a bad fire . . . get us out. We're burning up.'"[77] Aaron had to



Launch of the Gemini IX spacecraft from the Kennedy Space Center's launch complex on June 3, 1966 (22311.S.66.34098, Jerry Elliott Collection, OHS Research Division).

listen to it all, and there was nothing he could do, he was powerless to do anything for the astronauts in Florida from his console in Houston. It affected Aaron "very, very deeply" because he "felt so helpless" just sitting there listening. Forty-five years later it is still difficult for him to talk about the tragedy.[78]

But soon enough, NASA's fortunes changed and with them came Aaron's highest moment at NASA. Not even two years after the fire, NASA redesigned and rebuilt the world's most complex flying machine. After an orbital test of Apollo VII, NASA made the bold decision to send Apollo VIII to orbit the moon as the first human venture beyond earth's gravity. Aaron was in Mission Control as Apollo VIII orbited the moon. He was both awed and deeply moved when the crew unexpectedly read from the book of Genesis on Christmas Eve 1968 as the surface of the moon, for the first time, sped beneath human astronauts in the spacecraft. For Aaron this was an even higher point in his career than being present in Mission Control when Apollo XI landed on the moon.[79] Perhaps the photos of earthrise awed him most of all.[80] Aaron also had the pleasure of hearing a crater on the moon named for him.[81]

The effect of Apollo XI's lunar landing awed Aaron a little less, but was possibly more lingering. As command module EECOM Aaron could actually relax somewhat, and had the opportunity to watch events un-

furl on the moon as his responsibility, the Apollo XI command module, flawlessly circled the moon while the lunar module made its excursion to the moon's surface.[82] It was after Armstrong and Aldrin exited the lunar module and walked on the moon's surface that Aaron left Mission Control and looked up at the crescent moon in the night sky. As he looked up at the moon he knew it would never seem the same again. There were humans there and they were there "against overwhelming odds. . . . That was [Apollo] XI."[83]

Although Aaron received extraordinary responsibility almost from the start of his NASA career—enjoying the highest confidence of flight directors, consistently finding himself on duty in the riskiest phases of missions, and relied upon for crucial opinions—it was four months after man first walked on the moon when he made the split-second decision to "switch SCE to Aux" that saved Apollo XII. But, it was the next act of his career that earned Aaron even greater fame among those knowledgeable about space exploration.

On the evening of April 13, 1970, Mission Commander James Lovell, father of four and America's most experienced astronaut, along with crewmembers Fred Haise, a father of three, expecting a fourth, and bachelor Jack Swigert wrapped up a telecast from 200,000 miles in space and en route to the moon, another 45,000 miles.[84] Less than a year earlier the first attempt to accomplish what had been considered impossible for millennia electrified the world: putting a man on the moon. But NASA made the first and second landings look too easy. On this third mission to the moon everything was going smoothly and according to plan. So smoothly, in fact, that ratings conscious network television, reluctant to risk losing viewers, aired entertainment programming instead. As a result, only coworkers, friends, and relatives in Mission Control at NASA viewed the telecast.[85] With the telecast at an end, friends and relatives left for home. Mission Control then directed the crew to complete some routine tasks.[86]

Had anyone known about a manufacturing defect and assembly damage in one of the fuel cell systems, it would have been fixed long before Apollo XIII ever left for the moon. But Swigert, as ignorant as everybody else of the defect, followed instructions from Mission Control and flipped the switch that prepared the hydrogen and oxygen into a consistency useful to the fuel cells.[87] A bare wire was exposed to gaseous oxygen in the fuel cell system. A spark would set off an explosion.[88]

About ninety seconds later an explosion rocked the spacecraft.[89] Immediately, the ship began yawing and pitching through space, almost out of control. Alarms sounded, numerous warning lights illuminated and gauges indicated a developing emergency. Mission Control in

Houston lost almost all of the data transmitted from the spacecraft.[90] Swigert and Lovell uttered the famous phrase, "Houston, we've had a problem."[91] In Houston, as data transmitted from the spacecraft appeared on the myriad screens at the Johnson Space Center many flight controllers could not believe what they saw.[92] Mission Control hoped it was merely a glitch in the collection of data or its communication to earth.[93]

Among other responses to the frightening events, Mission Control telephoned John Aaron at home to pick his brain. Aaron had specialized knowledge in instrumentation. Caught shaving in preparation for his shift, Mission Control informed Aaron of the data readouts on flight controller's screens. Aaron quickly deduced that the problem was not data collection or instrumentation. According to Aaron the deadly serious problems indicated by the data, or lack of it, were very real.[94] Mission Control began confronting the terrible reality about Apollo XIII.

An oxygen tank exploded and ripped through the section of the spacecraft that also contained the fuel cell systems. The fuel cells that provided water, heat, and electricity that powered every system on the command module had suffered catastrophic damage, rendering them useless. With the fuel cells out of commission the command module began consuming the short-lived reentry batteries.[95] Lovell looked out the window of his spacecraft and saw their oxygen streaming into space.[96] What he saw was likely fatal; the crew would be without adequate oxygen, water, or electricity to survive the return voyage to earth.

The batteries provided the only power to control the spacecraft during its critical reentry into the earth's atmosphere. At the rate the batteries were being consumed they were certain to die days before the astronauts reached the atmosphere. This would leave the astronauts without adequate electricity to control their fiery flight into and through the atmosphere, if they could somehow make it that far on the water and oxygen available.[97] Without electrical power to control its descent, the death of the crew was certain. The crew and Mission Control in Houston soon came to the same conclusion: the Command Module, the only part of the spacecraft capable of returning the crew to earth, was "swiftly dying."[98]

This was a situation completely unlike Gemini V. Gemini V was matter of inconvenient reentry and perhaps a harrowing rescue in unfriendly territory or a long, long wait bobbing in unfamiliar waters. But the Gemini V astronauts were almost certain to survive, at least until they exited the spacecraft.

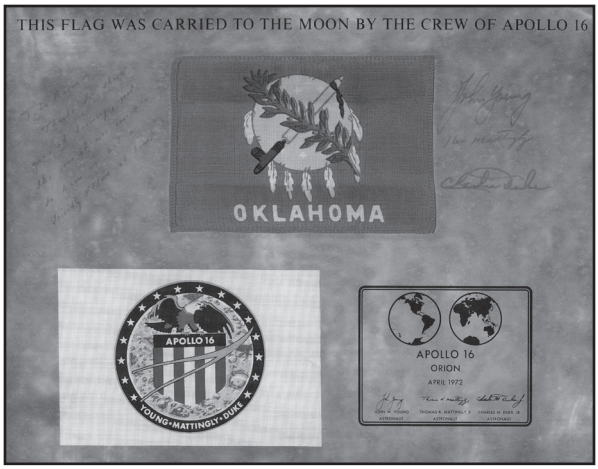
On Apollo XIII it was probable that America was about to lose its first astronauts in space. John Young, a savvy engineer and fearless

astronaut, worriedly watched the oxygen gauge dropping.[99] He thought the crew was lost for sure.[100] Jay Greene, a flight controller, said the environment in Mission Control "was pretty grim. I don't think there was anybody who expected that crew to live."[101] Lunar Module Backup Pilot Charles Duke said his first impression was, "No way we're going to get them home."[102]

In this atmosphere of impending doom and likely death, NASA's lead flight director for Apollo XIII Gene Kranz, the man with ultimate responsibility for crew safety, recognized that the "objective from here on was survival."[103] Kranz turned to Aaron to find electrical power, oxygen, and water to get the command module safely through the inferno of reentry, saving the lives of the three crewmen.[104] Aaron, in turn, felt that perhaps his greatest contribution, although others disagreed, was convincing Mission Control quickly that they were burning up the precious reentry batteries trying to fix something that they could not fix.[105] Aaron did not know what had happened out there two hundred thousand miles from earth, but he deduced from all the telemetry that Mission Control was not going to fix it.[106] Again, flight directors Kranz and Kraft trusted him. "Missions," Kranz says, "run on trust."[107]

Aaron was one of three men that Kranz placed at the top of a massive pyramid of manpower. Tens of thousands of people around the nation reported to work in factories to analyze parts plans and components of the lunar and command modules for electrical consumption. Information was quickly passed up the pyramid.[108] How to use the information ultimately came to rest with Aaron. Kranz said, "Aaron [would] develop the checklist strategy and has the spacecraft resources. He will build and control the budgets for the electrical, water, life support, and any other resources to get us home. Whatever he says, goes. He has absolute veto authority over any use of our consumables." Aaron was the bottleneck through which the information necessary to get the Apollo XIII spacecraft to the atmosphere had to pass. "He was the perfect guy to manage the resources during a crisis. He had a good grasp of not only his spacecraft but of the lunar module and the capabilities of the lunar module."[109]

It should be emphasized that a very large NASA team had a critical, indispensable role in calculations, life-and-death decision making, and other phases of the effort to return Apollo XIII to earth. But it was also the twenty-seven-year-old Aaron who had been given dictatorial powers over the return of the mission up to contact with the atmosphere. Those decisions made his slide rule, intuition, graph paper, and gentlemanly country manner necessary to negotiate electrical consumption with other stubborn flight controllers crucial in determining whether



This Oklahoma state flag, taken to the moon on Apollo XVI, was given to John Aaron by the crew and now hangs on his office wall (photograph courtesy of John Aaron).

there would be enough electricity to control the return through the atmosphere. The margins he worked with were razor thin. They were often "educated guesses" according to flight director Chris Kraft, but ultimately "it was John's brainpower and training that got us to the point where we were satisfied we could get back."[110]

On April 17, 1970, Apollo XIII splashed down safely when four days before so many had thought the crew lost. It was a spectacular, death-defying success for NASA. Yet later, Mission Commander Lovell almost dismissively described the danger his crew faced: "Yes, consumables were going to be a problem but weren't Kranz, and the Tiger Team, and the legendary John Aaron working on that?"[111] Many around NASA and familiar with manned spaceflight generally considered Apollo XIII Aaron's most spectacular success.

In 1973 Aaron was heavily involved in the salvage of Skylab, a project that had very serious objectives and a very serious problem but which took on, at times, an almost comical aspect. At launch a solar shield designed to protect Skylab from solar heating ripped away, apparently displacing a solar panel in the process.[112] Without crew aboard, Skylab would remain unmanned for several weeks with no one to repair it. Without the solar shield, areas of the delicate space station would quickly overheat and other sides would just as quickly cool below tolerances. Film, food for forthcoming crews, temperature sensitive frame members, and equipment would be destroyed, possibly rendering the station useless or causing catastrophic structural damage.

Aaron was on the launch phase when the problem appeared. A spirited debate began with NASA engineers and designers nationwide over

John Aaron worked with the space shuttle and space station programs after his work on the Apollo missions (photograph courtesy of John Aaron).

the solution in which Aaron, the environmental officer, eventually convinced everyone that the spacecraft had to be frequently maneuvered to balance temperatures.[113] Thus began a carefully controlled, sporadic tumble through space that went on for weeks.[114]

The process quickly became fatiguing. Because a solution was being sought, the normal four shifts were reduced to two, with two shifts trying to solve the problem and two shifts controlling the attitude of Skylab. Consequently, EECOMs spent two hours getting briefed then twelve hours at their consoles watching numerous temperature monitors while trying to develop a compromised attitude for Skylab with respect to the sun that would illuminate previously cool spots on the spacecraft to warm them, and darken hot spots to cool them. Then EECOMs had to direct skeptical guidance officers to make the very delicate changes required, requests that elicited the response "EECOM, do you know what the hell you're doing?"[115] The process was repeated to some other attitude. The exhausting process required enormous concentration.[116]

Once Skylab was repaired by an astronaut crew Aaron found that, for the first time in his NASA career, he was a little bored. Skylab was functioning perfectly, which meant almost nothing to do. He also became concerned that he might be getting a little conservative for a flight controller's console. He found himself studying material on the new, experimental design for the space shuttle, and it led to a startling change in direction for a physicist-mathematician.[117]

Aaron was transferred to the team developing control computer software for the space shuttle.[118] Aaron attended college at a time when computers were a distant prospect for a student at Southwestern Oklahoma State College. Primitive forms had been used in the Apollo project, but Aaron knew little to nothing about computer software when he was moved to the space shuttle project, yet he mastered it so well and so quickly that by 1981 he became chief of the project.[119] Although countless modifications were made over the life of the space shuttle, the core of the software that flew and controlled the space shuttle during each mission, developed under Aaron's supervision, was used right to the end of the project.[120]

The single speed bump in Aaron's career followed. In 1989 Aaron was put in charge of the space station, which was a large, extremely complex vehicle administered by a dramatically more bureaucratized NASA badly beset by pork-barrel politics and internal provincialism.[121] Thirteen countries were involved in design and production. Systems in the space station ran from one end of the massive ship to another, requiring design meetings in gymnasium-sized conference rooms.[122] Cost overruns totaled $500 million and Aaron inevitably got the blame, especially from Texas Senator Robert Krueger who demanded Aaron's ouster. Under pressure from inside NASA and Krueger, Aaron resigned from the management of the program.[123]

Upon stepping down Aaron was reassigned to head the Systems Engineering Office at the Johnson Space Center. Such was NASA's opinion of him that less than one year later, in February 1993, he ironically was assigned to lead an engineering "tiger team" to redesign the space station, the results of which are orbiting today as the International Space Station.[124] Aaron retired from NASA in April 2000 with a litany of awards and recognition on his resume.[125]

Aaron's extraordinary career would raise questions even had he grown up in a suburban neighborhood with scientist parents and siblings and had attended the best schools. As it is, the questions are even more pronounced. Undoubtedly native intelligence, probably genius, contributed to his successes. His parents' confidence in him from his childhood no doubt engendered confidence in him. From the day he made his emotional, introspective commitment to his mother that he would no longer dither away his educational opportunities he made good on his word. Southwestern Oklahoma State College and the motivation and instruction of Professor J. R. Pratt also factored significantly into that promise and the equation that resulted in Aaron's superb career. Aaron felt that he had good mentors early in his career.[126]

Extreme hard work ultimately brought Aaron's career to fruition. Fellow flight controller Jerry Bostick reflected that Aaron spent "hours and hours" preparing for flights.[127] Aaron's wife—who would know—reflected that he worked "very, very long hours" and "analyze[d] everything." Aaron credits his wife with keeping him at NASA when a handful of times the workload and the overwhelming nature of Houston and the NASA culture to a country boy just about ran him out of Mission Control.[128] He came to thrive on it all thanks in part to the former Cheryl Hart of Vinson.

The astronauts were not the only national heroes of the space program. The physical courage and intellect of the astronauts is not diminished by recognizing the brilliance, responsibility, and life-or-death, split-second decision making pressure of the flight controllers. The legendary, steely-eyed missile man from Vinson, John Aaron, is foremost among them.

Endnotes

[*] Andrew L. Warren holds a law degree from Washburn University and a master's degree in history from Fort Hays State University. He serves as associate professor of criminal justice at Western New Mexico University where he also teaches occasional courses in American history.

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[23] John Aaron, e-mail message to author, January 3, 2014.

[24] Alan Bean, interview by Michelle Kelly, JSC Oral History Project, June 23, 1998, accessed January 30, 2011; DeNooyer, *Race to the Moon.*

[25] Lovell and Kluger, *Lost Moon*, 159, 212; Gerry Griffin, interview by the author, June 24, 2013, Kerrville, TX, transcript, 1. The term "steely-eyed missile man" is not an official designation, but it is an unofficial appellation given to very few NASA employees who have inspired awe among fellow personnel in Mission Control.

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