Air and Space this Week

Item of the Week

BURAN VERSUS THE SPACE SHUTTLE

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NASA's earliest history was all about competition with the USSR. Which economic system was best for accomplishing "Great Things?" Since both sides had nukes, Space became a "safe" battlefield of symbols. The Russians got to orbit first, but the United States soon caught up, and got to the Moon first. The Russians did accomplish an amazing feat with their Moon program, return samples three different times with a purely robotic mission. Both sides were worried about the potential military uses of Space, and both sides used Space-based reconnaissance facilities to the best the state-of-the-art allowed to keep track of each other's activities, thereby keeping the Peace. We both built Space Stations. And we both built a reusable crewed Space plane. Ours worked, theirs didn't. This is their story.

THE NEED

Using disposable, single-use rockets to launch items to low Earth orbit is extremely costly. Political leadership recognized the value for national prestige and to develop new Space-based communications, navigation, meteorological, and scientific purposes, but over time, building an expensive launch vehicle, using it once, then discarding all of it was increasingly difficult to justify. So once the push to the Moon was over, it was time for both sides to re-asses their pathway to orbit.

NASA's post-Apollo efforts took two separate paths after the premature termination of the Apollo program: Solar System exploration (with the associated development of new technology), and building a Space Shuttle that was basically re-usable. The former retained some of its value as a symbol of national technological prowess, and produced some very interesting science besides. And a re-usable Space plane that took off like a rocket but landed like a cargo plane, could significantly reduce launch costs, thereby making many applications of orbital access economically feasible.

The Russians similarly recognized some sort of shuttle as a feasible solution to the high cost of orbit access.

THE CHALLENGE

A reusable Space plane that could carry a 60-ton payload could be used to launch all sorts of civilian satellites to utilize the unique value of the highest of high ground perspectives, both

civilian and military. But building such a craft proved to be an extremely large and extremely difficult proposition!

Two problem areas were difficult to overcome. How could a spacecraft that was to land like an airplane have powerful enough (heavy) engines to get it to orbit, and how could it carry enough fuel internally to do so was ones. How to get that spacecraft back through the Earth's atmosphere without burning up was the other.

Large levels of funding and some of the finest engineering minds in the country were brought to bear. Numerous design options were considered, refined, and discarded. Powerful engines could be made available, but the fuel issue not so readily dealt with. NASA ultimately decided to put much of the fuel required for getting the Shuttle into orbit in a disposable external fuel tank. That still wasn't going to deliver the oomph needed, and the only feasible solution available was to have the spacecraft also use two large solid-fueled boosters that would be jettisoned in the initial phase of the launch. If the spent boosters could be retrieved, they could be reconditioned and probably be reused, but the main fuel tank was strictly a one-use deal.

Work progressed on the new Space transport system. A Boeing 747 was modified and became the *Shuttle Carrier Aircraft* (*SCA*), used to carry the Shuttle from place-to-place on Earth, and it was used to carry the Shuttle test model aloft and cut it loose to make sure it could, in fact, fly (dead stick), and land like an airplane.

The test Shuttle was built at the Rockwell facility in Palmdale, California, and had its first roll-out on September 17, 1976. The roll-out ceremony had been meticulously planned. The test flight Shuttle had originally been named "Constitution," and the roll-out date was picked because September 17th is Constitution Day. Then NASA showed the ability to pivot. A spirited write-in campaign was undertaken by *Star Trek* fans, resulting in the *Constitution* being renamed the *Enterprise*. They stuck with the same date, and NASA Administrator James Fletcher was there as originally planned, but now Gene Roddenberry and the cast of the original *Star Trek* series were invited. So was the press, and the four astronauts selected to fly the *Enterprise* on its flight/landing tests, Richard Truly, Joe Engle, Gordon Fullerton, and Fred Haise. This was an all-star selection of pilots!

Truly would serve as the CAPCOMM on all three Skylab missions, would fly on the STS-2 and STS-8 Shuttle flights, and would become the NASA Administrator in 1989. He held a number of important corporate positions after leaving NASA, and is presently the Vice Chairman of the Board of Trustees for the Colorado School of Mines.

Joe Engle had been an X-15 pilot (and is now the last one still living), served as back-up LM pilot for *Apollo 14*, and was slated to be LM pilot for *Apollo 17*, but was bumped in favor of geologist Harrison Schmidt once it became clear that Apollo 17 would be the final mission to the Moon. After that, he was given a choice as to his next NASA assignment: *Skylab*, *Apollo-Soyuz*, or Space Shuttle. Ever a pilot, he chose the Shuttle. After the *Enterprise* test flight program, he also flew on STS-2, and was the mission commander on STS-52-I. He held a number of important positions after that at NASA, then with NORAD. He retired as a Major General.

Gordon Fullerton was a colonel in the U.S. Air Force, and flew a number of important flights at NASA Dryden, including the B-52 mothership for flight test of the hottest jets and the *SCA*. He was selected to fly the Air Force *Manned Orbiting Laboratory*, but that program was canceled. He flew the *Enterprise* test vehicle, and would later fly the Space Shuttle as pilot on STS-3 and STS-52-F. He continued his test piloting and served as project pilot on a number of important tests at Dryden, logging a grand total of over 16,000 hours of flying time. He suffered a stroke in 2009 and died from its complications on August 21, 2013.

Fred Haise was almost the topic of this particular Item of the Week, because his **90th birthday is Tuesday, November 14**. He had a solid career as a Marine Corps fighter pilot, flying the F2H-4 Banshee and F9F-8 Cougar at MCAS Cherry Point in the late 1950s. After service, he went back to school, but kept his hand in with a stint in the Oklahoma Air National Guard, flying the F-86D. He then became a research pilot for NASA's Lewis Research Center in Ohio (now NASA's Glenn Research Center). He applied for the Astronaut program, and was selected, and drew an assignment as LM pilot for *Apollo 14*, but the original Apollo 14 team was moved one flight sooner because Alan Shepard needed more training time (hoo boy, is THAT another story). Haise remained in the astronaut rotation, serving as back-up commander for *Apollo 16*, which put him in line to command the Apollo 19 mission, which never flew. After that, he was assigned to the *Enterprise* flight/landing tests. He was slated to fly the STS-2A mission, to attach a booster to *Skylab* to raise its orbit and prolong its life, but *Skylab* reentered before the STS-2A mission could be flown. Haise never made a Shuttle flight. On August 22, 1973, Haise was flying the Commemorative Air Force's Convair BT-13, which had been reconfigured to resemble a Japanese WWII-era Aichi D3A "Val" dive bomber, for the filming of *Tora, Tora, Tora*. The plane suffered an engine failure and crashed. Haise suffered serious burns.

Enterprise Test Program

The first test sequence needed to test out the Shuttle prototype was to attach it to the *SCA*, sans crew, and make a flight to see how the *SCA* handled with the Shuttle atop it. Five flights were made, all were successful. Next up in the program were three similar "captive" flights, but this time with a flight crew aboard the *Enterprise*. Finally, there were five free-flying test flights. The actual Shuttle would make a "dead stick" landing, one without power, so the *Enterprise* tests were perfect for testing the Shuttle as a high-speed glider. The first four free-flight tests had the Enterprise land on the dry lake bed at Edwards, but the fifth landed on the long concrete runway. The lake bed landings went off without a hitch, but the runway landing revealed that the Shuttle control system could induce "pilot-induced-oscillation," the kind of thing that wrecked the lifting body *M2-F2* and hurt Bruce Peterson, and Steve Austin (actually, the same crash). Corrections were made on the flight model of the Shuttle.

Flights of the *Enterprise*			
1st Captive-Active Flight	June 18, 1977	Haise	Fullerton
2nd Captive-Active Flight	June 28, 1977	Engle	Truly

3rd Captive-Active Flight	July 26, 1977	Haise	Fullerton
1st Free Flight	August 12, 1977	Haise	Fullerton
2nd Free Flight	September 13, 1977	Engle	Truly
3rd Free Flight	September 23, 1977	Haise	Fullerton
4th Free Flight	October 12, 1977	Engle	Truly
5th Free Flight	October 26, 1977	Haise	Fullerton

The data from the flight tests of Enterprise informed designers about the changes needed before the Space Shuttle *Columbia* would launch 42 months later. But it was clear to NASA and the rest of the world that the U.S. Space Shuttle was coming.

THE THREAT

An orbiting vehicle that could carry a 60-ton payload could carry a large satellite to orbit. It could also carry a lot of bombs, and that had the Russians worried. The election of Ronald Reagan in 1980 and his talk of "Star Wars" technology was sounding more and more feasible what with a vehicle like the Shuttle coming on line. Particularly of concern for the Russians was their getting wind of the development of a high-powered X-ray laser system, a potential anti-missile system that could fry the electronics of a missile in flight. And if it were powerful enough, a Shuttle-based X-ray laser system could conceivably destroy missiles in their silos. The solution to this problem that the Russians chose to follow was to build a Shuttle of their own. They concern level rose when the U.S. launched an operational Shuttle, on **April 12, 1981**. [See the Aside section below.] John Young, the mission commander of *Apollo 16*, was the command pilot for the first Shuttle flight. Roger Crippen was the pilot.

Does the date seem familiar? It was also the 20th anniversary of the very first manned Spaceflight, by Yuri Gagarin in *Vostok 1*! Like I said before, the planning for events relating to America's return to Space were meticulously planned!

BURAN

The Russians had not been idle while the U.S. Shuttle was being developed. Their Buran program began in 1974. Since they were solving similar aerodynamic problems, one might expect that the end product of both country's efforts would look alike. Well, that and some espionage.

The U.S. Shuttle was a complicated aircraft, and the state of Russian technology was not up to the test of making an operational carbon copy. The program's chief engineer, Valentin Glushko, had an unusual amount of freedom to design and build a Shuttle that was, on paper, better than ours.

The U.S. Shuttle was designed and built to have most of its components be reuseable; only the main fuel tank would not be. That decision forced the use of large, segmented, solid rocket boosters, as related earlier. The Russians simply could not produce the large segmented solid rocket boosters like those used on the U.S. Shuttle perhaps a good thing. [A failure of a joint between rocket segment was the cause of the *Challenger* disaster.] Four existing boosters were clustered together, each with its own guidance, navigation, and control system; the booster package became known as the "Energia." It was separate from the orbiter, and would be expended on each flight. The Buran had no main engines of its own. The separate boosters live on today; they became the Russian mid-size Zenit launcher. The Energia was very powerful, and could handle a much heavier lift than the U.S. Shuttle, capable of meeting the USSR's military needs as well as their civilian Space program. [The Kremlin liked the public relations aspect of civilian Spaceflight, but their actual focus was on the military use of a Shuttle, and they believed that the U.S. emphasis on the Shuttle as a scientific and commercial launch system was a mere smokescreen for military use.]

The first orbiter in the USSR's Shuttle program was named "OK-GLI." It was completed to the point where it could be flown under its own power (four AL-31 turbofan engines were attached to its fuselage), but it was really a testbed like *Enterprise*, to be used for aerodynamic testing. Over a period extending from November 10, 1985 to April 15, 1988, *OK-GLI* would make 23 test flights, checking out all systems, including an autonomous automatic landing capability.

Seven Russian cosmonauts were trained for Buran flight operations. Buran management wanted at least one of the *Buran*'s two-man crew to have Spaceflight experience, based on problems that arose with an all-rookie crew on *Soyuz 25* (they made five unsuccessful docking attempts at *Salyut 6* before having to give up and return to Earth). Two of the seven made Spaceflights: Igor Volk and Anatoli Levchenko. Volk flew on *Soyuz T-12* in 1984, rushed into Space to allow Svetlana Savitskaya to beat Kathryn Sullivan from having that distinction. Levchenko flew on *Soyuz TM-4* to *Mir* in 1987. Volk was slated to fly *Buran*'s maiden voyage, with Levchenko leading the back-up. But the Russians had very bad luck with the Buran crew candidates. Levchenko died from a brain tumor in 1988, leaving the program without an experienced cosmonaut for the *Buran* back-up crew. One of the seven left the program for medical reasons, one served as a back-up on the *Soyuz-TM-4* flight but died in a plane crash soon thereafter, and another died in an air show crash. The remaining two had not been assigned to a mission when the Buran program ended.

A total of eight Buran-class vehicles were built. One was the OK-GLI, two others were loaded on their 3M-T cargo carrier and flown to Baikonur. The remaining vehicles were used at the manufacturing plant for stress, vibration, and other testing.

The first operational orbiter, *Buran*, was finally ready by mid-1988. ["Buran" is the name of the program, the class of spacecraft, and the first orbiter of that class.] *Buran* was launched on November 15, 1988, using the Energia booster cluster, but without a crew. It flew two orbits, and landed autonomously at Baikonur in the Kazakh SSR (now Kazakhstan). The automated landing system worked well, and the flight was considered a success, although the orbiter did

lose some of its thermal protection tiles. It was the last time Buran ever flew, and none of its sister orbiters were ever completed.

Political changes in the soon-to-be-former USSR, and the accompanying financial woes, doomed the Buran program, even though the program has never been officially canceled.

AFTERMATH

The two Buran-class orbiter prototypes that made it to Baikonur are still there. They were stored in a hangar originally built to house the Soviet N1 Moon rocket (their answer to the Saturn V). The hangar was to serve the same function as NASA's Vehicle Assembly Building (the Russians planned to mate the Buran to Energia in the hangar, then transport the assembly to the launch site and erect it into launch position there, rather than assemble and erect the stack in the "hangar," as NASA did). One of the vehicles was almost flight-ready, the other was more of an engineering test bed. Alas, the hangar roof collapsed in May, 2002, killing eight workers and covering the two vehicles within with debris.

In retrospect, both the U.S. Space Shuttle and *Buran* were technologies in search of a mission. Much like the Concorde (and its supersonic bomber counterpart, the Valkyrie), the Shuttles were too expensive and too complex (and too dangerous) for extended operational use.

The special relationship between the U.S. Government and the Smithsonian Institution, dating back almost two centuries, gives the National Air and Space Museum "first dibs" on retired NASA equipment. That is why John Glenn's *Friendship 7* Mercury capsule, the *Gemini 4* capsule, and the *Apollo 11* command module are in NASM's collection. That's also why the *Enterprise* was in their collection, too, and was on display at NASM's Steven F. Udvar-Hazy Center for years. When the Space Shuttle fleet was retired, NASM claimed the senior surviving Shuttle, *Discovery*. *Enterprise* went to the Intrepid Museum in New York City; *Atlantis* went to the Kennedy Space Center's Visitor Complex, and *Endeavour* went to the California Science Center in Los Angeles.

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DIDJA KNOW?

When NASA delivered *Discovery* to the Udvar-Hazy Center, for a few days, NASM had both *Discovery* and *Enterprise*. The *STA* that brought in *Discovery* flew away with *Enterprise*. Getting *Enterprise* to New York was easy, but getting it to the Intrepid Museum was not.

There was a meeting at NASM to discuss how getting *Enterprise* to its new home would work, and I was fortunate to attend. It was a tough problem, and I was impressed by the free-flowing brainstorming session was considering all sorts of ideas. But no feasible plan was bubbling to the surface, and I could tell that frustration was building in the room.

Captain Sullenberger and the “Miracle on the Hudson” had occurred a short time earlier, and his piloting and the rescue of all crew and passengers was on everyone’s mind.

I don’t know what got into me, but I decided to pipe up with a joke, saying, “I’m guessing that the *Intrepid* still has its arresting gear either in place or in storage nearby. I know that Captain Sully has some time on his hands. Why don’t we re-rig the arresting gear, hang a big tail hook on *Enterprise*, put Sully in the pilot’s seat, and drop him from the *SAT* and have him dead stick the *Enterprise* right onto *Intrepid*’s flight deck?”

There was dead silence for about ten seconds, as the affrontery of the ridiculous concept penetrated the room’s collective consciousness. Then the laughter began, slowly at first, step by step, until the room was chuckling. It was a nice break from trying to solve a difficult transportation problem!

And no, that’s not how it was done. (See here)

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