CANADA'S SPACE MEDICINE PIONEERS: OWEN COONS

By Lydia Dotto

The 1960s—Tragedy and Triumphs in Space

We didn't know what was wrong, but it was an eerie quiet that wasn't natural, and we were all very concerned at the Control Center. Just a few minutes later—it seemed like an eternity—Guenter Wendt, who was the pad leader, came up on the emergency communications system just screaming. His voice was about two octaves above normal and just yelling, "Oh, my God, Oh, my God! It's terrible, it's terrible! Oh, my God!"

- Dwight Owen Coons, deputy medical director, NASA Manned Spacecraft Center, Houston[1]

Apollo 1 mission patch. Image: NASA.

At 6:31 p.m. on January 27, 1967, Dwight Owen Coons, sitting at a medical console in Mission Control, was about to get the worst possible news that a NASA flight surgeon could hear: fire had broken out in the Apollo command module being tested on the launch pad at the Kennedy Space Center and the three astronauts who were slated to fly the first Apollo mission—Virgil (Gus) Grissom, Edward White and Roger Chaffee—had been trapped inside.

The crew never had a chance; the fire burned furiously in the 100% oxygen atmosphere of the spacecraft and the astronauts were unable to open the hatch fast enough to save themselves. It was all over in minutes—the first, and one of the worst, tragedies of the U.S. space program.

For Coons, a former Canadian military doctor, it was the grimmest day of his six-year tenure with NASA, then a fledgling organization struggling to fulfill President John F. Kennedy's pledge to reach the moon before the end of the decade. A pioneer in operational space medicine, Coons was directly involved in overseeing the health and safety of America's first astronauts as they were first learning how to live and work in space.

He had a front-row seat for the early triumphs as well, such as the first spacewalk by an American astronaut. As deputy medical director of the Manned Spacecraft Center (now the Johnson Space Center) in Houston, he was a key member of the NASA team during the Gemini and Apollo programs until he left in 1969, the year of the first landing on the moon. Consumed

[1] The interview on which this article is based is from NASA's Johnson Space Centre History Collection "Great Moments in Space Medicine" series. Done in 1986, it was one of a series of interviews with NASA doctors and medical experts.

by the demands of the punishing flight schedule, he once commented: "We tend to remember our lives, date our lives, by the flight. Not by the calendar, but by the flight."

Military Doctor

Born in Hamilton, Ont., in 1925, Coons graduated from the University of Toronto medical school and joined what was then the Royal Canadian Air Force (RCAF) as a flight surgeon. He became interested in space medicine before it really even existed as a medical discipline. As early as 1951—a decade before the first human would fly in space—he attended a conference in Texas that focused on the physiological consequences of flying to the highest reaches of the earth's atmosphere.

Former Deputy Medical Director at the NASA Manned Spacecraft Center, Dwight Owen Coons. DND Photo #PL 2728.

At the time, he was interested in medical issues related to pilots trying to escape from a new generation of high-flying aircraft. "I had been working on high-altitude and high-speed escape, ejection seats, and cabin pressurization systems," he said. "We all knew that we had some real problems about getting out of our new high performance aircraft—what we called high performance at that time. We were concerned about the safety of the pilots and their survivability in the event of cabin pressure loss or the loss of their vehicle. We were concerned…how they would get to the ground alive."

It was not surprising, therefore, that he was intrigued by talk within the aviation medical community about the possibility that humans could fly into space. Though the talk was still "very conjectural"—this was even before the first satellite, Sputnik, was launched—he viewed the people who were doing the conjecturing as farsighted and he eagerly sought out opportunities to meet with them, to learn what they were doing and to share with them the results of aeromedical research being done in Canada.

He had every intention of remaining in the Canadian military. "I had no thought that I would ever wind up in the space program, nor had I a thought of coming to the States for any reasons other than medical liaison work." He described himself as a "grassroots, field-type flight surgeon. I worked with the air crews out on the line, and I worked with some of the people who were trying to design our new aircraft, to help them on the physiological and human factors design." He described himself as their ferret. "They had problems; they had questions; they wanted to know what's going on. I'd go out and find what was going on and come back and tell them."

After a period of overseas duty in Europe with a wing of F-86 fighter pilots, his boss, Director General Medical Services Gordon Corbet, encouraged him to become a specialist in aviation medicine. As a result, in 1955, the Canadian government sent him to Harvard University to get a Masters degree in Public Health. It was at Harvard that he had a fateful meeting with US Air Force flight surgeon Charles (Chuck) Berry, who would later become NASA's medical director of manned space flight. "Chuck Berry and I lived near each other out west of Boston,"

said Coons. “We car-pooled together and our families picnicked together and we got to know each other quite well.”

Owen Coons checks over a young patient, February 1953. DND Photo # PL-62796.

After a year at Harvard, Coons returned to Canada and began working at RCAF headquarters in Ottawa on projects related to aviation medicine; flight safety, including accident investigation and prevention, and human factors in the design and development of new aircraft. Three years later, he was posted to Washington, D.C. as a member of the Canadian Joint Staff, a military office in the Canadian embassy. “It was a really choice job and I was delighted because it was giving me an opportunity to pursue this work of following aviation medical research from the States and reporting back to Canada.”

Coincidentally—and much to his surprise—Coons discovered that Chuck Berry had also been sent to work in Washington, where he became Coons’ primary contact in the Office of the Air Force Surgeon General.

The U.S. space program was just gearing up in the late 1950s and Canadian military officials were aware that many of the doctors working in the program were being borrowed from the military. They asked Coons to investigate opportunities for Canada to participate. “Our Director General felt that it would be appropriate to have some Canadians have an opportunity to go in and help like the American Armed Forces medical officers were doing, to try to keep up with the program,” said Coons.

He prepared a report identifying potential roles for two Canadian medical officers in the space program. Unfortunately, he was told that Canada didn’t have anyone to fill those slots at the time, that “we’d just keep it in mind and if we had someone, we would approach them again and see if they had a need.”

When he met with General Charles Roadman, who was head of NASA’s medical operations at the time, to tell him this news, Roadman surprised him by asking if he would consider coming to work for NASA. Coons said he hadn’t even considered the idea; he was planning to make his career in the RCAF and, in fact, was about to be re-assigned back to

Canada. He was not overly happy about the assignment, however, because he was slated to do a tour of duty with the Canadian Navy.

At the time, Canada was unifying the three branches of its armed forces—the Army, Navy and Air Force—and the process had started with the doctors and chaplains. "We had already unified the Medical Services of all three armed forces into one medical service," Coons said. "The idea was to make a better career for physicians and it was a step toward unifying all the armed forces, which they eventually did."

Coons wasn't enthusiastic about unifying the Medical Services, believing it would distance him from the pilots he was caring for. "I had gotten to know a lot of very fine pilots and I felt a kinship with them; I was their doctor and I hated to be sequestered from them, taken away from them."

Roadman's offer of a NASA job intrigued him, not just because of his disenchantment with the prospect of unification, but also because it was "a unique opportunity to do something really new and different." On the other hand, the fact that he was being sent to the Navy meant that he was being groomed for advancement. He believed he was on track to eventually become the Surgeon General of the Canadian forces and "we all sort of tacitly understood that I had to get cross-serviced…so that when it became my turn to take the responsibility of the Surgeon General, I'd be prepared. It was a unique opportunity there, too, so you can see my dilemma. I had a career in Canada and I really didn't want to throw the career over."

He agreed to fill out an application for a NASA job with the understanding that Roadman would keep it quiet. Coons did tell Chuck Berry, however. As it turned out, Berry had just been assigned to take charge of medical operations at the Manned Spacecraft Center in Houston. "He said, 'I think you ought to come with me.' Chuck and I had in mind that we'd go to Houston…and set up the shop there." This idea greatly appealed to Coons and he told Roadman that's what he'd like to do.

Because he was a foreigner, it took time to process his application. Coons returned to Canada in August 1962 and was assigned to work on an aircraft carrier at sea. In January 1963, when the carrier put into port in Halifax, Nova Scotia, he got a telegram from NASA with a job offer to work in Houston. He accepted immediately, but it took another six months of paperwork before he could resign from the RCAF.

"You had to get royal assent at that time to resign the Queen's Commission. It was just tedious and frustrating to not be able to say, 'Look, I'm giving you 30 days notice. Goodbye!' But I finally did get out in July of '63. I packed the family up and we headed for Houston. I got to Houston in August of '63 and took up my post there."

He became the deputy medical director of the space center, working directly for Berry, who had already been there for about a year. "We started…right into it with both feet."

The Gemini Program – Preparing for the Moon

Coons arrived in Houston just after the end of the Mercury flights, which represented the first phase in NASA's effort to reach the moon. The second phase, the Gemini program, was just beginning. While Mercury was designed to answer some of the most basic questions about whether humans could live and work in space, Gemini was more focused on developing the procedures and hardware needed to get humans to the moon. Its major medical goal was to ensure that astronauts could survive and work effectively for the roughly two weeks it would take to get to the moon and back.

It was an ambitious program with a punishing schedule, one that would place extraordinary demands on the human body. And, while Mercury had proved that microgravity was not immediately life-threatening to humans, it had also provided the first evidence that the human body changed physiologically in response to weightlessness in ways that were not well understood. Space doctors were still exploring the implications for the long-term health and safety of astronauts and for their ability to carry out their duties, and Coons was on the front lines of that effort.

One of his first tasks, in July 1964, was to trek out to the Canary Islands with a NASA flight control team to help check out components of the Gemini ground tracking network. Today, communications between Mission Control and astronauts on the space shuttle or space station are largely relayed through communications satellites, but in the early days, if NASA wanted ongoing contact with crews in space, it needed a network of ground stations around the world to pick up signals as the spacecraft flew overhead.

Owen Coons (right) in Mission Control with Chuck Berry (left).

Coons was primarily concerned with the equipment that would allow him to monitor the medical condition of the astronauts. The tests involved simulations using an aircraft that flew overhead and sent taped data to the ground station. This data mimicked the data that would be transmitted from a spacecraft. These simulations often deliberately included "glitches" and problems to test the troubleshooting capabilities of the ground crew and equipment.

"The tapes could be made in such a way that you could just absolutely overwhelm the ground tracking engineers and medical officers," said Coons. He recalled that one simulation was particularly rife with problems, and the fact that the tropical tracking station had no air conditioning didn't help. One of the engineers finally "stood up in absolute frustration, ripped off his shirt, threw it over the console and sat down in a pool of sweat because he couldn't handle it. Of course, you hoped that you'd never run into a situation that critical in the real monitoring mode from a real spacecraft. But we did have quite a good time. The equipment checked out beautifully; certainly we had no problem with the medical part of the console. Those were the prototypes for all the other tracking stations for the Gemini program."

First American Spacewalk

The Gemini astronauts started flying in March 1965, with Gemini 3. Unlike the one-man Mercury vehicle, the Gemini capsule was large enough for a crew of two. Gus Grissom was the commander and John Young was the pilot. Medical objectives on the flight included an evaluation of the biomedical monitoring instruments the astronauts wore on their bodies that transmitted data to the doctors on the ground. The personal hygiene system on the spacecraft was also tested.

The most memorable quasi-medical incident on that flight involved a corned beef sandwich from "Wolfe's", a restaurant near the launch site in Florida. It was acquired by another astronaut, Walter Schirra, and smuggled on board by Young, who handed it to Grissom during the flight. Not wanting to risk a blizzard of floating crumbs in the cockpit, Grissom ate only a few bites.

The NASA docs weren't pleased. "The concern was that…there'd be bits of bread floating around," said Coons. "We were worried about accidental inhalation of particles of food. And, of course, we weren't exactly sure how long before the flight it had been made and how it had been stored in the meantime and, being corned beef, whether there might be some bacterial growth on it that might make them sick."

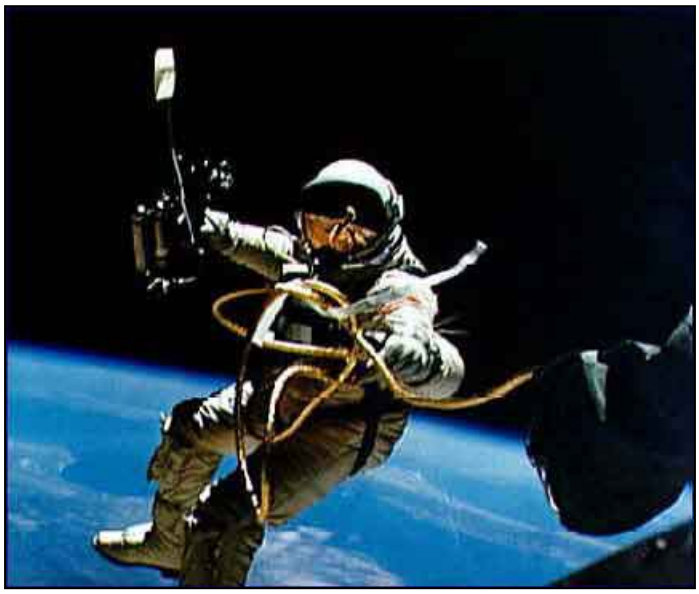
However, it was a short flight—only three orbits lasting just five hours—and nothing untoward befell the crew. The prank nevertheless caused a considerable fuss—all the way up to Congress, in fact—and resulted in stringent new rules about what astronauts could and could not take onboard their spacecraft.

In March 1965, Coons was also preparing for the Gemini 4 flight, scheduled for June. The four-day mission would be the longest-duration flight in the American space program up to that time; in addition to the technical objectives, it was intended to evaluate crew rest, work, and eating schedules. It was around this time that Coons got a call from George Low, then deputy director of the Manned Spacecraft Center, who told him that a Russian cosmonaut, Alexei Leonov, had just performed the first spacewalk. "We were pretty surprised at this and we were concerned that they had pulled another 'first' on us," Coons said. (The Russians had been the first to orbit a satellite—Sputnik in 1957— and the first to put a man in space with the April, 1961, flight of Yuri Gagarin.)

The Americans weren't planning their first spacewalk (otherwise known as extravehicular activity or EVA) until Gemini 6, scheduled for late 1965. Low wanted Coons' advice on whether they could move it up to Gemini 4, which would be flown by astronauts James McDivitt and Ed White. Coons told him it would be a real challenge because the environmental control system that would deliver oxygen and maintain atmospheric pressure in the EVA astronaut's space suit was not ready. "It was a fairly sophisticated device and it wasn't qualified as yet, because it wasn't planned for until around November or December, and here it was March."

Low wanted to know if they could try another approach—for example, rigging an umbilical cable that could provide the necessary oxygen and atmospheric pressure. Coons replied there would still have to be a backup oxygen system mounted on the astronaut's suit in

case the umbilical failed, as well as equipment to regulate the suit's pressure. He agreed to talk with the engineering and medical people to see if it could be done.



On June 3, 1965, Astronaut Edward White 11 became the first American to leave the safety of his spacecraft and walk in space. Image: NASA.

"What it finally boiled down to was that we would try to design, in-house, a chest-mounted pressure controller and combine that with an emergency source of oxygen. And that an umbilical would be built that could be plugged into the spacecraft and plugged into the suit. The thing was put together and then we started testing it secretly and privately." Late at night, they put Ed White, the astronaut designated to do the spacewalk—and, coincidentally, Coons' next-door neighbour—through tests with the equipment in a decompression chamber.

When they were satisfied it was "man-rated"—that is, safe for astronauts to use—Low and his boss, MSC director Robert Gilruth, informed NASA headquarters what they'd been up to. "I guess the headquarters people had a little bit of a fit, but they came down and we had a design review conference in Gilruth's office and they bought off on it," said Coons. Thus it was that a spacewalk was slotted into the Gemini flight schedule roughly six months earlier than originally planned.

The Problem of Decompression Sickness

For Coons, this created an immediate medical issue: how to ensure the astronauts did not experience decompression sickness (otherwise known as "the bends") when the spacecraft was depressurized for the spacewalk. Unlike the space shuttle and the space station, the tiny Gemini spacecraft did not have an airlock that would allow one astronaut to go outside while the other remained in a pressurized environment. With crew members suited up, the Gemini spacecraft was depressurized and White would open the hatch and float out on his tether.

The symptoms of decompression sickness, which is caused by nitrogen bubbling out of blood and tissues, range from muscle and joint pain, shortness of breath, and severe headaches to chest pains, double vision, and comas. Left untreated, it can cause death. Nitrogen saturation of body tissues results from breathing air (which is 78% nitrogen and 21% oxygen) at 14.7 pounds per square inch (psi) —the atmospheric pressure at the earth's surface. When someone moves to a lower-pressure environment, this dissolved nitrogen is released, sometimes very rapidly if the pressure change occurs too fast.

On Earth, decompression sickness can afflict divers who ascend too quickly from deep waters, where the external pressure on their bodies is greater than it is at the surface. Doing a

spacewalk is physiologically equivalent to surfacing from a deep dive because space suits are pressurized at a lower level than inside the spacecraft or on Earth. In the case of Gemini 4, the spacecraft was pressurized at 5 psi with a pure oxygen environment. The suit Ed White would wear during his spacewalk was pressurized at 2.75 psi, also with a pure oxygen breathing system.

One way to minimize the risk of decompression sickness is to have astronauts breathe pure oxygen for several hours before the spacewalk, which flushes nitrogen out of their bodies. This is what the Gemini 4 crew was going to do, but there was a problem: the spacewalk was scheduled too early in the flight to give them enough time breathing pure oxygen in the spacecraft.

"The plan was to do the walk on the second revolution, very quick in the flight," said Coons. "Get it done, get it over, and get back on the old flight plan. You've got the crew on the ground, initially, breathing air at 15 psi. They go into the spacecraft for the count and, gradually, the spacecraft atmosphere is being brought up to 100% oxygen during that period. Then you launch, you do one revolution, which is 90 minutes; then, on the second revolution, maybe 45 minutes later, you're going to decompress the spacecraft and have Ed White go out in the suit that is at 2.75 psi.

"So they go from 15 psi air in a fairly short time to 5 psi cabin pressure on 100% oxygen to 2.75 psi 100% oxygen and there's not enough time for all the nitrogen to wash out. You can't get rid of enough nitrogen in that time to obviate the risk of having bends and we certainly didn't want to have that. So we had to develop a protocol for having the crew pre-breathe oxygen with carry-around oxygen bottles and a face mask for about two and one half to three hours prior to flight."

This protocol complicated the logistics of preparing the crew immediately before the flight. "We were having problems about when the crew would be wakened, when they would eat," said Coons. They had to eat first, and they couldn't wear oxygen masks for that. Then they had their final pre-flight and weather briefings, followed by the process of getting into their suits, riding out to the launch pad and getting into the spacecraft.

"This pre-breathing requirement was kind of getting in the way of things," Coons acknowledged. He recalls a confrontation with astronaut Alan Shepard, who was managing the crew's pre-flight activities at the Kennedy Space Center (KSC) in Florida. Shepard announced that they were going to cut the pre-breathing period. "Al was proposing to shorten it because he wasn't going to have the crew encumbered with these masks and carry-around oxygen bottles through this period. I just about had a fit. I said, 'Look, Al, we've got an agreement and you know we've got to stick to it. It's part of the protocol and the mission rules and we're going to go by it.' "

Coons was wary about shortcuts because pre-breathing isn't an exact science. "You can't know how much nitrogen you've got rid of exactly and our collective best judgment was what we agreed upon." He told Shepard he wanted to hear from the crew whether they were willing to do this and also suggested a conference call in Houston with Chuck Berry and Deke Slayton, the head of the astronaut corps, to hash the matter out. "The conference call didn't come and didn't come and finally, several hours later, Al came back down to the medical offices and said, 'I've decided that they're going to pre-breathe as we agreed.' He never made the call, and I never did think afterwards of talking to Ed White about it. It never occurred to me whether he and Jim McDivitt knew anything about this. It was a closed subject by then and we were too busy."

Confrontations between the astronauts and the doctors were not unusual in the early days of the space program; the test pilots who made up the astronaut corps sometimes balked at

jumping through the hoops the medical people wanted. Coons speculated that Shepard may have been pushing him to justify the pre-breathing protocol. “He was just bullying me, I think, or twisting my tail, to see if we’d ‘give’ or see if we were convinced of the necessity of it. I don’t know why, really; that’s my guess.”

In the end, White didn’t even do the spacewalk on the second orbit because he and McDivitt were unable to get everything ready in time; instead, he went out on the third revolution. This delay put Coons in a time squeeze; he had to catch a plane back to Houston in order to serve as the flight surgeon in Mission Control on the 11pm to 7am shift (Gemini 4 was the first flight to be controlled from Houston, rather than from KSC).

It was decided Coons would head out to the airport and wait to see what happened on the spacewalk. “I listened to the walk on a portable radio in the airport and, fortunately, I didn’t have to get on the airplane till it was all over. Had there been any problem, I could have whistled back…but there was no problem. They did the walk successfully so I got on the airplane and came back to Houston and picked up my shift that night. It all went very well.”

Heart-Stopping Countdown

The same could not be said for the next flight, Gemini 5, flown by Gordon Cooper and Charles Conrad. This was an eight-day mission and one of its primary goals was to evaluate the effects of weightlessness on the crew. That was nearly all that was accomplished on the mission; problems with the spacecraft’s fuel cell caused a serious power shortage that forced most of the mission’s technical objectives to be abandoned.

This had a direct physiological impact on the crew: they were miserably cold because much of the equipment on board was powered down to conserve electricity. Equipment was a major source of heat and, without it, “the spacecraft got very cold, indeed,” said Coons. The fact that the spacecraft spent half of each orbit shielded from the sun by the earth only made the problem worse. He could see evidence of what this was doing to the astronauts on the medical data transmitted to Mission Control. “The crew was shivering. You could see the evidence of shivering on the traces that we were getting on the ground.”

Launch of Gemini 5, August 21, 1965. Image: NASA.

On this mission, there was some tension between the astronauts and the doctors over pre-flight medical tests. “We had had some difficulty in getting some blood samples from Gordon Cooper and he’d complained bitterly about the needle jabs that he had received prior to the flight at the Cape.” This apparently made his arm tender and caused him discomfort because of chaffing from the space suit. “It created some ill will between the crew and the medical people because of the discomfort,” said Coons. “It gave the crew an opportunity to complain about pre-flight testing.”

Coons acknowledged that Cooper “had some basis for complaint,” but emphasized that pre-flight testing was necessary. “We didn’t have any alternative. The thing was to do it well, and I have to say, from a medical point of view, we didn’t really do that well for that flight.”

The next mission—Gemini 6, flown by Walter Schirra and Thomas Stafford—was also trouble-plagued. So much so that the delays caused it to be launched out of sequence, after Gemini 7, which carried Frank Borman and James Lovell. Gemini 6 was only a one-day mission,

while Gemini 7 lasted 14 days; the missions were overlapped so the two spacecraft could test rendezvous procedures that would be needed in the Apollo program.

The most heart-stopping moment of Gemini 6 occurred before it even got off the ground. The launch vehicle automatically shut down on the launch pad; however, there was a false indication of lift-off in the cockpit that should have—but didn't—prompt the crew to use a risky ejection seat system. (The Gemini spacecraft, unlike the previous Mercury vehicles, did not have a small rocket motor on top that could lift the crew capsule up and away from the launch vehicle in an emergency. This was because of the equipment needed for the docking maneuvers.)

It all happened within a few seconds. First, two small rocket motors fired up to drive the pumping of fuel into the main engines, an action that produced a visible puff of smoke and steam from the bottom of the launch vehicle. At this point a clock in the cockpit started running, an indication to the crew that lift-off had occurred; but, in fact, the launch vehicle wasn't moving. The computers detected a problem and stopped the flood of fuel into the main engines, shutting the rocket down.

According to a NASA history document called "On The Shoulders of Titans", "one of the most suspense-filled moments in the whole Gemini program followed. If ever there were a time to use the spacecraft ejection seats to get away from a cocked and dangerous rocket, this seemed to be it…if the clock were right, then the vehicle had left the ground. Had it climbed only a few centimeters, the engine shutdown would have brought 136 tonnes…of propellants encased in a fragile metal shell crashing back to Earth. There could be no escape from the ensuing holocaust."

Mission rules called for the crew to eject under such circumstances. But commander Wally Schirra, a very cool veteran test pilot whose hand was on the "D-ring" that would punch the astronauts out of the spacecraft, chose to believe the seat of his pants rather than the clock. He could tell the vehicle wasn't going anywhere and, as a result, neither did they.

Coons was sitting at the medical console in Mission Control while this was going on. It was, he acknowledged, "a fairly anxious time. We used to talk about it being 'sweaty palm time' because the palms of your hands would start to perspire. We knew that there were those pump engines running. If you glanced at your monitor, you could see [the launch vehicle] on the pad, billowing this smoke and steam. We had this pump engine start; then we had an indication for liftoff and then shutdown. Well, that's a disaster if that happens. Wally knew enough from his previous experience and from, I guess, figuring it out in a split second, that he wasn't flying, so he didn't eject.

"Everyone was in a panic in the Control Center because the Control Center also gets the indication of liftoff and shutdown, in that order. We all looked up at the screen and there's the old bird sitting right there, calm as you please, the smoke all disappearing and being blown away by the wind; and Wally and Tom talking to the flight director and everything's okay."

Ejecting would have been quite an adventure. "The doors are blown open and both seats go, because, if you send one seat before the other, you burn the guy who's left behind with the rocket motor of the seat that's going. So you both have to go together," said Coons, who added that the system was designed to deposit the crew some "600 feet away from whatever bad thing was going on at the pad. But we never tested it, so we didn't know if it would really do the job or not. That ejection system, as far as I know, was never man-rated."

A photograph taken by Gemini 7 crewmembers that shows Gemini 6 in orbit 257km above the Earth. Image: NASA.

This was the second launch delay for Gemini 6. The first occurred because of a post-launch loss of an unmanned craft known as the Gemini Agena Target Vehicle that was originally going to be used for the rendezvous and docking procedures. (This was to have been a rehearsal for a procedure that would be conducted in earth orbit during the Apollo moon missions. Before it could leave for the moon, the Apollo command module would have to turn around and dock with the lunar module, the spindly craft that would land on the moon's surface, to extract it from an enclosure that protected it during launch.)

In the aftermath of the setback caused by the Agena failure, a plan was hatched to launch the Gemini 7 crew first, then the Gemini 6 crew shortly after, and have them practice rendezvous procedures with each other. Launching two missions so close together was a considerable technical challenge and the first reaction of senior NASA officials to this proposal was, 'It can't be done.' But, in the end, it could be—Gemini 7 was launched on Dec. 4, 1965 and Gemini 6 followed on Dec. 15.

Gemini 6 stayed up only one day, just long enough to do the rendezvous tests. Schirra and Stafford had argued for a spacewalk as well—even suggesting swapping two astronauts between the spacecraft as a simulation of a space rescue. This idea "met a pronounced rebuff" from Gemini 7 commander Frank Borman, according to "On the Shoulders of Titans." It quoted Borman as saying: "Wally could have had all the EVA he wanted but I wasn't going to open the hatch." The proposed spacewalk presented serious risks, since the astronauts would have to detach their life support systems from each spacecraft and rely only on their backup systems during the transfer. "One little slip could have lost the farm," Borman said.

While the two Gemini spacecraft were in close proximity, the astronauts took close-up pictures of the vehicles, particularly the aft end where Gemini separated from the rocket booster that launched it into space. Coons was concerned when he saw torn pieces of aluminum back there, because, on an upcoming flight, astronaut Eugene Cernan was scheduled to do a spacewalk that would take him near this part of the spacecraft. "There were a lot of jagged edges around, very sharp stuff that could cut a suit. They got some good pictures…so that was helpful."

The dual mission presented challenges for the ground controllers because Mission Control in Houston did not have a redundant system to monitor data, including crew medical information, from two spacecraft simultaneously. Fortunately, the remote tracking stations that Coons had helped set up around the world did have backup systems, which were used to relay data from the second spacecraft to Houston.

A Two-Week Camp-Out in Space

Gemini 7 was a crucial flight from a human factors point of view. It would be the only flight prior to the Apollo program that would last as long as the lunar missions were scheduled to run and its major objective was to evaluate the effects of such a long stay in microgravity on the crew. The NASA history document noted that "they needed to figure out how to live in such confined quarters for so long and still perform useful work. As successful as the preceding missions had been, they still wondered if six extra days could be safely added to the flight. Edward White and James McDivitt had been fatigued; Cooper and Conrad, tired and bored. Both crews stressed the impossibility of sleeping alternately. Borman and Lovell resolved to sleep and work together."

As it turned out, Borman didn't get much sleep. This was not surprising; Coons noted that, on most flights, the commander didn't sleep as well as his crewmate, known as the pilot. "We could pretty well tell from their respiration rate and their pulse rate whether they were asleep or awake. The command pilots didn't rest very much during their quiet periods. The pilots generally did, and that was certainly true in the Gemini 7 flight when Frank was awake a lot and Jim was asleep a lot. It must have been a very tiring flight for Frank, but he was tough, determined, and he wouldn't be letting anything like that get to him at all."

Gemini 7 carried a higher proportion of medical experiments than any previous flight. The astronauts were not very enthusiastic about some of them. For example, they were concerned about a study of in-flight sleep patterns, which involved taking electroencephalographic measurements of their brain waves. Aware that EEG readings could reveal other medical problems, the crew was concerned about how the data would be interpreted. They were also less than thrilled with another study that required them to keep track of everything that went into and came out of their bodies for the entire flight, as well as nine days before and four days after.

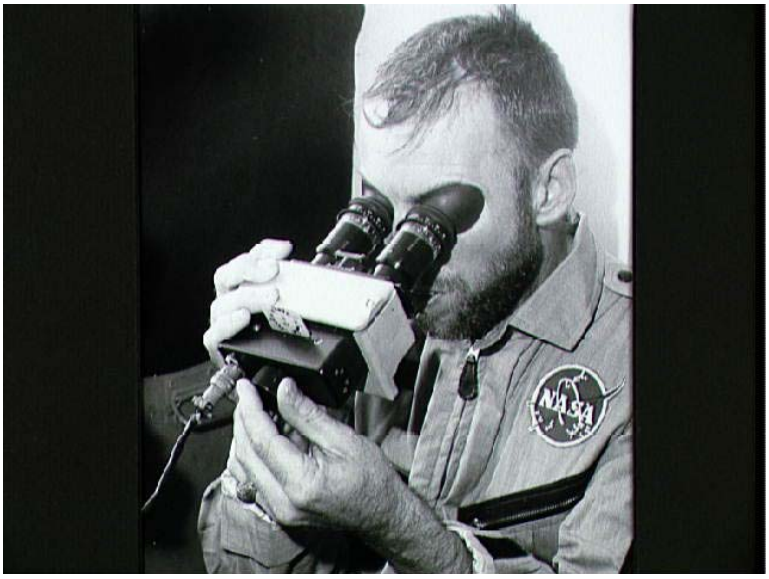
Portrait of Gemini 7 crew James A. Lovell and Frank Borman. Image: NASA.

Coon felt that Borman and Lovell came to regard the mission as a "long, boring survival operation." The fact that the spacecraft was so small made everything difficult, including figuring where to put 14 days worth of food wrappers. They also suffered during the early part of the flight because of a mission rule that one of them always had to be wearing a spacesuit in case of an emergency. Unfortunately, the spacecraft was quite warm and the suit caused profuse sweating. After much grumbling from the crew, who had stuffy noses and burning eyes, and much debate on the ground, it was decided that the benefits of taking the suits off outweighed the risks. Medical Director Charles Berry noted that the astronauts' blood pressure and pulse rates were more normal when they were unsuited.

The Gemini 7 astronauts were really doing more than their fair share on the medical front, Coons said. The original plan was to spread the medical tests out over all the Gemini missions, but for one reason or another, many were taken off earlier flights. "They kept dumping them onto the Gemini 7 flight, onto Borman and Lovell, and they wound up with all the experiments. The crew was not really enchanted about having to do the medical things because this was test flying. There was a tendency for a lot of foot-dragging on doing the medical experiments on any of the flights; that's how a bunch of them got passed down to [Gemini 7]. None of us felt that it was fair that it be dumped on Frank and Jim, but there it was." The tests were important, however, because Gemini 7 "was our 14-day test. We needed to qualify them for the period of time that would cover the lunar mission time scale."

Coons credited Borman with getting the medical testing program on track. He recalled a meeting where Borman acknowledged that the crew was "not very fussy about doing these experiments," feeling they interfered with everything else they had to do. Nevertheless, the commander supported the tests. "He said, 'Look, we've got to do them. I want them done right on my flight and we're going to get with it.' That helped tremendously."

Coons added that the scientific community was demanding these medical tests be done. Early in the space program, there had been dire predictions about the survivability of humans in microgravity, so "it was almost an obligation on our part, to prove our opinion that man could adapt very well to space, and these were the means by which we were attempting to prove it."



Astronaut James Lovell using in-flight vision tester. Image: NASA.

More importantly, even though many of those dire predictions had been laid to rest in the Mercury program, it was becoming increasingly apparent that microgravity *did* change the human body and it was important to understand the implications for long-duration flights. These adaptations included changes in the blood volume and red blood cell mass, shifting of fluids to the upper part of the body, and loss of calcium from the bones. Coons described the latter as "a genuine worry" because calcium leached from the bones goes into the

kidneys and can cause kidney stones. “If you get a kidney stone, you’re in big trouble in space. You’ve got no way to cope with it. So these things, some of them, were very legitimate scientific concerns and others were to put the doomsayers to rest.”

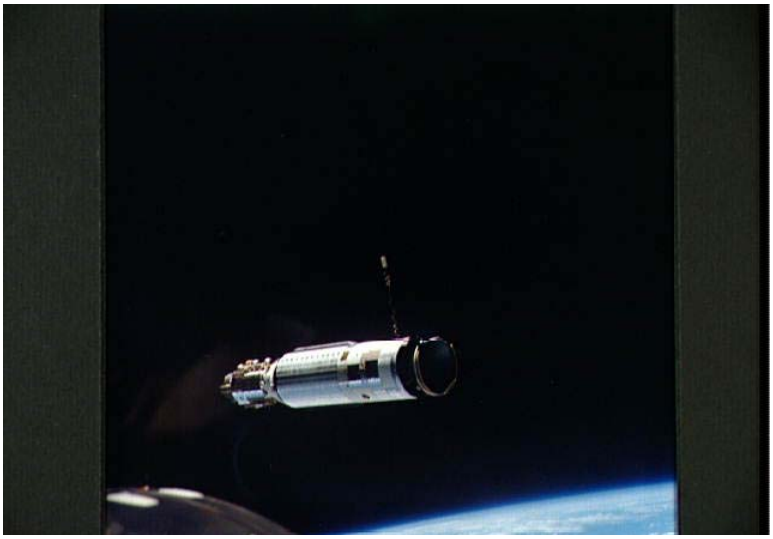
The concern about bone calcium loss in space stemmed from earth-based studies that found this phenomenon in people immobilized by illness; confined to beds or wheelchairs, they are unable to perform weight-bearing activities like running or walking that keep bones strong. Floating in microgravity is, of course, the ultimate in non-weight-bearing activity, so it was natural to conclude that astronauts would experience similar physiological effects. “It was a theoretical possibility and we wanted to find what the order of magnitude was,” said Coons. “And there was a negative calcium balance; there isn’t any question about it.”

Every Gemini flight seemed to have an event that gave the NASA doctors some nail-biting moments. On Gemini 8, flown by Neil Armstrong and David Scott in March 1966, it was a stuck thruster that sent the spacecraft spinning rapidly. The main goal of this mission was to perform the docking with an Agena target vehicle that had been scrubbed from Gemini 6. Armstrong accomplished the delicate docking maneuver successfully and his report to Mission Control that “we are docked. It’s…really a smoothie” precipitated cheers and backslapping on the ground.

But the happiness was short-lived, as was their docked state. A short time later, while Gemini was out of contact with the ground, the linked spacecraft began rolling faster and faster, defying efforts by the crew to stabilize the situation by firing maneuvering thrusters on the Gemini spacecraft.

Armstrong undocked from the Agena in a hurry. And then, as he later reported, “we really took off.” Gemini started spinning at a dizzying rate. When the crew came back into range of the ground communications system, Scott told Mission Control: “We have serious problems…we have a violent left roll here…” Armstrong, who was struggling to control the spacecraft, elaborated: “We can’t turn anything off. Continuously increasing in a left roll.”

“It finally spun up to a rate of roll that approached 400 degrees per second. Now, that’s more than one revolution in a second, so you’re really going fast,” said Coons, who was in Mission Control during the event, even though it was not his shift. “It was interesting that Neil and Dave were able to maintain a reasonable sense of position and equilibrium in spite of the high rate of roll. I recall their saying that they were thrown against the side of the spacecraft.”



The Agena Target vehicle as seen from the Gemini 8 spacecraft during rendezvous. Image: NASA.

Nevertheless, the rolling was making them dizzy and blurring their vision, so immediate action was needed. With some difficulty, they succeeded in cutting off the thruster system that was causing the trouble and switched to a backup system. This stabilized Gemini but unfortunately, it

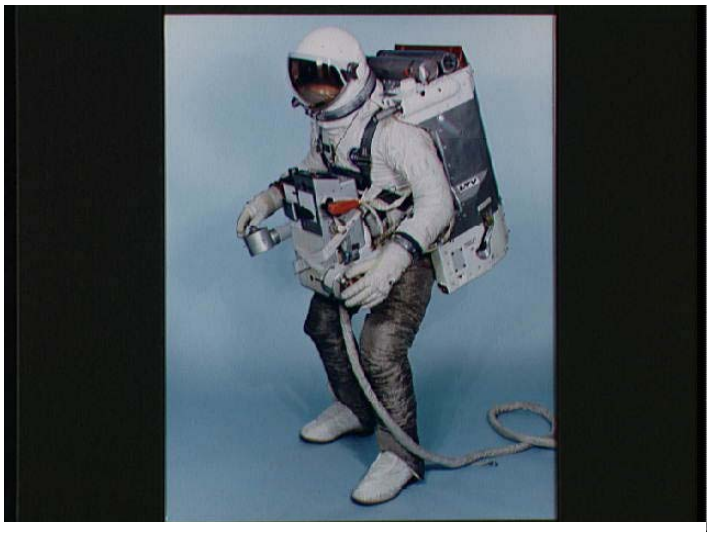
forced them to head for home immediately; the thrusters they were now using were essential for controlling their re-entry into the earth's atmosphere and they couldn't take a chance on something going wrong with them. Cutting the mission short scrubbed the second American spacewalk, which Scott was scheduled to perform.

The Physiological Rigours of Spacewalking

Gemini 9, a three-day mission flown by Thomas Stafford and Eugene Cernan in June 1966, picked up where Gemini 8 left off. Its flight plan also included docking procedures and a spacewalk by Cernan, who was going to test a new life support system, the Astronaut Maneuvering Unit (AMU). The AMU was a backpack-like thruster-powered device that would allow astronauts to fly away from the spacecraft.

The mission was not overly successful. The docking tests could only be partially completed because a protective clam-shell shroud failed to drop off the unmanned vehicle they were supposed to dock with. Stafford made it famous by remarking: "It looks like an angry alligator out here rotating around."

The spacewalk also ran into trouble. From the beginning Cernan found it a challenge to control his body as it floated in microgravity. According to "On the Shoulders of Titans", the astronaut found that everything took longer to do than expected. "Every movement of an arm or leg in free space exacted a reaction from his body. Minute forces that would scarcely be noticed in Earth's gravity upset his equilibrium in space. He had only to twitch his fingers to set his body in motion."



Gemini 9 configured EVA spacesuit assembly. Image: NASA

Working his way to the back of the spacecraft, where the AMU was located, proved extremely arduous. The handholds and velcro installed on the outside of Gemini were not of much help in keeping his body in the correct position and he found his umbilical cable, which he called "the snake", difficult to control. While he was checking out the AMU, he found he simply could not control his body and none of the restraints helped. Everything was a fight.

Then, to make matters infinitely worse, the faceplate on his helmet began to fog up. Coon explained that the environmental life support system (ELSS) in Cernan's suit "was not capable of handling the heat and the moisture load that Gene was putting out in struggling to get this maneuvering unit strapped to his backside. He wound up being unable to see through his visor except for two tiny little holes where his nostrils were directing air from his lungs onto the visor. He could sort of look down his nose and through these little holes and that's all he could see."

It got so bad that Cernan worried he wouldn't be able to see anything while flying the AMU, so he and Stafford decided it was best to cancel the test. Half blind, he struggled his way

back to the cockpit. “He had to look through the little holes that he had, gradually feel his way back and get into the cockpit and close up. I don’t know how he did it,” said Coons.

The exertions of getting back into the capsule caused Cernan to overheat and his visor fogged up completely. Stafford helped him in and started repressurizing the capsule. Almost helmet-to-helmet with Cernan, Stafford could not see his crewmate’s face through the totally fogged visor.

It was apparent the ELSS was not up to handling the rigours of spacewalking. “We were still learning,” said Coons. “We didn’t know how much energy expenditure was really going to be required in EVA to do the work.” However, as far as he knew, the engineers who designed the ELSS did not ask the medical office for assistance in assessing the physiological demands of EVA. “I certainly didn’t have any opportunity to make any inputs; I really never even addressed myself to the question. I didn’t think that there was a problem.”

He speculated that the design criteria might have been based on studies done by the military. He believed the engineers had done the best they could with the available data, but the failure of Cernan’s EVA “was expensive learning, in that we weren’t able to complete that EVA the way it was intended in the flight plan. And, of course, the crew was as disappointed as the Crew Systems Division people. It was an embarrassing time for everyone, and awkward, because you’d feel guilt, you’d feel that a finger was being pointed at you. It was a failure, you see…and we didn’t want any of those.”

There was no attempt to repeat the AMU test on the following flight, Gemini 10. On this three-day mission in July 1966, John Young and Michael Collins were able to successfully perform a docking procedure. As well, Collins did a “stand-up” EVA, a spacewalk that literally involved standing up in his seat.

Gemini 11, flown by Charles Conrad and Richard Gordon in September 1966, was also three days long and primarily devoted to continuing the docking tests. Gordon performed a more extensive EVA; once again, it became all too apparent that working in microgravity was extremely taxing and that procedures were more difficult to perform in space than they were in simulations on earth.

One of Gordon’s tasks involved hooking a tether line between the Gemini spacecraft and the Agena docking target. Like Cernan, he had to fight to maintain his body position. “He had to try to wrap his legs around the nose of the spacecraft, which is like trying to ride a horse,” said Coons. “The suit, of course, was pressurized and it was difficult for him to bend his legs around the spacecraft and he was slipping. He was having trouble fixing his body to the nose of the Gemini spacecraft. He was obviously struggling because we began to see his heart rate going up, what we felt was excessively, and his respiration was increasing.” He started sweating profusely and his eyes were stinging from the dripping sweat. His laboured breathing kept keying the microphone in his suit, which cut off communications between the ground and the spacecraft.

Although the spacewalk was scheduled to last nearly two hours, Conrad, concerned about Gordon’s growing exhaustion, called him in after 33 minutes, “He got so hot and sweaty, he couldn’t see,” Conrad told Mission Control. Gordon later did a “stand-up” EVA that went well.

Later Gordon commented that Cernan had warned him how much longer it took to do things in space and “I took it to heart. I knew it was going to be harder, but I had no idea of the magnitude.”

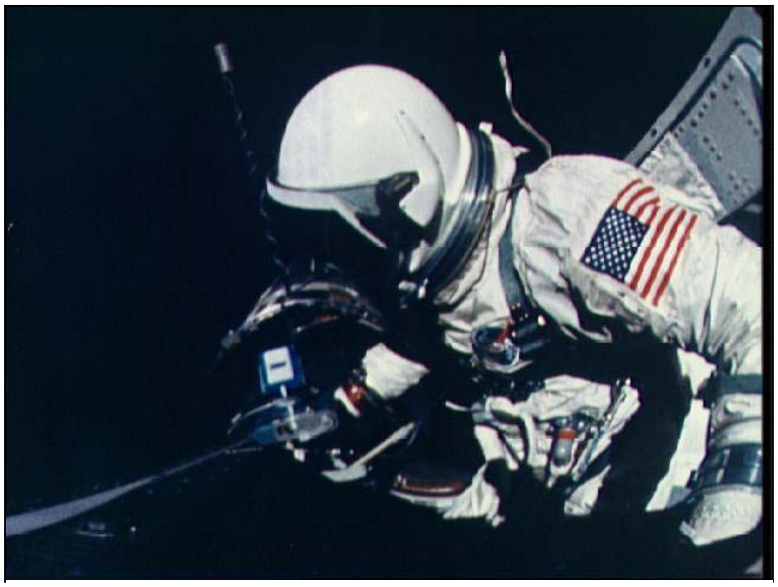
In fact, Cernan’s difficulties had prompted the NASA doctors to evaluate the workload associated with Gordon’s EVA prior to the flight. “We wanted to see how he would react and how the system that he would be using, the suit and life support system, would do because of our unfortunate experiences on the previous flights…We were concerned about whether it would do

the job," said Coons. When they had Gordon do exercises in a decompression chamber wearing his spacesuit, they found his heart rate went up enough to be worrying.

Coons believed that part of the problem stemmed from the fact that, in those days, astronauts did not have a prescribed fitness program and some of them, including Gordon, were smokers. "They weren't required to have a specific physical training program; they weren't required to achieve any particular physical standards by testing, by exercise tolerance tests or anything like that. They were expected to do that on their own."

They were provided with exercise facilities and a trainer and most were motivated to maintain their fitness because they were inherently very competitive people. "The majority of them felt that it was their obligation to remain fit and be prepared for their flights…We never had too much problem with that, except that some of them smoked regularly when they weren't designated or coming up on a flight. Those who did would usually stop for some period of time…before the flight, but, apparently, some didn't."

The EVA problems encountered by Cernan and Gordon raised serious concerns about whether astronauts were going to be able to accomplish the work that would be demanded of them on the moon. As a result, gaining a better understanding of how microgravity affected the body became an urgent priority for the EVA on Gemini 12, the last in the program. A review board recommended that Gemini 12 be devoted to "a basic investigation of EVA fundamentals…through repetitive performance of basic, easily monitored, and calibrated tasks."



Gemini 12 Astronaut Edwin Aldrin in open hatch of spacecraft during EVA. Image: NASA.

Mission planners backtracked on their plans to include increasingly ambitious tasks. Plans to test the AMU were scrapped and efforts were increased to improve the training of astronauts and the development of restraints that would help them control their body position in microgravity. Working in a large water tank, which is now an essential staple of astronaut training, really came into its own at this time because the underwater environment allowed crews to experience the slow-motion movements and physical demands of working in a pressurized spacesuit in microgravity.

The work paid off: on Gemini 12, flown by James Lovell and Edwin (Buzz) Aldrin, Aldrin did three EVAs, two "stand-ups", and a two-hour tethered spacewalk in which he crawled from the front to the back of the spacecraft and tested hand rails and foot restraints that helped him control his body position. He also performed several tasks such as turning bolts and cutting metal; some involved using tools designed for the Apollo moon program. Much to NASA's relief, everyone came away from the mission feeling much more confident that humans could perform useful work in space.

Space Sickness

One medical problem that astronauts in the Gemini program appeared to have avoided was space motion sickness. "It was never reported in the Gemini crews," said Coons. "I don't know whether they didn't have it or whether they had it and they didn't want to admit they had it. But my impression was that we would have learned about it sooner or later from one of them, if it had been the case." What worried the NASA doctors most was the possibility of someone getting sick during an EVA. "We thought a lot about what would happen if a person became nauseated and needed to vomit inside a space suit. We were terrified of that."

In retrospect, it seems somewhat puzzling that the Gemini astronauts were spared—if, indeed, they were. It's now known that most astronauts are afflicted by space sickness to some degree during the first few days in flight. The fact that the Gemini capsules were so cramped might have had something to do with it; later spacecraft, such as Apollo, Skylab, the space shuttle and the space station, provided crews much more room to move around, which increases the probability of disorientation and space sickness. "As long as they were strapped in, it minimized it," said Craig Fischer, Chief of Space Medicine and Health Care Systems at the Johnson Space Center, a veteran of the early days of the space program.

However, even the astronauts who performed EVAs in Gemini did not report problems with space sickness. "I don't think there was ever any mention of it and I don't know whether they ever had it or not," said Coon. According to Fischer, however, one Gemini spacecraft came back with a dark stain on the console. Medical director Chuck Berry had it analyzed. "Berry was worried it was blood," said Fischer. "We saw on the test that it was chocolate pudding. I have no idea how it got there; I don't know whether that was the first documented episode of pitching chocolate pudding."

The first time the issue really attracted the attention of the media and the public was during Apollo 9, when astronaut Russell Schweikart abruptly vomited twice. This prompted commander James McDivitt to request a private conference with doctors on the ground. "Rusty Schweikart really got sick and the cat was out of the bag," said Fischer. "When you went back, you found out that there had been some episodes before that, but they never made a point of it."

The private medical conference on Apollo 9 raised a considerable fuss among reporters, who believed all aspects of the mission should be public knowledge. But the astronauts were pushing for greater security for their medical information. "In those days, everything that got called down became sensationalized," said Fischer. Private medical conferences—which are now a standard feature of space shuttle and space station missions—were a way to ensure that "it's not going to become part of the national press when they have a bowel movement, if they vomited, if they didn't get a good night's sleep. Now, it's between the flight surgeon and the crew. The agreement with PAO [Public Affairs Office] is, if someone really gets in trouble, gets sick up there, it goes in the open, but that's only if it's a really significant impact to the mission. If the flight surgeon doesn't feel that there's any significant impact, he would not relay it to anybody else because he alone is responsible for the crew conference."

Apollo Fire

After Gemini ended, Coons and the other NASA doctors were busy preparing medical reports for an end-of-program conference that would assess the results of each flight with a view to applying what had been learned in the upcoming Apollo missions. Testing of the new Apollo

spacecraft, and the Saturn rocket on which it would ride, was also going on at this time and Coons was involved in these activities.

In late January 1967, he participated in a "plugs-out" test of the Apollo 204 spacecraft, the first that would carry a crew. "This is running a spacecraft on its own internal power and telemetering the data with the radio systems rather than hard-wiring them," he explained. The crew, Gus Grissom, Ed White and Roger Chafee, suited up and climbed into the command module, picking up the countdown at minus two hours and 30 minutes before launch. The plan was to run through the whole launch sequence, except for fuelling the vehicle.

"I didn't have anybody to send to monitor the tests, so I spent the day in the Control Center myself," said Coons. "We were running into problems all day. We were having great difficulty communicating; there was a lot of static on the headsets. The noise and the static…was getting worse all the time and we just couldn't get on with it because we couldn't understand what one another was saying.

"I remember Gus Grissom came up on the radio, while we were in a hold, just furious—and understandably so, because they had been in the spacecraft all day. No food, nothing, just lying there trying to get the job done. He came up on the radio and said, 'Goddamnit, you guys, how the hell do you expect to get the moon, if we can't talk to one another down here?' It wasn't two or three minutes later there was a terrible noise in our headsets. Just white noise, static. You could hear a little talking behind and then everything went dead all of a sudden. Now we didn't know what was wrong, but it was an eerie quiet that wasn't natural and we were all very concerned at the Control Center."

Then he heard the anguished cries of Guenter Wendt, who was in charge of the launch pad activities. "Pretty soon, Guenter Wendt was able to tell us there'd been a fire in the spacecraft. They were having trouble getting the door open because it was so hot. They finally did get the door open to find the inside of the spacecraft just black and charred. Ed White, at the door, had been trying to get out, but died at the door." In fact, White and Grissom were tangled together below the hatch, their space suits literally fused by the heat, while Chaffee died in his seat. The autopsies revealed that the crew had died from asphyxiation after inhaling toxic gases, with second- and third-degree burns as a contributing factor.

There was evidence that the fire had actually travelled right into the environmental control unit, controlling the flow of pure oxygen to the astronauts' suits and the spacecraft. "It couldn't be a worse place for the fire," said Coons. "We had evidence postmortem that the fire came up the tubes into the suits of the crewmen, because their trachea and bronchia were badly burned. And, of course, it depleted the oxygen very quickly. A fire in a small compartment like that, with polyurethane foam that was oxygen soaked, makes a grand fuel. Terrible. It happened very quickly and we think they died very quickly, although Ed had time to get out of the seat and was trying to get the door open. In analyzing the tapes afterwards, that voice that we heard through the noise turned out to be Roger Chaffee, yelling, 'Fire in the cockpit!' "

A number of factors contributed to the accident, notably the spacecraft's wiring, the existence of flammable components inside the spacecraft that burned rapidly in the 100% oxygen, a 16.7 psi environment, and the fact that the crew could not open the hatch quickly from inside. It was an inward-opening hatch and the slightly higher than normal pressure inside the command module made it impossible for White to wrench it open. One of the outcomes of the investigation was a re-designed hatch that could be opened outward in three to five seconds.

Coons was one of those who had the wrenching job of telling an astronaut's wife that her husband was dead. Ed White had been his next-door neighbour, so he headed home to tell White's wife, Pat. "I got home and already the TV cameras were out in front of her house and

the crews had gathered, because word passes very quickly when there's a big problem at the Cape…I couldn't go around the front door because of the TV people, so I just went out my patio door and through the back yard and into the White's patio door. Neil and Jan Armstrong, who lived on the other side of the Whites from us, were already there. I took Pat back into the bedroom and told her and she said she knew by the look on my face coming through the door what I had to tell her."

He travelled with the family to the funeral. It was January 31, a day that had been scheduled for the Gemini review conference. "See, on my calendar, I've got everything crossed out…scrubbed, everything scrubbed." One of the items on his schedule was grimly ironic: it said "204 Aeromed review."

Apollo 1 Astronauts (left to right): Gus Grissom, Ed White, and Roger Chaffee. Image: NASA.

Like everyone else in the program, Coons found his work on the Apollo program impacted by the fallout from the fire. For example, the re-designed hatch weighed more than the previous one—weight was always a critical issue with Apollo and literally every ounce counted—so something had to go. "Everyone was under the gun to lighten up," said Coons. "We started looking at the food and the medical kit. We were counting aspirins, to see how many aspirins we could take out of the medical kit."

Moving On

After the Apollo fire, NASA struggled with budget cuts and constraints while trying to get the lunar program back on track. In the Medical Directorate, a proposal was floated to re-organize and do more ground-based research. Coons thought this would have been a good idea if NASA had the resources, but he didn't think it was feasible; he felt it would be difficult to find enough of the right kind of scientists and researchers to make the program a success. When the decision was made to proceed with the re-organization, he decided it was time to move on.

Coons completed the work he had in hand, including helping to prepare the Lunar Receiving Lab that would be used to quarantine astronauts and rocks returning from the moon.

He also helped select from the first group of scientist-astronauts in 1967. In 1969, he resigned from NASA and started a private practice in Dallas, specializing in treating professional pilots—not a surprising choice for a man who'd left the Canadian military partly because he did not want to be taken away from "his pilots."

Coons was much admired by his colleagues and the astronauts, said Craig Fischer, who worked with him in the 60s. "He was a very gifted leader. He was the person who knew the crews best; they admired him. They knew he'd do the right thing. He had a going-away party and every single astronaut was there."

Owen Coons died of cancer in 1997 at the age of 72. An article in the Hamilton *Spectator* quoted Chuck Berry describing Coons as his right-hand man during the "golden era" of spaceflight. "We had to build a team to do a very difficult job. He was…an integral part of that.'' The article also quoted astronaut Jim Lovell, who said: "Some of the astronauts were sort of like prima donnas. Owen Coons was very good at being able to accomplish his task and, at the same time, satisfy all the desires and demands of the astronauts."

Coons himself described his participation in the golden era of spaceflight as somewhat frantic but rewarding. "It was just running from one flight to the other all the time and you didn't really have the time to sit down and analyze the data and write the report. But they were interesting times and they were good times. I think we did good work."

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