# Journal of Space Safety Engineering

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## Aims and Scope
The Journal of Space Safety Engineering (JSSE) provides an authoritative source of information in the field of space safety design, research and development. It serves applied scientists, engineers, policy makers and safety advocates with a platform to develop, promote and coordinate the science, technology and practice of space safety. JSSE seeks to establish channels of communication between industry, academy and government in the field of space safety and sustainability.

## Main JSSE Topics
- Safety by design
- Safety on long duration missions
- Launch and re-entry safety
- Space hazards (debris, NEO objects)
- Space weather and radiation
- Environmental impacts
- Nuclear safety for space systems
- Human factors and performance
- Safety critical software design
- Safety risk assessment
- Safety risk management
- Organizational culture and safety
- Regulations and standards for safety
- Space-based safety critical systems
- Space Situational Awareness
- Space traffic control
- Space traffic and air traffic interfaces
- Space materials safety
- Safe & Rescue
- Safety lessons learned

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*International Association for the Advancement of Space Safety*
FOREWORD

John H. Glenn Jr. (July 18, 1921 – December 8, 2016) first American astronaut to orbit Earth, was a humble person, a magnificent pilot, a courageous patriot. He flew twice in space: in 1962 on the historical flight on Friendship VII Mercury capsule, and in January 1998 on Shuttle Discovery STS-95 mission, aged 77, the oldest person to go in space.

In 2006, Jerry Hammack, his old friend since the early times of NASA, asked John Glenn to endorse the International Association for the Advancement of Space Safety (IAASS) by accepting the nomination as Honorary Member. John Glenn promptly accepted. The fresh memory of the Shuttle Columbia accident was there to remind everybody that no matter the huge progress made since the sixties, the future of human spaceflight very much depended on making it safer.

Following the death of John Glenn, much was written about him. Mostly of what he used to call, with some embarrassment, “adulation”. The IAASS wants to honour his memory and historical heritage by telling a little bit of his amazing human story in his own words.

In August 1997 John Glenn was interviewed at Johnson Space Center in Houston, as part of NASA Oral History Projects. Excerpts from those transcripts have been used in this commemorative article to tell the story of becoming John Glenn in his own words.

1. THE PILOT

“I always had an interest in flying ever since I was a little kid. I remember riding along with my dad in the car and I’d have one of these little airplanes with a little prop that would run. I’d hold it out the window and watch the prop run.

I never really thought in the early days that I’d be able to fly myself, because flying was pretty expensive. But when I was in college, just prior to World War II, the government started a program called Civilian Pilot Training (CPT), and you could take flight training in little light planes. I took it and learned to fly in a Taylorcraft with 65-horsepower Lycoming engine. I still remember that.

I had my private pilot’s license and about around sixty hours of total flight time when World War II started.

Few days after Pearl Harbor, I volunteered and went in flight training for a year and then overseas. We were flying the old Corsairs, the gull-wing airplane that is still pretty famous, even to this day. I had more flight time in that than anything I ever flew. I got over 3,000 hours in that old airplane. I came back from World War II and decided to keep on flying. I liked it, loved it, and I was good at it. I won’t be humble about that: I was good at it. I decided to stay in the Marine Corps as a fighter pilot, and I got checked out in jets when they came along.

I was out again in the Korean War, in which we were, once again, doing close-air support, this time with jets. I volunteered to go up with the Air Force and fly F-86s air-to-air combat against the MiGs. There was a lot of real wild flying. If you have an airplane coming toward you at 550 or 600 miles an hour and you’re doing the same thing toward him, you’re closing at 1,000 miles an hour, and your decision-making and your maneuvering have to be really accelerated. We didn’t have radar, it was all visual. You had six .50-caliber machine guns mounted on your airplane, and you had to maneuver in behind the other airplane and get in to within about 800 to 1,000 feet with him maneuvering, too, and draw a lead on him. It was that kind of flying, at jet speeds but basically with World War I-type tactics. I shot down three MiGs in the last nine days of the war.

Before leaving Korea, I requested assignment to flight test training and I was accepted. My orders out of Korea were to go home, have leave, and then go to Patuxent River, Maryland, Naval Air Station. I went through test pilot training and I did test work for about four years. I was lucky to get there at that time because it was when the first U.S. Navy and Marine supersonic fighters and attack aircraft were just being tested. It was a great time to be there”.

2. BECOMING AN ASTRONAUT

2.1 Selection

“At the end of the four years at Patuxent, when I came off test duty, I was assigned to the old Bureau of Aeronautics
in Washington as a project officer. It was just the time when they started looking for astronauts, and I immediately volunteered. I thought that was a natural extension of the test pilot work I'd been doing, and sounded like it would be fascinating.

In the early days of astronauts' selection, they wanted people who had test piloting background and combat experience if possible. Not everyone in the first group of seven selected had combat experience. Only three of us: "Deke" [Donald K.] Slayton had been in combat in the old B-25s and Wally [Walter M.] Schirra [Jr.] had been on a carrier off the coast of Korea. I had a good combat record, and I'm sure that may have been one of the reasons I was picked. The fact that you'd been in dangerous situations was something that was of interest to those making the selection, at that time.

We were taken to Lovelace Clinic, and they made every measurement you can possibly make on the human body, plus all the things that would occur in any physical exam, and then other things like, oh, putting cold water in your ear with a syringe. The fluids in your inner ear would start circulating because of the temperature differential and you would get the same effect as though you'd been spun up on a chair until you were extremely dizzy, and you had nystagmus, as it's called, and your eyes want to drift off. You can't keep them focused on a spot. They would measure how long it took for us to recover from that.

They would measure the body density by putting you in a water tank, and to get your exact body volume, they rubbed all over your body to get even the tiniest of air bubbles off. Then you submerged in the tank, and they measured the amount the water had raised. They could define from that what your lean mass and body proportions were.

We went through a heat chamber test at 135 oF, with thermocouples on your body, and you had heat measurements being made including deep body temperatures. We stayed in the heat chamber as long as we could, until the pulse was too high and doctors thought it was becoming dangerous.

They ran isolation tests, where they put you in an anechoic chamber, no light, no sound, no nothing, and they had body sensors on to see how we reacted to that, and they wouldn't tell you in advance how long you were going to be in there. They wanted to know whether under those unusual conditions you were still in control of yourself and what you were doing. They had us in there just at a plain desk before the lights went out, just sitting there, and there wasn't anything on the desk at all. I remember after the lights went out, I sat there for a while, and then I thought, "Well, I'll see what I can find in a drawer." So I found in a drawer what I thought was a tablet, and I tore off some pages to make sure I had a blank page, and I had a pencil, and so I sat there in the dark keeping track of what line I was on, and I wrote little doggerel poetry, which I like to do sometimes, and we still have that at home someplace. There was a lot of other psychological testing. They had a psychiatrist from the University of Pennsylvania, George Ruff. We had every psychological test, every questionnaire, every interview, every Rorschach that you could fold out, and they always looked like butterflies to me.

About 130 people started out originally to be screened, and then they immediately broke it down to, I think it was thirty-two or thirty-some that were put through the whole Lovelace Clinic tests. They made their final selection from that. The fellow that was in charge of some of the NASA testing program was a man who had been a Navy officer in charge of selecting people for special duty, like for hazardous work, for special submarine operations and special underwater operations, and for special naval volunteer SEAL operations. He'd been in charge of selecting people. His name was Bob [Robert B.] Voas. Bob was the one who sort of set up some of the selection criteria or worked with the other NASA officials in setting that up. But they didn't know, no one knew for sure, exactly what it was we were going to be doing. We knew we were going to be going into orbital flight, but what was going to be required or what pressures would your body operate at, and what Gs could you take and things like that”.

### 2.2 Training

“Once you'd been through all this and you had other guys around who had been through it, you did have a little bit of a bond. But remember that in the early days of the program, we didn't know how far the program was going to go. For a while we didn't even know if it was going to go. It was all pretty much up in the air. So, everybody was keyed in to making the first flight or an early flight to make sure you got to do something for all this effort. It was very competitive, after the selection phase.

Once selected we started the training program. Some pretty good things were included but it was sort of open-ended as to what kind of things people could think up for us to do that might have some weird, remote relation to space flight. We didn't know what we'd be able to do as far as high Gs. We were going to be taking the G levels in a different direction than you normally do in a fighter aircraft. The Gs would be taken on a vector straight into your chest, because we were going to be lying down in a supine position. We called the two different ways the G
forces were going EI or EO, for "eyeballs in" or "eyeballs out". They didn't know what we'd be able to do at high Gs, and so they took us up to the Naval Air Development Center at Johnsville, Pennsylvania, where there was a fifty-foot centrifuge.

They had no actual replica of the spacecraft, but a couch like you would use in a spacecraft, mounted in a capsule on the end of this fifty-foot arm. As the arm started to rotate, it went faster and faster and faster, the capsule, then, would turn so that your G vectors were the same as you'd take in a spacecraft on launch. As you slowed down towards the end of the test you were back to vertical.

I don't think everybody went above ten or eleven Gs, but Al [Alan B.] Shepard Jr., "Gordo" [L. Gordon Cooper, Jr.] and I we went up to sixteen G. At sixteen G, even in that supine position with the Gs straight into your chest, you're straining just as hard as you possibly can strain to keep enough blood up in your head to keep from blacking out. Now, if you even just thought of relaxing a bit, your vision would start coming in tunnel vision and you'd start getting big black splottes going around. At sixteen G, you're on the verge of losing control no matter how much you strain against it.

We wanted to define at what G level you could still reach up to change a switch or something on the instrument panel, and seven Gs was about the most you couldn't lift your arm out of the couch, no matter how hard you tried, you couldn't lift your arm out of the couch about six to seven Gs. Beyond that you were just supported there. You could still see, and you could watch the instruments. That was a level that was important, because on the Mercury flights we were expected to get up to around eight Gs, and that was what happened later on. I got up to 7.9 on the first orbital flight, 7.9 on exit, on insertion into orbit, and 7.9 during reentry.

On the centrifuge there was another exercise that Al and I went through. I think just the two of us are the ones that did this one. We were concerned that if you had to make an emergency reentry and you did not hit on water but on land, that was going to be a major impact. And if you landed where there was wind and the wind was over that meant the parachute would detach immediately, but then you're hitting sideways, and the capsule would probably tumble. So, if you took Gs out of the couch, what would your reaction be to that and what could you take? Those were real tough runs we did on the centrifuge. What we did was set up our restraint system to see whether it was adequate. The restraint system was plain, had the belts, the crotch strap hooked into the belt, the shoulder straps came down and hooked into it, too. And what we wanted to do was simulate Gs where you were coming out of the couch and hitting the restraint harness.

Another interesting thing they didn't know in the early days was what you could be able to do if there was a runaway spacecraft, I mean a runaway of its rotational speed. Let's say you have a runaway thruster, and it starts turning in roll and you can't control it, and it's going faster and faster and faster. They wanted to find where the astronaut would phase out as being able to control it. So, at Lewis Lab in Cleveland, they built a rig called MASTIF (Multi Axis Space Training Inertial Facility). It had three gimbals, one built inside the other, for roll, pitch, and yaw. The astronaut sat in a couch placed in the middle in a simulated cockpit. He had rate instruments and a three-axis control handle operating compressed air that could turn up any one of the gimbals in whatever mode, either in roll or pitch or yaw, or two axes as a time or three axes all at once. They would start just in one axis at a time, say yaw. You would rotate and you'd learn how to control that to zero. Then two axes and finally all three axes at a time. The "graduation exercise" was to control it while running at 30rpm on all three axes simultaneously. Now you figure your body motion's going around like this in roll, pitch, and yaw at the same time. You're looking at the rate instruments trying to control it, truly it was the original vomit machine, I'll tell you. That was a gut-buster."

3. WEIGHTLESSNESS

"The main scientific purpose of my flight was to find out what reaction the human body had to extended weightlessness. Some of the doctors thought that my vision might change during flight because of lack of support by the structure under the eye. The eye might gradually change shape and get horribly myopic. So, on the instrument panel, and you can still see this on my spacecraft, Friendship VII on display at Smithsonian, at the top of the instrument panel there is a miniaturized Snellen Chart, the eye chart doctors use to measure visual acuity. It was made small to account for the distance from my eyes to the panel, and I was to read it every twenty minutes during flight and report to ground.

Another thing the doctors wanted to investigate was the effect of weightless on the fluids in the inner ear that give you the sense of balance. In weightlessness those fluids are more free to randomly move about, rather than being held down by gravity or sensing acceleration as you change your head position, you might get uncontrollable nausea and vertigo. They feared that you would not be able to make even an emergency reentry because you'd have such nystagmus [involuntary, rapid and repetitive movement of the eyes] that you wouldn't be able to see the instrument panel properly. I had to take a Tigan pill, a motion-sickness pill, if I started feeling the least bit woo-
zy. They gave me in addition a stuff in a solution, I kept it in a pocket on my leg, in a special syringe with a spring. If needed, I would place it on my leg and the spring would drive the needle through the suit into my leg and inject the medicine. That was to be a get-me-down type of operation, if I was getting so out of control that I felt I had to make an emergency reentry wherever I was.

So, eyes were one thing that I was to check. Whether I felt any imbalance or vertigo was another thing to be checked. They didn't know whether I could swallow properly or not. I wasn't going to be up long enough that I really had to have a meal or two meals or anything, but they wanted me to take food along to swallow, which I did. They wanted to know if there was any change of feel, fingers or anything like that, any tendency toward any sickness. Many of the things they were concerned about were put to rest on that first flight or certainly in the first two or three flights”.

4. AFTER THE FLIGHT

“After my flight, there had been such an outpouring of national attention, that if you weren't there and went through it, it's sort of hard to comprehend the attention we had and the "adulation", is the only word that comes to mind.

After my flight, I wanted to get back in rotation and go up again. Bob Gilruth, who was running the NASA program at that time, said that he wanted me to go into management of training, and I said I didn't want to do that. I wanted to get back in line again for another flight. But he said that headquarters wanted it that way, at least for a little while. I didn't know what was the reason and I kept going back. Every month or two I'd go back and talk to him again about when do I get back in rotation again, and he'd tell me, "Well, not now. Headquarters doesn't want you to do this yet". If I'd know as much about Washington operations as I know now, I'd have gone to Washington and talked to somebody, but I didn't know that much then. So, I accepted that for what it was, and this went on for the better part of two years. I finally decided that I'd go on and do other things, and I wound up eventually in the U.S. Senate. I didn't know until some years later that apparently, President John F. Kennedy decided that I wasn't going to fly for a while. I guess that President Kennedy was afraid of the political fallout or what would have happened if I flew again. I don't know why, but he didn't want me to fly again right away. That's the reason I never got another flight. And it wasn't that I had not done a good job on the first flight. I had problems on that first flight, control system problems, and we made an unusual reentry. We had to leave the retro pack on, let it burn off. We came through all that in good shape. I got nothing but high marks for performance on the flight, so I knew it wasn't that”.

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