NORTH AMERICAN AVIATION

Retirees Bulletin

"Where The Best Never Rest"

Fall 2016

America's First Women Astronauts

Shannon W. Lucid, Ph.D. Judith A. Resnik, Ph.D. Kathryn D. Sullivan, Ph.D.
Sally K. Ride, Ph.D. Anna L. Fisher, M.D. M. Rhea Seddon, M.D.

NORTH AMERICAN AVIATION
Retirees Bulletin

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North American Aviation Retirees Bulletin
P. O. Box 3797
Seal Beach, CA 90740

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Dear NAA Retirees Bulletin Subscriber

After much soul searching, we have decided that this will be our final year of publication. It is ironic that now that we have access to all the North American Aviation historical files at the Boeing historical archives, there are only two of us still standing of the five volunteers that started this project 17 years ago. In the same proportion, many of our wonderful readers have moved on to "Higher Ground" or are in assisted living care and have no further interest in their own history. Now! All the naysayers will come out and say, "We told you! They wouldn't last!" However, we are still not finished. We are completing one final project that we hope to have ready after the first of the year! Each of you that are current subscribers will receive these with our gratitude for your consistent support of our modest efforts. We consider all of you "Part of Our North American Aviation Family" because you are "Family!"

We met Astronaut "Hoot" Gibson last winter and he kindly obliged us with an article dealing with his racing souped-up P-51 Mustangs in the Unlimited Class at the Reno Air Races. In the ensuing preparation of his article, "Hoot" was so amiable, we ventured to ask if his Astronaut wife, Dr. Rhea Seddon, would also favor us with an article? The response was affirmative and the topic to be presented was about the first six women Astronauts in which we present *"Shuttlenauts and Astronettes"* in this issue. Dr. Seddon was a young girl growing up in Murfreesboro, Tennessee when she watched, with her Dad, the Russian *Sputnik* go beeping across the sky. She went on to become an Emergency Room Physician, no small accomplishment for a small town girl. When NASA announced that six women would be admitted into the next Astronaut group, she applied and was accepted! She completed three Space Shuttle missions. Her book, *"Go For Orbit"* serves as an inspiration and should be read by every teenager trying to decide his/her future career path!

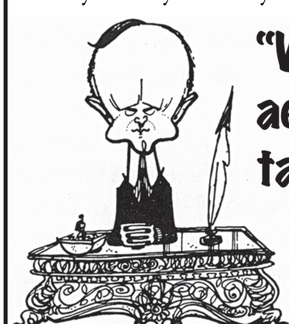
Our author/technical speaker/all-around nice guy, Chuck Lowry has come up with another fascinating article. How can a program with 50,000 failures be called a success? Chuck provides some interesting facts which I am sure will stimulate much thought and encourage plenty of conjecture.

Our Larry Korb is back with *"Man's Quest for Flight."* We think that Larry is that Man. We read books about this Quest, Larry writes them.

As to the NAA Memorial bench at the USAF Academy, we believe the Old Colonels have expressed their stone cold feelings in their silence! Nothing we do will change that! Some people grow old while others are born old! Not to worry! Several other USAF sites have learned about our benches and will be pleased to welcome us! As we mentioned before: our test pilot, Wheaties Welch, got airborne that Sunday morning at Pearl Harbor and managed to shoot down several Japanese attackers. It was suggested that he should be awarded the Congressional Medal of Honor. He didn't because he did not wait for the order to take off from his commanding officer! Does anyone remember the name of his commanding officer?

I am using this issue to express my Last Word! Some of you may agree while others may hate it! Since our next issue will be our last—we are leaving some space for you to express your Last Word! So give us your best shot!

May all of you always stand in the light of God's Blessings!



"Why can't we buy just one aeroplane and let the aviators take turns flying it?"

Calvin Coolidge
During his term in office

Shuttlenauts and Astronettes

by Astronaut Rhea Seddon, M.D.

It took a long time for American women to get into space. The "Space Age" began with the launch of the Russian satellite, Sputnik, on October 4, 1957. This event also began what became known as the "Space Race" – the competition for dominance in this new world. The Russians always wanted to be in the lead. Hurriedly, the U.S. launched its first satellite, Explorer 1, on January 31, 1958 and the race was on.

There was considerable concern in the United States that the Russians were ahead of the U.S. in engineering and technology and would somehow take military advantage of their position. Americans were challenged with improving our educational system and training more engineers and scientists for the future of our Space Program. It propelled young people into these subject areas with the goal of someday being a part of something new and great.

Yuri Gagarin began the "manned" space program with his orbital flight on April 12, 1961. The U.S. had selected seven American astronauts for the Mercury program in 1968 and Alan Shepherd made a 15 minute sub-orbital flight on May 5, 1961. It was apparent that the Americans were behind in the Space Race. On May 25, 1961, President Kennedy made his famous speech announcing that the U.S. was committed to putting a man on the moon and returning him safely to Earth before the end of the decade. Over the decade of the 1960s that is exactly what we did, moving well ahead of the Russians – except in one area.

Early in the Russian space program, it was decided that the first woman to fly into space should be from the Soviet Union. Twenty six year old Valentina Tereshkova, a factory worker and amateur skydiver, flew alone on a three-day flight aboard Vostok 6 in June of 1963. None of the other four women with whom she had trained ever flew. It was 19 years before another Russian woman went to space. It was obvious the Russians did not intend to truly include women in their cosmonaut corps.

A group of American women pilots who became known as the Mercury 13 wanted to prove that women should become astronauts. In the early 1960s they passed the physical exams that the male astronaut candidates were given at the Lovelace Clinic in New Mexico. Although all of them had over 1,000 flight hours, unfortunately those hours were not in high performance aircraft and so they didn't meet the requirements for selection. Women were not allowed to fly military high performance aircraft at the time and were not admitted to test pilot schools. Although they fiercely lobbied Congress and the President in 1962 their requests were rejected. It would take more than fifteen years for women to break this sky-high glass ceiling.

The Mercury, Gemini and early Apollo flights proved American prowess in space, culminating in the Apollo 11 landing on the moon on July 20, 1969. Other lunar landings followed then the Apollo-Soyuz joint mission with the Soviets and three Skylab flights by 1974. The next American space vehicle, called the Space Shuttle, had begun its development in the late 1960s and in the early 1970s the final design was complete. A reusable orbiter was capable of carrying a much larger crew of seven – and there was room for a space toilet. Under considerable pressure from the American public, NASA decided to open the

NASA photo

Jerrie Cobb, a well-known female pilot in the 1950s, flies the Gimbal Rig in the Altitude Wind Tunnel in April 1960 at the Lewis Research Center (now Glenn Research Center) in Cleveland, Ohio. As part of a privately funded initiative, Jerrie Cobb was the first woman to pass all three phases of the Mercury astronaut screening program. However, U.S. Government policy at the time stipulated very specific qualifications for becoming an astronaut, including experience as a military test pilot. Although the women who had volunteered for this private initiative did as well, or better, on the various screening tests than the original seven astronauts, the effort collapsed when it became clear that the Government was not going to overturn the existing list of qualifications to admit any of the women into the astronaut corps.

Astronaut Corps to women and minorities. In July 1976, over 17 years after the opening of applications for the male Mercury astronauts, an announcement was sent out that qualified pilots, scientists and engineers were invited to apply for the Space Shuttle program. Some called the Shuttlenauts but that title soon faded. Women and minorities were welcome to apply before June 30, 1977. A door had opened.

In all, over 8,000 people sent in applications, 1,544 of them women. Only about half of the applicants met the basic requirements. Two hundred seven of these would-be astronauts were invited to the Johnson Space Center for interviews beginning in late summer of 1977; twenty one were women. Non-pilots would hold the title of Mission Specialist Astronauts.

In August of 1977, I received a life-changing telephone call. NASA was interviewing a third group of twenty applicants – all life scientists. The two earlier groups had been of test pilots – all male. There were eight very well qualified women in the group. The week-long trip to Houston would include extensive physical exams, briefings on the Mission Specialist job, and a 90 minute interview. We arrived at the Center on Sunday afternoon and to my surprise since I had learned little about what this new job would entail, my interview was on Monday morning. This officially made me the first woman to be interviewed for the Astronaut Corps.

The Selection Board was made up of astronauts and a few male NASA managers. Dr. Carolyn Huntoon, head of the biochemistry lab, was the sole woman and Dr. Joe Kerwin, a physician astronaut who had flown on a Skylab mission, was the only life scientist. I had the feeling they weren't sure what to ask scientists – or women. But then, I had no idea how to best answer their questions so I just had to be myself. We had a pleasant hour and a half with no idea how I had done. The physical exam was extensive but I passed all the tests.

Much to our dismay, there was an insane amount of media interest in the women in this group. Wanting to be treated like our male colleagues, it gave us a brief look at what being a female astronaut would be like.

On January 16, 1978 NASA announced that a class of 35 astronauts had been chosen including six women. I was one of them.

Because of all the press interest in the women, the men jokingly referred to our group as "the six women and the other 29." Other unflattering (sometimes ridiculous) terms for women astronauts surfaced. Would we be known as Astronettes or Space Ladies or what? One jokester suggested we be labeled the Non-men Astronauts. Insisting that we wanted to be considered part of the group, our class became the "Thirty Five New Guys" or TFNGs.

We were a diverse group: Anna Fisher and I were M.D.s, and Sally Ride, Judy Resnik, Kathy Sullivan, and Shannon Lucid, all Ph.Ds. We knew there would be considerable interest in how we would perform. We had heard that some of the 27 astronauts already in the office were not in favor of including women. However, I personally never felt we were discriminated against. We six all knew we would have to form a group to support one another – and we did.

Our first year of training was arduous – both physically and mentally. Since Mission Specialists would be flying in the back seat of the NASA jets, the first order of business was aviation training. There was ground school, ejection seat briefings, water and land parachute training (using parasails), physiologic training and lessons on T-38 communication and navigation systems. Finally, we began a NASA syllabus of flight training. As we began traveling about the country, Air Traffic Controllers were confused to hear female voices coming from NASA jets. I had my private pilot's license in small single engine planes so it was quite a change to be going almost supersonic at 41,000 feet. But I got to log jet co-pilot time.

Soon we started our "technical training." First there were lessons on Orbiter systems, then shuttle flight and mission operations. Since many space walks were planned, Extravehicular Activity or EVA training began. This included SCUBA training in a pool, then progressed to exercises in a huge water tank in the space suits. This was when I found that I was too small to fit into the smallest of the suits and so was not eligible for EVAs – but there were plenty of other jobs on Shuttle missions.

Next we had training in all the scientific fields that were being proposed for NASA payloads. That included geology, earth observation, life and material sciences, astronomy, and so on. Most exciting we had lectures about the early days of the Space Program, many of them by former astronauts like Neil Armstrong, Jim Lovell and Alan Shepard. These men had been our heroes growing up.

Then we were given our first Technical Assignments. This was really on-the-job training. At first we would shadow the older astronauts, then we'd be given an assignment to work in a particular area of Shuttle development or operations. Some of these jobs were in areas we knew little about but needed to learn. Others were in areas that reflected our expertise to which we could make a contribution. In a way, it revealed where each of the new astronaut trainees stood in the pecking order. Some were sent to work on EVA, some to be CAPCOMs in Mission Control (although the Shuttle wasn't flying, there were crews training), some to the Kennedy Space Center to work on shuttle itself, which were all plum assignments. I was sent to work on the food systems. I had done some research in nutrition – still, it felt a little sexist. I took advantage of the opportunity to do extra work learning all the systems that supported the galley in the Shuttle and made the most of the short term assignment.

After a year in September of 1979, it was decided that we had completed enough initial training and our services could be used best by helping to get the first Shuttle flights and crews off the ground. The first six crews had been named from the astronauts who had been in the office during the Apollo days.

All of the TFNGs wondered when members of our class would be assigned. In the meantime, we supported the

NASA photo courtesy of Dr. Rhea Seddon

NASA Group 8 – the "Thirty-Five New Guys"

NASA photo courtesy of Dr. Rhea Seddon

Five of the six first American women astronauts in the U.S. space program take a well-deserved break from various training exercises during their water survival training course at Homestead AFB in Florida in August 1978. From left to right are: Sally K. Ride, Judith A. Resnik, Anna L. Fisher, Kathryn D. Sullivan and M. Rhea Seddon. Not pictured: Shannon W. Lucid.

upcoming Shuttle flights. I was assigned to head up a team of Astronaut physicians who would assist the Search and Rescue teams that would be deployed for the first four flights. For these flights, called the Orbital Test Flights, the two man crews would have ejection seats. Many possible emergency scenarios were practiced – a return-to-launch-site abort that either crashed near Cape Canaveral or ran off the runway in Florida into the moat around the landing zone, a crash near the intended landing runway at Edwards Air Force Base, or a bail out over the Atlantic or Pacific. Rescue forces were standing by and the astronaut physicians were assigned to provide expertise about the Shuttle and the suits worn by the crewmembers. Having never been part of a helicopter crew with Vietnam-experienced parajumpers as my assistants, it was a most interesting assignment.

On April 12, 1981, exactly 20 years after the first man, Yuri Gagarin, flew in space, *Columbia* gracefully lifted off from Cape Canaveral in Florida. After two days in orbit, it landed safely on the dry lakebed runway at Edwards AFB in California – the first reusable space vehicle was a success. In early 1982, it was decided that it was time to assign larger crews after STS-6. On April 19, 1982 the first of the 1978 group, the TFNGs, were assigned to STS-7.

NASA photo courtesy of Dr. Rhea Seddon

Astronauts Rhea Seddon and Robert "Hoot" Gibson prepare for a flight in a NASA T-38 supersonic trainer.

NASA photo courtesy of Dr. Rhea Seddon

NASA's first six women astronauts stand with a mockup of a personal rescue enclosure (PRE) or "rescue ball" in the crew systems laboratory at the Johnson Space Center in Houston, Texas. The PRE was designed as a possible means of transporting astronauts in the vacuum of space from one Space Shuttle orbiter to another in case of an emergency. The PRE only reached the prototype stage in development and never flew on any Space Shuttle mission. The mission specialists from the NASA Astronaut Group 8 are, from left to right: Rhea Seddon, Kathy Sullivan, Judy Resnick, Sally Ride, Anna Fisher, and Shannon Lucid.

In order of our assignment to flight, here are the stories of the first six women astronauts:

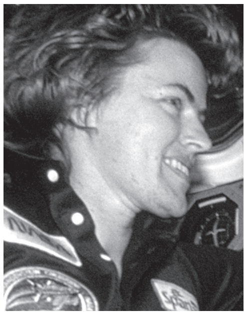
Sally Ride was from California, her father a professor and her sister a minister. Brilliant, she attended a fine private high school and was a nationally ranked tennis player as a teen. She was a staunch feminist. Mike Mullane (author of the hilarious book *Riding Rockets*) was one of the clueless males in our class who often ran afoul of Sally. In 1982, she was the first female to be assigned to a flight. There were many decisions to be made about how women would be treated and accommodated on the flights and Sally involved all of the other women astronauts in addressing issues that came up. The pressure on her from the media responsibilities was daunting and while Sally handled it well, she did not enjoy it. At times, she merely declined to participate and sometimes she tried to be invisible. There was the time she was asked to be on a Bob Hope show. Because she didn't like the way women were portrayed on that show, she merely left town for a few days. She flew on STS-7 in 1983 and on STS-41-G in 1985 and left NASA in 1987. She served on the accident boards investigating the crashes of both *Challenger* and *Columbia* shuttles, became a professor at the University of California, and founded Sally Ride Science to inspire young women to study science. Unfortunately, she died of pancreatic cancer at age 61 in 2012.

Judy Resnik or "JR" as she preferred to be called, was kidded about being a Jewish American Princess although she was not religious. Clever and flirty, she was really good at giving a cute comeback when kidded by one of the guys. She was the second of the women to be assigned to a flight. On the first launch attempt of STS-41-D in 1984, she was aboard *Discovery* when the shuttle main engines were shut down seconds before launch – but flew two months later. The flight experienced a toilet failure and the crew had to improvise. The men found that urinating into a plastic bag didn't work well unless there was something to absorb the liquid. All the socks that had been stowed onboard were soon put to use. It was not so easy for JR, but she managed. Early in the flight she had great fun letting her luxurious long curly hair float free – until it got caught in a large camera. She made the flight commander promise on threat of death that he would not report it to Mission Control. Sadly, her second time to fly was on the *Challenger* flight that exploded 73 seconds after lift-off.

As for me, on May 30, 1981 I married a fellow TFNG, Navy fighter pilot Robert Gibson, known by all as "Hoot" after the cowboy movie hero of the early twentieth century. When we found I was pregnant in late 1981, we kept it a secret. It was a good thing we did tell everyone the next March so I could be taken out of consideration for the flight assignments that were made in 1982. My first child, Paul, was born in July 1982 as Sally was beginning her flight training. I felt I had the better deal. It was an honor to be the third of the women to be added to a flight crew. I was to fly in mid-1984 but that flight was canceled and we were moved first to one, then a second flight in 1985. We finally lifted off on April 12, 1985, on the twenty-fourth anniversary of the first human in space and the fourth of the first shuttle launch. One of the satellites we deployed failed to activate and our crew, with a spectacular planning effort by fellow astronauts on the ground and Mission Control, had to perform an unplanned spacewalk, rendezvous and robot arm operation to flip a switch on the side of the huge satellite that was floating out our window. We accomplished all our tasks but the satellite didn't activate and a crew on a later flight rescued it. My second and third flights were Spacelab missions dedicated to life science research. Both were dream jobs for me. I had my second child before my second flight and my third after my third mission. I also served as an "astronaut spouse" for Hoot's five missions. It was a busy life! I retired from NASA in 1996 to become the Assistant Chief Medical Officer at the Vanderbilt Medical Center in Nashville, Tennessee, and then became a founding partner in LifeWings Partners LLC, which teaches teamwork to healthcare organizations. In 2015, I published a memoir about my NASA career.

Anna Fisher, the fourth of us to be assigned to fly, was the most like me. She was an emergency room physician who grew up in California and had been in the group that had interviewed with me. She married Bill Fisher, a physician who had also applied to the program, just days before her interview. Bill joined our office with the 1980 class. Anna got pregnant right after my baby was born and it was impressive to see her working at Cape Canaveral preparing shuttles to fly in an oversized borrowed flight suit as her belly expanded. Her first child was born almost exactly a year after my son. She made her first flight just 16 months later. On that flight, STS-51-A in November of 1984, she helped retrieve two satellites that had failed on my husband's first flight. Because my first flight had been delayed, Anna became the first astronaut mom in space. With the birth of her second child in 1989, she took a leave of absence to raise her family. In 1996 she returned to work on the development of the International Space Station and she is now an astronaut manager. She is the only one of our group of first six women astronauts to still be in the Astronaut Corps.

Next to be assigned was Kathy Sullivan who called California home. An oceanographer and geologist by training, she was tall, athletic and very smart. It was clear to all of us that she would be the first female astronaut to do a spacewalk. She was assigned to fly on STS-41-G to launch in October of 1984. (Not to be outdone, the Russians hurriedly launched cosmonaut Svetlana Savitskaya who did a spacewalk in July of 1984.) She and crewmate Dave Leestma demonstrated the feasibility of satellite refueling from the shuttle. She flew two more missions, the second of which was a Spacelab flight called Mission to Planet Earth. She left NASA in 1993 to become president of a science museum in Columbus, Ohio. In 2011, she went to work for the National Oceanic and Atmospheric Administration, becoming the Administrator in 2014. She demonstrated extraordinary leadership skills in all three of her careers.



Shannon Lucid was the last of our group to be assigned to flight – but she ended up with more flight hours and years at NASA than any of us other six. A biochemist from Oklahoma, she flew on four shuttle missions (one with me, STS-58, Spacelab Life Sciences 2). One of the most arduous duties astronauts were assigned in the 1990s was to go to Russia to train for a mission on the Russian Space Station *Mir*. It entailed a year of language and flight training in Russia culminating in five months in Earth orbit. Launched on a Soyuz rocket in March of 1996, Shannon settled in with her two Russian crewmates with her usual cheerfulness and determination. Unexpectedly, the mission was lengthened by six weeks and she set a single-mission spaceflight endurance record of 188 days on the Space Station *Mir*. Combined with her 35 days on shuttle missions, she far exceeded the flight time for the rest of us six. She retired from NASA in 2012 at 69 years of age after almost 34 years as an astronaut.

This group of women were diverse in education, personality and career paths, but all were determined to prove that there was a place in space for women. During our careers at NASA more women were selected for the astronaut program – women from different races, women with different skill sets. Eileen Collins became the first woman to command a shuttle mission. Women were promoted to other roles within NASA. There were women flight directors in Mission Control, women leaders of directorates and now a woman Director of the Johnson Space Center, Dr. Ellen Ochoa. The first six of us opened the door for them and for other women who seek to reach for the stars!

About the Author: Dr. Rhea Seddon, one of the first six women to enter NASA's Astronaut Program in 1978, served as a Mission Specialist on missions STS-51-D and STS-40 and as Payload Commander in charge of all science activities on mission STS-58. Following her 19-year career with NASA, she was the Assistant Chief Medical Officer of the Vanderbilt Medical Group in Nashville, Tennessee for 11 years, where she led an initiative aimed at improving patient safety, quality of care, and team effectiveness by the use of an aviation-based model of Crew Resource Management. She was a founding partner of LifeWings Partners LLC which teaches this concept to healthcare institutions across the nation. In 2015, Rhea was inducted into the U.S. Astronaut Hall of Fame. She is married to fellow Astronaut Hall of Fame inductee Capt. Robert "Hoot" Gibson. They have four children and reside in Murfreesboro, Tennessee.

Finding Success Among the Failures

by Charles H. Lowry

How can a program with over 50,000 failures be called a success?

That was Apollo. How did we ever get to the Moon and back with that astounding number?

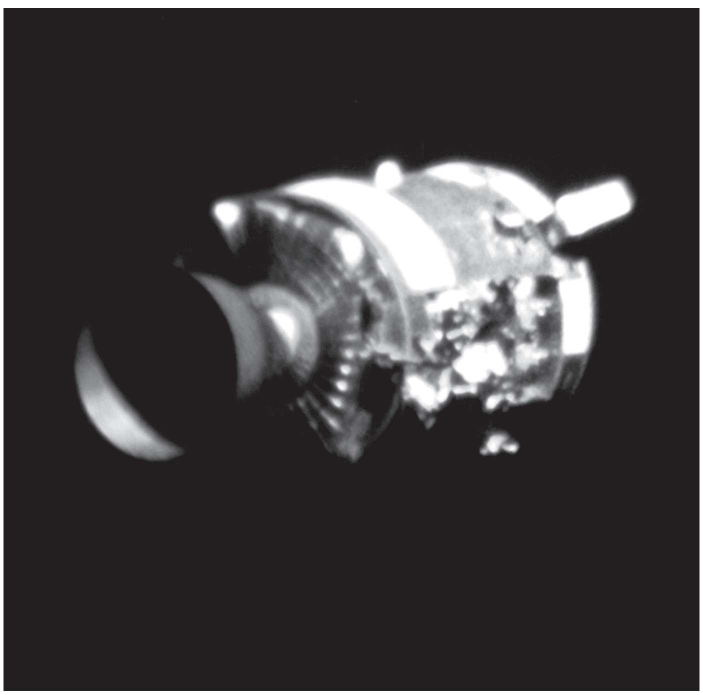
I'm sure we can all agree that Apollo was hugely successful. But if you worked on Apollo, you knew getting to the Moon was a rocky road. So it is for any complex, cutting-edge program.

What about these 50,000 plus failures? They were mostly individual piece-part/component failures. Those that kept an army of people scrambling to do failure analyses, corrective actions, retest requirements-and convincing the program and customer that we are still on track. One could ask-did we get to the Moon because of good parts, or did we get to the Moon in spite of bad parts?

We had big failures too—like Apollo 1 and Apollo 13. Plus, we had a number of significant potential show-stoppers during development like blowing up a service module tank in the pit and sinking B/P 28 after a water landing test.

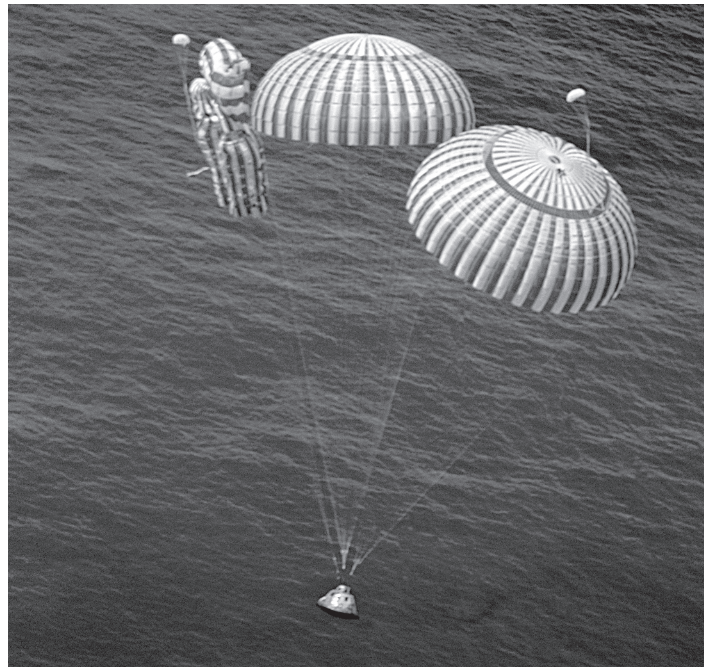
There were many in-flight anomalies, mostly forgotten by now but interesting to look back upon. Like the Apollo 14 docking probe and Apollo 15 parachute/RCS conflict.

But still, we successfully carried out the President's edict to land men on the Moon and bring them home safely in the decade of the 1960s. We didn't do badly in regards to the budget, either.



NASA Photo

***The damaged Apollo 13 Service Module (SM) was photographed from the Lunar Module/Command Module following SM jettisoning. An entire SM panel was blown away by the apparent explosion of oxygen tank number two located in Sector 4 of the SM. The damage to the SM caused the Apollo 13 astronauts to use the Lunar Module (LM) as a "lifeboat." The Lunar Module* "Aquarius" *was jettisoned just prior to Earth reentry by the Command Module* "Odyssey."**



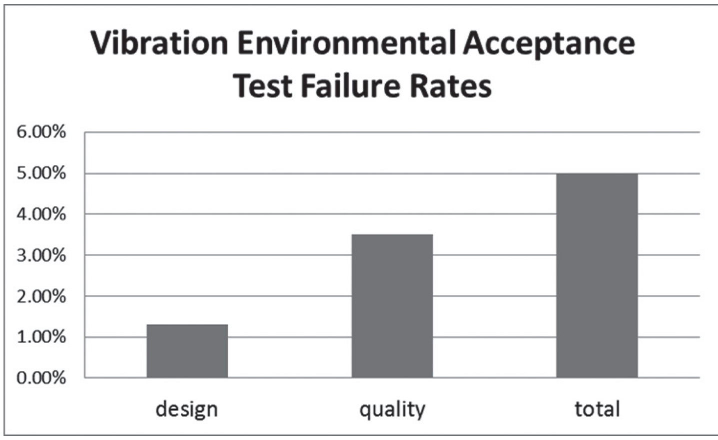
NASA Photo

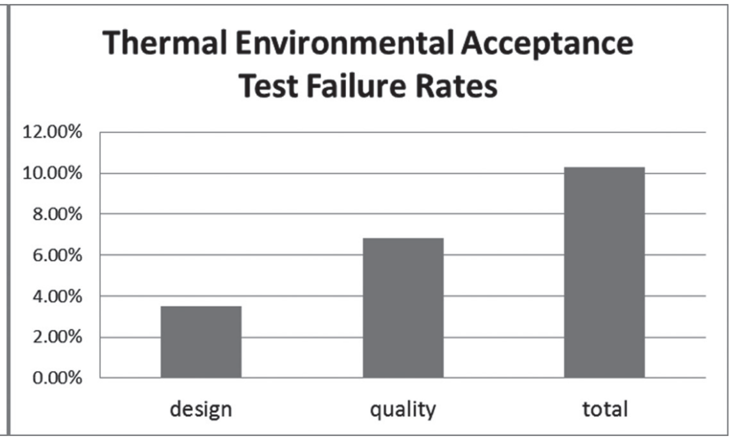
The Apollo 15 Command Module* "Endeavour" *nears a safe touchdown in the mid-Pacific Ocean. Although causing no harm to the astronauts, one of the three main parachutes failed to function properly.

Back to the part/component discussion—there were over 20,000 firms and over 250,000 people working on the Apollo program-many producing flight parts like valves, wiring, instruments, tanks, materials, uprighting bags, etc. All these were on contract to furnish "space rated" parts-parts that met high standards in terms of quality and reliability. Manufactured parts were required to be built to highly controlled standards, inspected, and typically subjected to defined acceptance tests to verify that they were good parts-and ready to go to the Moon. But early in the program it became evident that across-the-board failure rates were excessive. Parts were being received and installed, only to find that individual part failures kept our systems build-up and check-out processes in low (or reverse) gear.

In the wake of the Apollo 1 fire, a major effort was launched to significantly improve part/component quality/reliability. Additional and more stringent acceptance tests were defined for the Command/Service Modules (CSM) and the Lunar Module (LM). The objective was to weed out weak parts early. This move proved hugely successful.

Specifically, part/component acceptance tests were redefined to include vibration and thermal exposure tests, and were renamed "Environmental Acceptance Tests." Each part type was individually judged as to what exposure would be most appropriate for it, and factors such as sensitivity, inspectability, and criticality were considered. Obviously, the severity of exposure to vibration and thermal levels had to be carefully defined so as not to overly stress and thereby degrade parts that were going into the flight vehicles. Development testing of many types of parts established levels necessary to detect weak parts without being too severe.





Environmental Acceptance Tests

The charts above show results of a large number of these Environmental Acceptance Tests (NASA SP-287). The left hand table shows failure rates during vibration exposure of 11,447 parts of 166 different types. Roughly 5% of those parts failed, mostly for reasons of workmanship. The right hand table shows similar data from thermal exposure or thermal cycling of 3,685 parts of 127 types. Roughly 10% of these parts failed, again mostly for reasons of workmanship. The large numbers of tests under controlled and standardized conditions produced data of statistical value that allowed meaningful interpretation of underlying factors. The majority of these failures were found in electrical/electronic parts and were "material and processes" in nature. The startling realization was that these parts had been delivered as "space rated" parts, ready for installation, checkout, and on to the Moon!

The inclusion of these Environmental Acceptance Tests was of extreme value in terms of maintaining program schedules and conducting successful missions. One measure of value was to log data on how many "escapes" occurred-that is, how many parts successfully passed Environmental Acceptance Tests and subsequently failed in checkout or flight. For the CSM, it was only 3. (For Shuttle, it was 8.) Not bad!

On the Apollo CSM Program, a significant percentage of the effort and cost went to providing mission abort capability. The entire Launch Escape System with its 6 launches at White Sands Missile Range, plus all the associated mission planning and crew training were major efforts to provide this means of crew survival in case of booster or trajectory problems. And, of course, we never had such an abort, but was important that the necessary capability be there.

We did have a number of failures/anomalies in flight. The chart below (NASA SP-287) shows a tabulation of component failures for certain CSM and LM missions. Notice there is no downward trend in the reported failure rates that one might expect from continued usage and on-going scrutiny of parts/systems as more launches occur. Perhaps the answer can be found by (over-simplifying and) considering that if we have around 2 million parts in the vehicles-and if one assumes each part has a reliability rating of 0.99999 (can't average much better than that), then we would expect and predict around 20 failures per flight. That's not far from what we experienced!

Mission	CSM	LM
Apollo 7	22	—
Apollo 8	8	—
Apollo 9	14	12
Apollo 10	23	15
Apollo 11	9	13

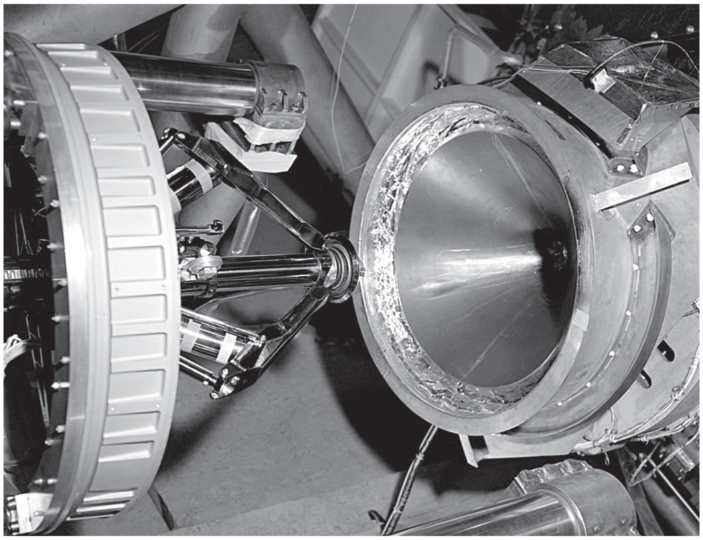
Documented In-Flight Anomalies

That says with such a huge number of parts on board, we cannot avoid several part failures on every mission, and we must prepare for that reality. Apollo did that masterfully, as evidenced by our many successful missions that overcame numerous in-flight anomalies. This was done by providing prudent component/system redundancy, stringent reliability-related activities, extensive flight crew and ground support training, and well thought-out procedures.

Of course, not all anomalies were due to parts failure. Some notable ones were caused by external influences-such as the collapsed main parachute on Apollo 15, referred to earlier. After a successful lunar landing and return to Earth's atmosphere, the cluster of 3 main chutes was observed to be fully inflated and descending properly. Midway through normal descent, suddenly one main chute collapsed and the Command Module descended to a safe, but rather hard landing with only 2 chutes. Investigation showed that early in the descent, the RCS was expelling surplus fuel (Hydrazine), and as it exited the hot RCS nozzles it was picking up oxygen from the air. The result was flaming globules of fuel (balls of fire) drifting up through the main chute cluster, severely damaging one of the chutes. Maybe we were lucky—it could have burned away 2 or even all 3.

This Apollo 15 experience was a case where really nothing failed—the two systems worked flawlessly but one system interfered with the other with near disastrous results. There was nothing the crew could do except grit their teeth and prepare for a rough landing. All ended well and the program learned more of the importance of scrutinizing possible "Intra-system" effects.

Let's look at Apollo 14 for an interesting study in part/system failures/anomalies. Since Commander Alan Shepard had been returned to flight status after several years of health problems, he was highly determined to lead a successful lunar landing mission—nothing was going to stop him. But soon



NASA Photo

An engineering set up of the docking system of the Apollo spacecraft. The docking probe on the Command Module (left) engages the cone-shaped drogue of the Lunar Module (right). The docking structure forms a tunnel through which the astronauts transfer from the Command Module to the Lunar Module. Following CSM/LM docking, the drogue and probe are removed to open the passageway between the modules.

after launch and trans-lunar injection, the crew was unable to conduct the first CSM docking with the LM. Five tries where the Apollo docking probe head was driven into the LM cone-shaped drogue failed to produce capture, or "soft" docking. The probe head had 3 spring-driven capture latches that should have engaged with the drogue, so that the probe could retract and pull the two vehicles together for a "hard" docking. So with the ground support training, preparation, and knowledge, a "brute force" procedure was worked out in real time. And with the flight crew's determination, docking was successfully accomplished on the sixth try—which salvaged the mission.

But solving the docking problem did not mean that all was well on the Apollo 14 mission. Upon separating (undocking) the LM from the CSM in preparation for lunar descent, a warning light in the LM indicated a circuit problem that would not allow arming the automatic LM abort system. This system would safely deliver the crew back to the safety of the CSM had the LM gotten into an unsafe situation prior to landing—and was mandatory for "go" for descent. Tapping the arming switch indicated some kind of intermittent condition, like perhaps a loose solder ball.

So Mission Support rounded up a person from home that quickly created and uploaded code that would bypass the errant circuit and allow normal descent. Great news, but one more problem awaited them. During descent, the landing radar did not arm when the switch was thrown—another mandatory system. After considerable troubleshooting, they were able to clear the problem by cycling the breaker. Successfully dealing with problems of this nature in real-time was due to extensive understanding of the hardware/software, preparation, training, and having the right people on standby.

Since Apollo 14 immediately followed the Apollo 13 failure to land on the Moon, severe political consequences would doubtlessly have hit the program had this lunar landing not been successful.

Did other programs of that day have comparable levels of anomalies and failures? The A-12/SR-71 program was under active development and operation roughly coincident with Apollo. They lost 20 aircraft over a period of 25 years. By one count, 11 of those 20 losses were caused by system malfunctions. And referring back to Apollo's 50,000 parts failures, this failure rate was reported to be 4 times improved, compared with Mercury. So yes, complex programs do and will have failures.

Much can be learned from a successful program as huge and as well documented as Apollo. After completion of the Apollo program, several excellent documents looked back and summarized various important aspects of the program. George Low (NASA SP-287) summarized the "3 basic ingredients" of Apollo's success: spacecraft hardware that is most reliable, flight missions that are extremely well planned and executed, and flight crews that are superbly trained and skilled. Then he added—attention to detail and personal dedication. Certainly all of these points played into the ultimate success of Apollo 14 and, indeed, all the missions.

J. H. Levine (AIAA 70-375) provided other valuable insights into the value (or not) of some of the program analyses we, grudgingly, spent a lot of time on. He said that FEMA/CILs and fault trees were good for identifying critical parts and functions and for providing basis for many kinds of critical, real-time decisions. But they were limited by analysis of what we thought could fail. He also said that numerical reliability predictions did not predict failure rates well (indeed, this was discontinued on much of the Space Shuttle program).

Mr. Levine continued by saying we were right by generally requiring qualification testing of 2 units of each design—one for design limit testing and the other for mission life testing. He added that testing at higher levels of assembly was highly advantageous if the proper environments could be achieved. Finally, he said post-test teardown and inspection was generally valuable, whether a failure had occurred or not. Summary comments like these are invaluable for the many important programs that followed Apollo, and those of today.

Aerospace programs today look back on Apollo as the trailblazer for superior technical management of complex programs. Environmental Acceptance Testing is routinely done today and some observers feel it is actually overdone—at a cost. And certainly NASA and commercial manned spacecraft programs draw heavily from Apollo experience, seeking excellence and efficiency in their current programs.

Those at NAA and Rockwell can take much pride in having a major role in that Apollo landmark program.

About the Author: Over the years, Chuck Lowry has become a well-known author to readers of the NAA Retiree Bulletin. He is deeply appreciated here at the Bulletin because he is the "Go To" person when there is a problem! Whether the call is, "Chuck, we need a three page article for the next issue and we need it yesterday" or it is "Chuck, we need a technical speaker for the USAF Academy. Can you make it?" Being a member of the North American Aviation family, the answer was always "Yes!"

Man's Quest for Flight

by Larry Korb

The Beginnings

Life apparently started in the oceans, for God made it easy to survive by moving away from danger. First of all, fish did not have to fight gravity as the later land animals did. Fish have a bladder, which they could fill with air or discharge air, allowing them to change depths by changing their buoyancy. As a result, they need much less oxygen and can survive by using their gills to extract the oxygen dissolved in the seawater, which is only 5-8 parts per million. Fish could also move more than 20 feet in a second with a mere flap of their tails. They could maneuver so easily! Animals migrated to land as the oxygen atmosphere arose to about 21% of the atmosphere or 210,000 parts per million. We needed so much more oxygen because we were often fighting against gravity.

Those animals on land did not have it so easy. They could jump into the air a few feet, temporarily fighting gravity for a split second. They could also climb a hill or steps, but many puffed heartily if the number of steps or the hill was too high, for gravity was the burden for living ashore.

Ancient men marveled at the birds that could seemingly take off into the air with a jump and a flap of its wings. They knew that objects heavier than air could fly. Birds could soar for hours, barely flapping a wing as they searched for prey from above.

Every year, millions of monarch butterflies, born in the fall of the year, migrate nearly 3,000 miles from Canada and United States to central Mexico to mate. Along the way, they have to fly across the mountain peaks. (It's hard to believe they can even have sex after this horrendous journey.)

Birds, such as the Sooty Shearwater have been tracked electronically flying a total migration distance of 40,000 miles, whereas bar-headed geese have been seen flying at an altitude of 29,000 feet, the height of Mount Everest. Man has tried not to be outdone! Throughout his history he has searched for ways to get airborne.

Kites

Perhaps the earliest recorded flight by man occurred in China in the decade of 550-559 AD, when Chinese Emperor Kao Yang carried out the systematic extermination of the T'opa and Yang families, massacring 721 of them in the last year of his reign. He had them thrown from the 100-foot Tower of the Golden Phoenix near the city of Lin Chang, after being harnessed to great bamboo mats for wings and allowed to fly to the ground. Gravity took care of the situation and all died.

Later, he had them jump as test pilots for large kites. One of these, the Prince of Wei, a member of the Yuan family, succeeded in flying his kite as far as the Purple Way, reputed to be over a mile distance, and then came to Earth alive. But rather than rewarding him by sparing his life he was handed over to the President of the Censorate, who had him starved to death. The Chinese discuss the use of manned kites for spying on enemy formations in the 6th century AD. Marco Polo recalled that Chinese ships, when getting ready to sail, had men put on willow kites, which were flown in the wind by the crew. If they rose out of sight, the sailing trip would be successful, but probably not for the kite pilot!

Hot Air and Helium Balloons

For the next 1,223 years, the kite was the only way man could break the gravitational umbilical to the Earth's surface. Then, in 1782, a couple of French brothers, Joseph and John Montgolfier, filled a silk bag with hot air and noticed it was lifted to a high ceiling. It was an example of using buoyancy, just like the fish do. If the bag and its internal gas weighed less than the ambient air, it would rise. I think most people at that time knew hot air is less dense and does rise, especially if they observed the flames rise from a burning fire. But the Montgolfiers were visionaries and they sought to exploit this observation. What better way to do it than make a much larger spherical bag and fill it with hot air from a fire and send up several farm animals in a basket beneath it! And so they did on April 26, 1783. It was very successful!

Apparently, the word had spread around and a French scientist, Pilatre De Rozier, launched a hot air balloon on September 19, 1783, containing a sheep, a duck, and a rooster. It stayed in the air for 15 minutes, before it came crashing to the ground. The Montgolfier brothers built a 70-foot diameter balloon, made of linen and paper lined, launched it at the Bois de Boulogne in Paris on November 23, 1793. It carried Pilatre de Rozier and the Marquis d'Artandes. The balloon rose to approximately 3,000 feet, remained aloft for 25 minutes, and traveled an estimated 5 miles. De Rozier became famous as the first hot-air balloonist but did not enjoy his fame for long.

Two years later, a French balloonist, Jean Blanchard, along with an American co-pilot, Dr. John Jeffries, became the first to fly across the English Channel. On his first trip, he added a hand-powered propeller and on his second trip, he added flapping wings. I don't think either helped his voyage.

That same year, de Rozier tried the same trip using a hydrogen balloon tied together with a hot-air balloon. While he knew hydrogen is about 1/14th as dense as air and the most efficient gas for filling balloons, apparently he didn't adequately address its combustibility. Five miles out, the balloon exploded and he died. Meanwhile, Jean Blanchard, some 8 years after successfully crossing the English Channel, brought ballooning to America and George Washington watched the launch. Accordingly, interest in ballooning has been continuous for the last 233 years. The use of hot air is still common for balloon trips carrying passengers for recreation but the use of helium, ~1/13th the density of air, is commonly related to scientific and commercial applications.

Hot-air ballooning has changed over the years, for many years the fuel for heating it was "anything that burns'" and consisted of paper, twigs, stalks, and straw. It wasn't until the 1853 that Abraham Gesner derived a flammable liquid from waxy hydrocarbons (called kerosene, after the Greek word for wax). Note that kerosene is the fuel used for first stage rockets, such as the Saturn V, and is called RP fuel. In spite of fuel limitations, altitudes of 13,000 feet were achieved just a year after the hot-air balloon was introduced and an altitude of 23,900 feet was achieved some 20 year later. Today, hot-air balloons use propane heaters and gas temperatures reach just above the boiling point of water (212 °F) and today's balloons are made of nylon or dacron fabrics. The world's altitude record for a hot-air balloon is 68,986 feet.

In 1978 the *Double Eagle II* became the first balloon to cross the Atlantic Ocean and was helium filled. Three passengers made the trip in a record 137 hours. In 1987, Richard Branson and Pier Lindstrand crossed the Atlantic in a hot-air balloon. They flew 2,900 miles in a record breaking time of 33 hours using a gigantic 23 million cubic-foot balloon. The same team flew across the Pacific Ocean in a hot-air balloon and traveled 6700 miles in 47 hours. In 1999, the first round-the-world balloon flight was made by Bertrand Piccard and Brian Jones in 19 days, 21 hours, and 55 minutes; again in a hot-air balloon.

The altitude record for a gas filled balloon is 128,100+ feet set on October 14, 2012 by Felix Baumgartner, who took it up for the world's highest parachute jump, but the record will not be accepted—he didn't return with the balloon to Earth. During his jump, he exceeded the sound barrier (Mach 1.24 or 833.8 miles per hour), and was subjected to temperatures of -70 °F. Strangely enough, it occurred on the 65th anniversary of Chuck Yeager's X-1 flight, which first broke the sound barrier. Baumgartner, an Austrian, had made more than 2,500 parachute jumps at that time.

Hot-air ballooning continues to be an exciting recreation for many in this country and more than 600 balloons show up annually at the Albuquerque International Hot-Air Balloon Fiesta.

Perhaps, the major disadvantage of hot-air ballooning is that you can control the flight in only one direction, the altitude. Otherwise you are at the mercy of the winds. You can rise to various altitudes to find a favorable wind, but usually the balloonist is in radio contact with a ground crew regarding where the balloon eventually will be landing. In addition, it takes a crew of 4-5 people to handle the balloon when it is being inflated and it can't be launched in winds exceeding five to 10 miles per hour. An experienced crew can have it in the air in 10-15 minutes. After landing, the balloonist has to fold and repack the balloon on a trailer.

Airships

Airships are a family of lighter-than-air (LTA) crafts that are propelled through the air in a horizontal direction. Generally, they are classified in 3 families: dirigibles, semi-rigid airships and blimps. They are generally cigar-shaped to aid in their forward motion and contain a vertical fin, and a small horizontal stabilizing wing-like structures on the tail end.

A dirigible has a structure in which gas-filled tank cells carry the lifting gas and the exterior skin is supported by these structural members.

A blimp has essentially no structural members and the skins are shaped by air pressure. It can be collapsed and transported as necessary. Because it is often necessary to add a flight control compartment to the underside (gondola), to which engines are attached, the semi-rigid airship has a keel to take the engine and gondola loads, but internal pressure shapes the skins. Actually, it was Baptiste Henri Jacques Giffard who made the first dirigible and launched it on September 24, 1852 (before the American Civil War) and made a flight of nearly 17 miles from Paris to Tappes. He was able to steer and turn the powered ship, but could not return because the wind was too strong on the return trip for his 3-horsepower, propeller-driven steam engine. The dirigible's steam engine weighed over 400 pounds. The dirigible was filled with hydrogen. There were many developments during the period from 1852 to 1900.

A Zeppelin is a dirigible built by the factory of Count Ferdinand von Zeppelin, who is considered the father of rigid air ships in that he perfected the dirigible in 1900. For power he used a propeller driven by the recently invented light gasoline engines and the newly developed lightweight aluminum for structure. The Zeppelin was the gold standard for many years. The *Graf Zeppelin*, certainly one of the most famous dirigibles, flew passenger from Frankfurt, Germany to Recife, Brazil from 1928 until 1937. What was the advantage? It was more than 2-1/2 times as fast as an ocean liner and was remarkably safe. The *Graf Zeppelin* traveled 990,000 miles without a passenger accident. It was 2-1/2 football fields long, 100 feet in diameter, and had a hydrogen gas capacity of 2,650,000 cubic feet and also had over a million cubic feet of blaugas (similar to propane) for fuel. It had almost 192,000 pounds of lift, and 5 engines of 550 horsepower each. It made 590 flights, flew 17,200 flight hours and carried a total of 34,000 passengers of which most were the flight crew (13,100 paying passengers). It also made the first round-the-world airship flight.

The *Hindenburg* Zeppelin was even larger. With a gas capacity of nearly 7,100,000 cubic feet, it was 2-2/3 football fields long and 135+ feet in diameter. It had a lifting capacity of 512,000 pounds, a cruising speed of 76 mph, and four 16-cylinder Daimler-Benz diesel engines, and was manned by a flight crew of 40 officers and men. It had 72 passenger sleeping berths. On May 6, 1937, minutes before approaching the mooring mast in Lakehurst, New Jersey, the tail caught on fire, burst into flames and the dirigible crashed. A total of 97 people were on board and 37 died. That was the death knell for hydrogen filled airships, and the next day the *Graf Zeppelin* was also taken out of service.

Hydrogen was easily obtained by reacting zinc or iron with sulfuric acid. Helium, the second lightest gas was in such short supply at that time that the two U.S. Navy dirigibles, the *Macon* and the *Shenandoah*, in 1923, had to operate one at time, sharing the helium gas, which at that time was most of the world's reserves.

Are there any other light gases that could be used, other than hydrogen, helium, and hot air? Yes, any gas that has a molecular weight of less than 29 (average molecular weight of air) could be used. Hydrogen can lift 71 pounds per 1,000 cubic feet, whereas helium can lift 66 pounds and steam can lift 39 pounds per 1,000 cubic feet. Other light gases such as methane, carbon monoxide, and ammonia, as well as hydrogen sulfide could be used, but all of these are flammable and many are toxic. If a dirigible filed with hydrogen sulfide blew up, it would raise a major stink! Even steam could be used, but you would have to keep it from turning to liquid in the upper atmosphere. The highest flight made by the *Graf Zeppelin* was 5,500 feet, but pressurized airships did reach 8,000 feet. Airships can be designed to attain some lift when traveling forward (up to 10% of the static lift capability).

As an offensive weapon, airships were useless. In World War I they were used to bomb London, but the cloud cover and poor bombing accuracy made them impossible to justify. But as a defensive weapon, they were superb. In the early days of World War II, German subs sank some 532 unescorted ships near the U.S. coast. By escorting ship convoys, the blimps dropped depth charges and forced the U-boats to submerge deeper and limited their range. U-boats were unable to move as fast as the convoys from these depths. Of more than 70,000 or so ships in convoy, protected by blimps, only one ship was lost, the tanker *Persephone*. A U-Boat did take out one blimp with its guns. Airships made 37,500 flights and flew 378,000 hours during World War II. In addition, blimps using magnetic anomaly detection equipment were stationed at the Straits of Gibraltar and could readily detect and attack German subs trying to enter in these shallow waters. The PBY bombers had the dayshift and the Blimps had the night shift. Today airships deliver us observations of football games and golf. They are also used to find Kimberlite pipes, geological features where diamonds are usually found.

Contrary to most people's expectations, a dirigible or blimp cannot be brought down by small arms or machine gun fire. Its pressure is slightly above ambient pressure and so helium leaks out very slowly. It can normally leak for several hours and the airship can still return to base.

What are the advantages of dirigible? Dirigibles have extremely high lifting power without using energy (due to buoyancy) and ability to hover. Their disadvantages: they move slowly, can be destroyed in a storm (The U.S. Navy lost its three dirigibles, the *Macon*, the *Shenandoah*, and the *Akron*, in a period of a decade due to severe storms (1925-1935).

Modern Dirigibles

Will the dirigible essentially become extinct? I doubt it. If you have the money, you can buy a NAGY airship for 210 million Euros, which will carry 600 passengers for a range of 7,000 miles. It has 4 floors and travels 200 mph. For 280 million Euros you can buy a 400-ton cargo carrier that can drop 118,000 gallons of water to fight fires, compared to less than 10,000 gallons for a "Super Scooper" aircraft. It can hover above the fire and refill quickly in open water. You could buy a large cargo carrier (1,065 tonnes lift—23.4 million pounds) which can travel 200 mph for a 7,000 mile range. It could take 15.8 million pounds to 10,000 feet altitudes and requires no energy to be added by man to achieve this-158 billion foot-pounds of potential energy. How neat is that! Airships are truly anti-gravity machines! (Airships use the same buoyancy principles developed by fish some 580,000,000 years ago.) What took us so long? This large cargo airship is ideal for carrying oil pipes to oil exploration sites anywhere on earth (at any altitude) and large bridge structures over difficult terrain and place the parts on the bridge that is being built. It will only cost you 360 million Euros. I don't think we have seen the last of the dirigibles.

Gliders (Sailplanes)

While many contributed to the development of gliders over the years, two scientists, in particular, defined the aerodynamics and the proof of concept of the glider that later allowed the Wright brother to invent the airplane. They are Sir George Cayley and Otto Lilienthal.

Sir George Cayley was born to an aristocratic family in England in 1773, the year the hot-air balloon was invented. He was fascinated by engineering projects and developed the tension spoke wheels (bicycle wheels) for weight savings, seat belts, small helicopters with counter rotating blades (at age 23), caterpillar tractors, and a small internal combustion engine in which he burned gunpowder. He also contributed in the field of prosthetics, air engines, electricity, theatre architecture, ballistics, optics, and land reclamation. In the field of aviation, he is credited with being the Father of Aviation. He defined the four aerodynamic forces: lift, drag, thrust, and weight that act upon a flying object. He found that by adding dihedral to the wings, it made the glider more stable (Dihedral is having wing tips higher than the wing attachment points). He studied the lifting power created by increasing the angle of attack and found out, through test, that a wing with a convex upper surface (camber) provided more lift than a flat wing. To investigate drag on objects traveling at various speeds, he built a "whirling arm apparatus, which had been developed for earlier ballistic studies of air resistance. In 1849, he built a triplane (3 wings) that was flown a few meters by a ten-year old boy.

His crowning achievement, however, was the design a large glider for flying across the Brompton Dale. The glider was similar to today's gliders in that it had large dihedral wings (477 square feet), which were uplifted 8-10 degrees from the horizontal, a long fuselage, a tail containing horizontal stabilizers and a vertical fin, and the center of gravity was adjustable by a movable weight. The weight was also below the level of the wings. The wings were made by stretching a fabric over cane frames and wire braced. The entire glider weighed 150 pounds and 150 pounds was left for the pilot. In 1853, as the story goes, he ordered his coachman to fly the glider, pointing out that since he, himself, was 79 years old, he was too old to be a pilot. The glider flew about 600 feet before it crashed. The coachman quit the next day! Note: this flight was 50 years before the successful flight by the Wright brothers.

Otto Lilienthal was born in Germany in 1848 and, because of his experiments and flights, became known as the Glider King. He and his brother Gustav were fascinated by the idea of manned flight. They made strap-on wings but could not fly off the ground. He built an artificial hill 40 feet high and conically shaped from which to fly, realizing, regardless of the wind direction, he always had a potential flight path.

He devised a small engine that worked on a system of tubular boilers and it was safer than existing engines at the time. This invention provided him the money for his gliding experiments.

Photo via Larry Korb

Otto Lilienthal in his Small Biplane glider in Germany, circa 1895.

His glider patent in 1894 in the United States had a bar for carrying and flying the "hang gliders." The A-frame of Lilienthal glider is today's control frame for hang gliders. He made over 2,000 flights witnessed by hundreds of people. He had some flights covering a distance of up to 82 feet, but when he could use the updraft of over 30 feet per second on the hill, he was able to attain distant flights. One day his first flight was 820 feet. The same day, however, on his fourth flight his glider nosed down and he crashed from about 50 feet high. He broke his neck, and despite an operation, lived only 36 more hours, dying in 1896. His gliders were designed to distribute weight as evenly as possible for stable flights. Like modern hang gliders, he could control them by shifting his weight. Unfortunately, his control bar was located at his shoulders and the flights had a tendency to nose down, unlike today's hang gliders whose wings are well above the pilot.

Seven years after Lilienthal's death, the Wright brothers flew the first manned powered glider, which we call an *airplane*. The table was set for the Wright brothers and they, in turn, presented the flight enthusiast with a large and exciting menu. For the next 30 years the airplane took center stage and the glider disappeared from the scene.

Modern Gliders

Starting in 1930, renewed emphasis on the glider appeared, led by development of lighter weight materials, advances in aerodynamics, and advances in instrumentation. This progress is best illustrated by the gain in the glide ratio from 17:1 to 70:1 over the next 80 years. (The glide ratio is the distance traveled horizontally for every foot of altitude lost.) The Boeing 767 has a glide ratio of 12:1, whereas the Space Shuttle has a glide ratio of 4.5:1. Early gliders used wood and cloth, later to be replaced by aluminum, then epoxy- fiberglass, and ultimately, epoxy-carbon composite, greatly lowering their weight. Aerodynamically, the wing was designed for a low-drag laminar flow airfoil and wing surfaces in fiberglass were shaped by molds to high accuracy, and then highly polished. Vertical winglets at the ends of the wings reduce drag and special aerodynamic seals at moving surfaces (rudder, elevators, and ailerons) were designed to stop airflow through the gaps. The more expensive sailplanes are designed to use wing flaps, allowing them to change both the lift and drag, similar to commercial planes when landing. Wings at mid span have zig-zag tape or holes in a line to trip the boundary layer, inducing turbulent flow and preventing the flow of laminar flow bubbles. Wing spans were significantly increased and wing widths were decreased. Some even have wipers to remove bugs from leading-edge surfaces, which interfere with desired airflow. Some even incorporate spoilers that can be used to increase the drag. The fact that the lift/drag ratios can be changed gives another dimension to piloting. Some gliders even have a water ballast tank that is used to minimize the down-force on the vertical stabilizer. (The water is jettisoned before landing.)

In the instrumentation area, the pilots use an altimeter, a compass, and an airspeed indicator. A variometer is also used. It is a device that sends out a sonic pitch that increases when you are increasing altitude and decreases when losing altitude. It is very accurate, detecting changes of about 0.5 inch per second. Thus, it aids in finding thermals. Prior to this, the pilot had to be skilled in reading the lay of the land, recognizing that thermals occur below cumulus clouds as warm air rises and condenses into the clouds. Upward currents occurred at ridges and cliff edges. An electronic variometer, using mathematics devised by Paul MacCready, tells the pilot how fast the pilot should fly between thermals and the amounts of lift or sink when in the cruise mode. This, in addition to computer devices and the GPS gives the glider's position in 3D, alerts pilot of nearby airspace restriction, shows airports within the range of the glider, determines wind speeds and direction at current altitude, provides final glide information and indicates the best speeds to fly under current conditions.

USAF photo

A sailplane set a distance record of 1,900 miles in 2010, a maximum speed of 170 miles per hour and achieved an altitude of 50,720 feet (obviously requiring parachutes and oxygen masks). Sailplanes are typically launched by being towed by airplanes or using high-speed winches with 4,000 feet of towrope. From a high-speed winch, a glider can gain 900 to 3,000 feet altitude. Skids or a single central wheel are used in landing. You can buy a glider for $2,700 to $190,000 from top European suppliers. I think George Cayley and Otto Lilienthal would have loved to see what they created. The table was set for the Wright brothers and they, in turn, presented the flight enthusiast with a large and exciting menu.

About the Author: Larry is very well known to Bulletin readers. He held leadership roles in the Apollo and Space Shuttle programs. He served on several investigating teams, including the Apollo 1 fire and the losses of Space Shuttles Challenger *and* Columbia. *He has provided the Bulletin several astute and scholarly articles reaching back into the past and far into the future. He is an Editor's dream author in his ability to produce a splendid saving article when a deadline disaster is looming in the Editor's face! Bravo Larry!*

The Last Word

by Ed Rusinek

After sixteen years as Editor of the North American Aviation Retirees Bulletin, I get the last word. When you read this editorial, you may ask, "Didn't he ever grow up?" Yes, I did grow up and am pushing ninety, but every so often, I revert back to a nine year-old boy in the 1930s when I used to sneak into the Detroit City Airport through a hole in the fence and wander from hangar to hangar, admiring all the beautiful airplanes, especially the Stinson Reliant, that could achieve speeds of several hundred miles per hour.

Eventually, I would get to the Main Concourse building and mooch baggage stickers from the various bored airline clerks. No one challenged my presence there because, at that time, nine year olds weren't supposed to be wandering around airports alone!

After returning from the service, obtaining my B.S. degree and joining NAA in 1951 at Downey on the Navaho Missile program, we had already flown past Mach 1! AND I never got to work on an airplane!

In 1957, the Russians launched *Sputnik* and the Space Race was on! Although we suffered some stupid disasters early in our Space Program trying to imitate *Sputnik*, we managed to recover through the efforts of Wernher von Braun. We later successfully built and launched an unmanned Apollo Command Module – Spacecraft 9, and went on to assemble the first manned vehicle, Apollo 1.

In conducting ground tests on the pad, NASA insisted that tests be under pressure with pure oxygen. A simple spark caused a blast furnace condition and we lost three Astronauts. Working on the commercial principle that the Customer is always right, several of our best managers had to take the "hemlock cup" and resign!

On the morning of the *Challenger* launch, the temperature had dropped so low that the seals on the two Solid Rocket Boosters were questionable and Morton Thiokol engineers recommended delay until the weather improved. NO! NASA insisted we had to launch because there was a teacher on board and all the school kids were watching! After the explosion seconds into the launch, they would be watching for three more long years before another space shuttle launch took place.

In 2003, we launched our veteran shuttle *Columbia* on her 28th mission. Our engineers noticed that as the vehicle left the pad a chunk of foam insulation broke off from the External Tank and struck the leading edge of the Shuttle's left wing. Our engineers were concerned that this was critical but NASA reasoned that there was nothing that could be done and that suggested delays and repairs were unnecessary. Upon return to the Earth's atmosphere, hot gases entered and destroyed the integrity of the wing, causing the vehicle to break apart. And scattered *Columbia* across two states.

This time, we lost two more years in the completion of the Space Station with the usual assumption of fault and destruction of reputations.

We now ended up with a fantastic Space Station, three very operable Space Shuttles and a strong cadre of highly educated and skilled Astronauts. What do our Diddly-Dos and Diddly-Don'ts in Washington do? They totally erase our Manned Space Program – destroying our three perfectly good shuttles and all supporting launch structure at KSC! We now must beg and pay the Russians $65 million to deliver each of our Astronauts to our own Space Station!

Like the Romans of Caesar's day – to reduce the outcry over their act of total stupidity – they provided the Masses a pompous show. They posted the three remaining flyable Shuttles around the country to show with chest beating pride, "See what we HAD accomplished!" Fifty years from now, people will look at these fantastic machines and wonder what idiot did this, in the same way as we look upon the monoliths at Easter Island and wonder who placed them there and why?

In 1995, I went to Russia to help coordinate the docking of the Shuttle to the Russian Space Station *Mir*. We arrived on a Saturday morning and, after checking in, went to the huge Flea Market located just outside of Moscow. I bumped into two chaps from Collins Radio, our sister division, and found out that they were there to head up an exhibit pavilion at the Moscow International Air Show starting the following Wednesday. After a brief conversation of three compatriots, they invited our group to the air show for the following Saturday providing transportation to Zhukovsky, the once top-secret air base, with the warmest guest hospitality!

We went, and it was a fantastic occasion. The displays were eye openers. From the flight line I watched an ancient airplane, painted olive drab, come in for a landing. It looked like a Douglas DC-3 but yet not a DC-3. Finally, I realized it was a Douglas DC-2. Among the aircraft on display was the Russian Shuttle – the *Buran*. It was an exact copy of our Shuttle with two jet engines added to fly as an airplane. In fact, it was flown in for the air show.

Lastly, among the variety of exhibits, stood an immaculate and shiny Yakovlev Yak-3, a Russian fighter of World War II fame. I entered the pavilion and was greeted by the Yakovlev representative – a grey haired man in his late fifties, neatly dressed in a blue jacket, gray slacks, white shirt and a matching tie – I asked if the plane outside had been so beautifully restored from an existing WWII aircraft. He smiled and said, *"No! American millionaires have discovered the Yak-3 and already ordered 22 of them, sans the engines. So we have dug up the old tooling and molds and have started a new small production line."* It was obvious the Russians do not destroy or throw anything away that they build, except, perhaps, THEIR STUPID POLITICIANS!

The man was so full of himself that I decided to frost his tongue. I said, *"You don't speak English like a Russian and you obviously aren't American. Who are you?"* He was somewhat befuddled and slowly said, *"I am English. I came to Russia many years ago and decided to stay."*

It was obvious that he was a Russian "Spook." I had enough of this charade and I told him, *"I think you were a spy for the Russians. You escaped from Britain and you can't go back because they will hang you!"* With that, I left him standing with his mouth agape!

In closing, we have witnessed the destruction of America's Manned Space Program in the elimination of our flying machines and the launch sites we used to launch and recover them! However, there is one more concern that I wish to bring up. The NASA has assembled the greatest group of highly trained, dedicated, intelligent and courageous Americans in our American Astronaut Corps. What are we going to do about utilizing this wonderful resource? Well, Golly Gee! Nobody said anything about them! Can't the Russians take care of them? Yes! They can deliver one American Astronaut to the Station every four months but what do the rest of them do in the meantime?

Here is a thought. We currently have no means of delivering them to the Space Station. However, we do have work going on creating new vehicles that can. In the meantime, can't we convert NASA's Johnson Space Center in Houston into a National Science Center capable of investigating and resolving the many diseases, disasters and major issues confronting our Nation today? To be led by these Astronauts, supported by the brightest engineers, scientists, doctors in the Nation and constantly to be invigorated by the very best young people coming out of our schools.

This is Ed Rusinek with The Last Word!

Congratulations and Best Wishes to

James and Geraldine Haywood of Bluffton, South Carolina celebrating their 72nd Wedding Anniversary

David and Ellen Herold of San Marcos, California celebrating their 69th Wedding Anniversary

Roderick and Rita Bang of Newberg, Oregon celebrating their 61st Wedding Anniversary

Contrails from the Past

by Ed Rusinek

Dear Ed,

I normally don't write letters, but I could not pass up the chance to add to the Jim Pearce "leg" tales.

I worked with Jim at the Cape on the Apollo Program and, one night, we went sailboat bracing off the Cape. We heard a flying fish come on board with a great commotion, then everything got very quiet. When we finally located a flashlight, we found that a flying fish had pushed its head into Jim's artificial leg! A real "hole in one!"

Jim was a great gentleman and good friend and always fun to be with at work or play.

Thanks!

— Dave Dysart, Bow, WA

Ed's Resp.: When I started "Contrails" so many years ago, I never realized the many short, short stories it would generate. Thank you, Dave, for a great story, although a bit "fishy."

Dear Ed,

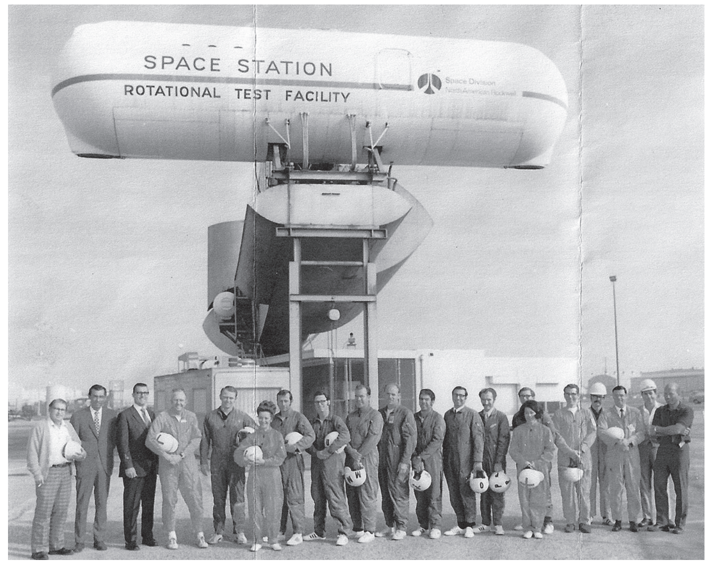
I am enclosing a clipping which indicates that the late Gary Gabelich, the last American land speed record holder, has been inducted into the Motorsports Hall of Fame.

I met Gary when I was a volunteer for tests conducted at the Space Station Rotational Test Facility in Downey. He was a test engineer on the program. When it ended in 1969, he returned to speed racing. In 1970, he drove *Blue Flame*, a 37-foot long rocket-powered car fueled by liquefied natural gas and hydrogen peroxide at the Bonneville Salt Flats. He established the land speed records in the flying mile of 622.407 mph and the flying kilometer of 1,014.52 kmph.

For my voluntary participation in the rotational tests, I received a certificate indicating I had completed a "mission" in the rotating vehicle and had undergone the "rigors of vestibular, oculogyral and proprioceptor stimulation, with some loss of gastro-intestinal equilibrium."

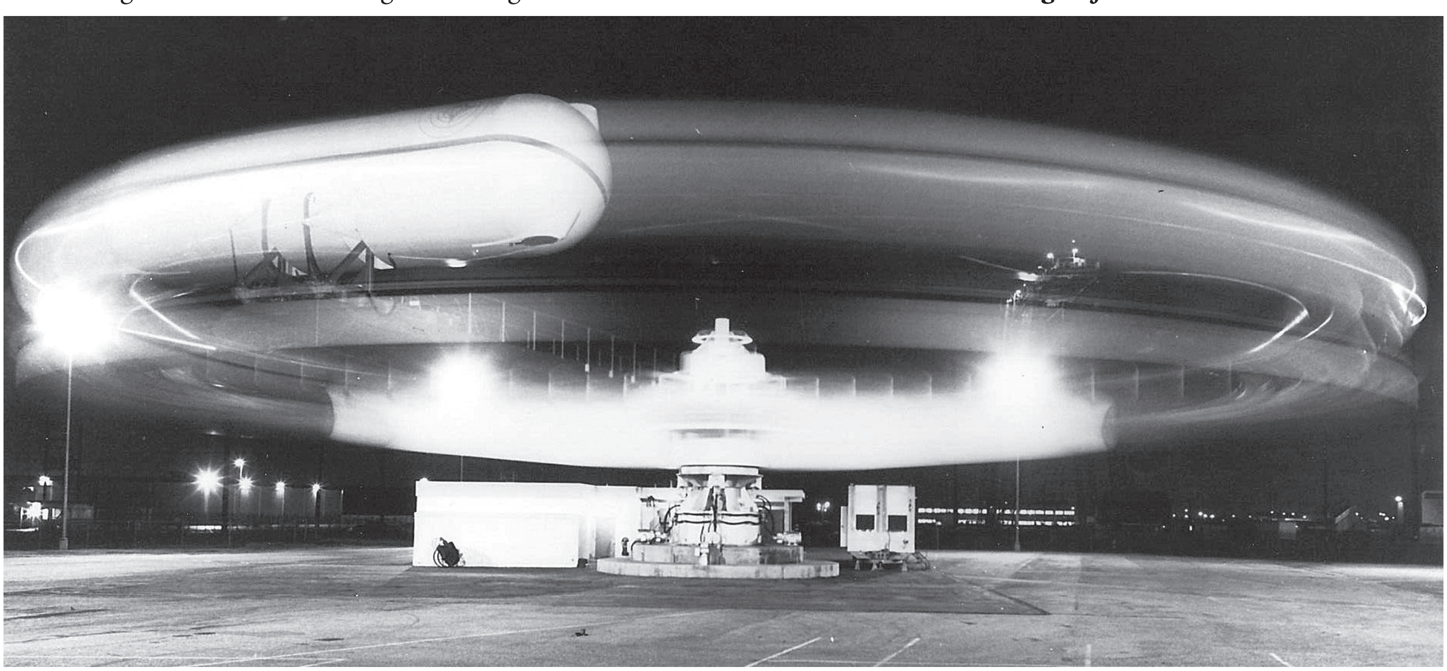
— William Hotarek, Ellensburg, WA

Ed's Resp.: Thank you, Bill, for your brief report on Gary's participation in the Space Station Rotational Tests. However, does the matter of you losing your gastro-intestinal equilibrium a nice way of saying you puked all over the test console?



Ed Rusinek collection

Volunteer participants and staff members of the Artificial Gravity Simulation Program, including Dr. James Green, Program Manager, and R.E. Greer, Vice President, Space Station Program during presentation of Certificates of Appreciation to the volunteers. Bill Hotarek is fifth from the right, front row.



Ed Rusinek collection

The Space Station Rotational Test Facility during operation appears to be almost tubular while in motion. Note the size of the fire extinguisher cart standing beside the building.

Apollo/Shuttle Engineering Luncheon

This month's Apollo/Shuttle Engineering Luncheon was held on July 20, 2016 with some new faces present. Standing in back: Pete Magoski, Ed Smith, Susan Smith, Jim Johnson, Ken Muzzy, Ralph Gatto, Chris Rogers, Chuck Lowry, Bruce Brandt, Wil Swan, Frances Farris, and Bob Kelly. Front row seated: Jerry Shamblin, Frank De Barro, Dave White, Jim Rowe, Larry Korb, Lloyd Mustin, Tak Shimamoto, Walt Rivera, and Diana Kelly.

This informal chance to break bread together is held on the 3rd Wednesday of the Month at the Hometown Buffet, 1008 E. 17th Street, Santa Ana, California at 11:30 A.M.

For more information, contact Jim Rowe at (714) 637-3020.

"For my confirmation, I didn't get a watch and my first pair of long pants, like most Lutheran boys. I got a telescope. My mother thought it would make the best gift."

— Wernher von Braun

The Silent Majority

by Stan Guzy

ACKER, OTTO G., 99 – of Columbus, OH passed away on August 13, 2016. He received his Aeronautical Engineering degree from Tri-State College in Angola, Indiana and started his career at Curtiss-Wright. He joined NAA at the Columbus Division. His assignments involved more than 40 airplane designs and working closely with the U.S. Navy included time on the aircraft carrier, USS *Independence*. He retired in 1977 with 26 years of service.

CICCHESE, JAMES J. 91 – of Agora Hills, CA passed away on July 29, 2016. Jim joined LAD in Materials in the late 1940s and retired in 1986 as Purchasing Manager of Major Subcontracts.

DEIGHT, LAWRENCE "LARRY", 92 – passed away peacefully on July 21, 2016. He came to California in 1953 and joined the B-1 effort after earning a B.S. in engineering degree at USC. After retiring, he received several commendations for his volunteer work, especially with the Huntington Beach Police Department.

GUERTIN, LESTER J., 82 – passed away in his daughter's home in Oakland, CA on July 28, 2016. Earning a degree in Chemistry from Loyola University, Les began his career at Sunkist before transferring to NAA. He worked Apollo and Space Shuttle programs. He is fondly remembered as a gentle and generous person.

MORGAN, WALLACE, 98 – of Fullerton, CA passed away on December 2015. Wallace retired from Space Division in 1987 with 27 years of service in the L&T Laboratories. He is survived by his loving wife of 46 years, Lorraine. She was also an NAA employee when they met and fell in love.

NICKEL, WALTER R., 89 – passed away on June 30, 2016. Walter came to California in 1953 and served in the Aerospace, Autonetics and Microelectronics divisions of NAA. Walt retired in 1986 and started his own engineering consulting firm. He will be remembered for his caring and gentle nature and his dedication to his family.

PRESCOTT, PHIL J. – the Bulletin received news that Phil Prescott of Los Altos, CA passed away on February 6, 2016. Phil retired in 1975 with 33 years of service at LAD and 2 at Space Division.

SARTAIN, JAMES, 84 – of Los Alamitos, CA passed away on August 16, 2016. After serving in the Army, Jim earned his B.S. degree from CSULB and an M.B.A. from USC. He retired from Autonetics in 1993 with 30 years of service and became a very active member of his church, St. Hedwig, in Los Alamitos, CA.

SPINNEY, VAN W., 78 – died on August 13, 2016. After serving in the Air Force, Van earned a B.S. degree from Northrop University and a M.B.S. in Engineering from CSU Fullerton in 1971. He retired from NAA with 28 years of service.

SQUIRES, RONALD A., 88 – of Yorba Linda, CA passed away on November 16, 2015. After serving in the Army, he earned advanced degrees from USC. Ronald retired in 1985 with 30 years of service and decided to return to his family homestead with his wife, Shirley. They returned to Yorba Linda, CA in 2000.

WOJTON, HENRY P., 94 – a true patriot, Henry passed away on June 1, 2016 in Titusville, FL. He served during WWII in the USAAF as a mechanic/crew chief. He joined NAA at the Columbus Division and was assigned to flight test at Eglin AFB. He reenlisted during the Korean War and, again, served as a mechanic/crew chief on the F-86. Returning to NAA at KSC, he served on the Apollo, Apollo-Soyuz, Skylab and Space Shuttle programs. He retired in 1983 with 31 years of service. Henry is survived by his loving wife of 55 years, Helene.

LOST SHEEP, BULLETIN RETURNED WITH NO FORWARDING ADDRESS

RICHARD HANSEN – SAN CLEMENTE, CA

PHILIP J. HODGETTS – WESTMINSTER, CA

BILLIE JO SCHELL – COCOA BEACH, FL

CARL R. SCHEUPLEIN – COCOA BEACH, FL

JOHN M. YOSAN – LA PALMA, CA

"We do not remember days, we remember moments."

— Cesare Pavese

NORTH AMERICAN AVIATION
RETIREES BULLETIN
P.O. Box 3797
Seal Beach, CA 90740

North American Aviation Retirees Bulletin
"Where The Best Never Rest"

Photo courtesy of Dr. Rhea Seddon

NASA Astronaut Dr. Rhea Seddon effortlessly lifts fellow Astronaut (and husband) Robert "Hoot" Gibson overhead while training in the KC-135 weightless environment simulator commonly referred to as the* "Vomit Comet." *Dr. Seddon was one of six women selected to become America's first women astronauts in 1978 as members of NASA's Astronaut Group 8.