7

Silver Pin Astronauts

"We actually have more jobs that we support
than any one individual can do in a career.
All of them have training value of some kind.
All of them are important to the program in some way;
some of them probably a little more fun than others."
Steve Hawley, JSC Oral History

As Steve Hawley explained, the astronauts would not be able to rotate through every support position in their careers, but some assignments were clearly more popular than others. "I never got to be a Capcom [Capsule Communicator], for example, but that's a job that lots of people get rotated through," Hawley observed. By the fall of 1979, with their Ascan training program completed a year earlier than planned, the rookie astronauts were assigned to technical and support roles in the Shuttle program, which they hoped would lead to at least one flight into space on the Space Shuttle.

What Do Astronauts Do?

This question was posed in an unsigned Astronaut Office handout dated April 3, 1986, as part of the briefing material provided to the Rogers Commission investigating the *Challenger* Accident. **[1]** The answer was given as:

- Provide flight crews for NASA space vehicles and stations
- Participate in the design, development and operations of space vehicles and space stations

D. J. Shayler, C. Burgess, *NASA's First Space Shuttle Astronaut Selection*,
Springer Praxis Books, https://doi.org/10.1007/978-3-030-45742-6_7

- Provide crew input into the design and development of space vehicle and station operating technologies and procedures
- Perform crew evaluations supporting design, text and checkout of space machines, and
- Perform other duties as assigned.

In order to achieve this, all astronauts are required to complete a range of technical and support assignments prior to and following their time as part of a flight crew; in training, in flight, or during post-flight periods. Many astronauts completed more than one assignment, and in fact some had concurrent triple or quadruple assignments or were in various stages of training having been assigned to more than one mission at one time. As the memo stated, the bottom line was that "many astronauts do more than one job."

TECHNICAL AND SUPPORT ASSIGNMENTS

Following on from a huge ground test program and the 1977 series of Approach and Landing Tests (ALT), the first orbital missions of the Shuttle system were flown under the Orbital Test Flight (OFT) program. OFT was designed to test and evaluate Shuttle hardware, systems and procedures from pre-launch to post-landing, prior to the system being declared 'operational.' Originally, the OFT program envisaged six missions, designated STS-1 through STS-6 and crewed by six, two-man teams of veteran astronauts chosen from earlier selections. Each flight initially had a back-up pair of astronauts, who would serve as the prime crew on a later OFT flight. By 1982, with the Thirty-Five New Guys (TFNG) four years into their careers at NASA and now eligible for crew assignment, the OFT program was cut to just four missions. The back-up positions were terminated after the third flight. NASA reasoned that there was a pool of suitably trained astronauts (though not all were flight experienced) to draw from to replace any ailing, injured or reassigned crewmember as required. Though the next two missions, STS-5 and STS-6, were no longer officially part of the OFT program, the assigned veterans were already in training as four-man crews, including the first astronauts to hold the Mission Specialist (MS) designation. As earlier documents suggested, the opportunity to assign the first Group 8 astronauts would therefore not arise until STS-7 onwards. In the meantime, there was plenty of work for them to do in support of these first six missions.

The flight crew on any space flight is the visible element of the mission, but that is only part of the story. There are those who work the consoles at the Mission Control Center (MCC) in Houston, and the hundreds of workers down at the Cape, at other NASA field sites, or at the dozens of contractors who process the hardware for each mission. During the Shuttle program, there was

another group who were often overlooked in the reporting of each mission: the astronaut support team.

As the program developed, the size of the astronaut team increased, and while the Shuttle flew between 5–7 persons on most missions, there were normally scores of other astronauts in the office, with many in training for forthcoming flights, or debriefing following a recent mission. Others were fulfilling their technical assignments, serving in managerial roles, on sick leave, or simply on vacation or a day off. As dedicated, busy and sought after as the astronauts naturally are, they remain human and need time away from 'the office', an opportunity to unwind with the family and home life.

Astronaut Silver Pin

Though not eligible for these first six missions, all 35 members of the 1978 selection were now termed 'astronauts' having completed their Ascan training program. Though this was their official title, they still prized the real goal of making a space flight and, when in front of the public, the chance to describe their experiences from a real mission rather than how they hoped it would be on a forthcoming flight. They had the title and the blue suit to wear, but the TFNG would remain space flight rookies for some time to come. "Once you go from astronaut candidate to astronaut, you get an astronaut pin that's silver," recalled Mike Mullane in his 2003 Oral History. **[2]** "Then, when you fly, you [are eligible for] a gold one. You're not really an astronaut until you're wearing that gold one, and I remember I never wore my silver one. I don't think I ever put it on, because I remember telling somebody [that] to wear that, to consider yourself an astronaut, to me it would be like a stewardess wearing flight attendant wings and saying you're a pilot... To me… you're not an astronaut until those SRBs ignite."

Though the experience of those Solid Rocket Boosters (SRB) igniting was still a few years away, there remained plenty of work to be done in supporting the OFT and the Shuttle program through their technical support assignments, well before any of them were announced to a crew. As Guion Bluford said in 2004: "After a year of training, and a strong demand for our talents in the Astronaut Office, John Young decided to put the Ascans to work. Several jobs were parceled out to us as the Johnson Space Center [JSC] prepared to fly the Space Shuttle for the first time." **[3]**

But what exactly are these 'technical or support assignments'? It is the work that usually goes under the radar with the public, but forms the bulk of the astronaut profession. Very little time, percentage wise, in any space explorer's career is spent actually 'in space' flying the mission. An astronaut's time is mostly spent on the ground, attending countless meetings, briefings, simulations, training sessions, survival courses, and public or press appearances.

Having expected to receive their first technical assignments once they had completed the two-year training program, or at least at the end of their first 12 months at NASA, it came as a bit of a surprise to the TFNG to learn that they would begin their initial technical assignments in April 1979, just nine months after joining the agency. They would be deemed fully-fledged astronauts after just 12 months – such was the pace of the program and the need to get the Shuttle in orbit – primarily in recognition of the way the whole group had performed in their short time at JSC. Whatever it was that the selection board had seen in these 35 candidates had shone through in their Ascan training, as each and every one of them progressed to earn their silver astronaut pin months before they had expected to. The objective now, over what was to prove to be three years, was to ensure that they were capable and ready for crew assignment on the Space Shuttle.

Fig. 7.1: STS-1 astronauts John Young (2nd from left) and Bob Crippen (2nd from right) pose inside the Vehicle Assembly Building at KSC during the Shuttle Interface Test prior to rollout to the launch pad. With them are support astronauts Dick Scobee (left) and Fred Gregory. Space Shuttle *Columbia* is visible behind them, mated to its External Tank and Solid Rocket Boosters (Image courtesy of Ed Hengeveld).

The Pilot Pool

While the new class of astronauts were now eligible to wear the silver pin, they were still some way away from the coveted gold version. As well as receiving their first technical assignments, the group were also transferred administratively to the Astronaut Pilot Pool, under the Mission Operations Directorate, Flight and Systems Branch at JSC, for their Advanced Training Program. This next phase of their preparations for space flight featured some 16 courses over the next twelve months or so, totaling approximately 375 hours, and were completed prior to their first crew assignment in addition to various technical assignments. It would provide them with the skills to operate the complex Space Shuttle, by completing a number of generic simulations and training programs (see Chapter 8).

An undated document, probably circa 1979/1980, researched by the authors reveals the initial technical assignments of the TFNG to be conducted over the next two to three years, prior to assignment to their first spaceflights. These are listed in Table 7.1.

TABLE 7.1: CLASS OF 1978 INITIAL ASTRONAUT OFFICE TECHNICAL ASSIGNMENTS 1979-1983

Bluford (MS): RMS; Spacelab 3; Shuttle systems; SAIL; FSL; DOD payloads.

Brandenstein (PLT): Support crew STS-1 & 2 (Capcom / cue card development / crew equipment); vehicle integration.

Buchli (MS): T-38 MS training development; support crew STS-1 & 2 (SMS / initial Orbiter EVA development / Capcom).

Coats (PLT): Landing and rollout; SAIL; training; support crew STS-4.

Covey (PLT): Back-up flight software; board representative / CRT (Cathode Ray Tube) verification) SAIL / FSL / STS-2 & STS-3 chase plane; prior STS-1 astronaut support Orbiter engineering development and testing.

Creighton (PLT): Initial SAIL crew; flight software (Version 18 coordinator / enhancement coordinator) T&O board and OAS CB representative / malfunction Caution & Display (C&D) system study; Contingency On-scene Director (COD).

Fabian (MS): Skylab re-boost support; RMS; proximity operations and rendezvous; crew equipment; leader of Operations Support Group; DOD payloads.

Fisher A. (MS): RMS; EVA; tile repair; medical operations STS-1 & 2; SAIL.

Gardner D. (MS): T-38 MS training development; Astronaut Project Manager for flight software in Shuttle onboard computers leading up to STS-1; flight software (Version 16 Coordinator / Enhancement Coordinator / T&O Board & ASCB Representative) / displays and controls; Flight Data File coordinator; STS-4 support crew; DOD payloads.

Gibson R. (PLT): Skylab re-boost; CRT display verification; STA HUD evaluation pilot; STS-1 & STS-2 chase pilot; SAIL.

Gregory F. (PLT): Crew station enhancement; vehicle integration; Flight Data File coordinator (Manager); CB representative KSC initial Orbiter checkout and launch support STS-1 & STS-2.

(continued)

TABLE 7.1: (continued)

Griggs (MS): TPS repair; development and testing of HUD; support crew STS-3 (Capcom); approach and landing avionics system; development of MMU; requirements definition and verification of on-orbit rendezvous, and entry flight phase software and procedures.

Hart (MS): Spacelab 1; Skylab re-boost support; support crew STS-1 & 2 (SSME liaison / Capcom / HP-41).

Hauck (PLT): Support crew STS-1 & 2 (Flight Data File crew coordinator / Orbiter GCA development / Capcom); Leader of Development Group; Orbiter night landing project officer (test pilot) for development of techniques and landing aids; Navy Administrative coordinator for miscellaneous activities.

Hawley (MS): Payload software; SAIL (simulation pilot prior to STS-1); vehicle integration.

Hoffman (MS): Spacelab 2; orbit navigation; guidance and control (orbit digital autopilot insertion/deorbit targeting); proximity operations and rendezvous; STS-6 support; During preparation for OFT he worked in the Flight Systems Laboratory (FSL) at Downey California; testing guidance, navigation and flight control systems.

Lucid (MS): Spacelab 1; crew training; SAIL; FSL (Downey, California); Space Telescope; proximity operations and rendezvous group; SPAS; FSL at Downey working with the prox ops and rendezvous Group.

McBride (PLT): STS-1 (lead) chase pilot; SAIL.

McNair (MS): Solar Maximum Mission retrieval; payload and RMS retention; IECM, PDP, REM; Space Telescope; Orbiter systems.

Mullane (MS): Spacelab 1; IUS, Syncom IV and TDRS; SAIL; Support crew STS-6; DOD payloads.

Nagel (PLT): Software; SAIL; STS-1 Chase; Support crew STS-1 & 2 (entry maneuvers & Capcom).

Nelson G. (MS): EMU / EVA development; Space Telescope; WB-57F crewman (scientific instrument operator); initial Malfunction Book development; STS-1 Chase (prime chase photographer); support crew STS-3 (Capcom).

Onizuka (MS): SSUS, IUS; TPS repair; vehicle integration; crew equipment; RMS; Shuttle Student Involvement Program; DOD payloads; member Orbiter Test and Checkout Team & Launch Support Team at KSC for STS-1 & STS-2.

Resnik (MS): Spacelab software; payload software; RMS software; RMS; Power Extension Package (PEP); 25 KW Power Module; training techniques; Orbiter development including experiment software.

Ride (MS): RMS; support crew STS-2 & 3 (on-orbit Capcom /visual operation I/F / RMS procedures / Orbit Flight Data File); STS-1 Chase

Scobee (PLT): Spacelab 1; SPS engineering simulation evaluations; SMS verification; 747 (SCA) Pilot / IP; vehicle integration; STS-1 chase; Leader of Verification Group; Instructor Pilot SCA Boeing 747.

Seddon (MS): Food systems; Spacelab 3 & 4; Orbiter & payload software; CRT display verification; orbital medical kit; medical checklists; medical ops STS-1, 2 & 3; SAIL; FDF; launch and landing rescue helicopter physician; support crew STS-6.

Shaw (PLT): Skylab re-boost support; SAIL initial crew; auto land; Optional TAEM Targeting (OTT); Shuttle Training Aircraft; STS-3 support; support crew & Entry Capcom STS-3 & 4.

Shriver (PLT): Vehicle integration; STS-2 chase; Vandenberg launch site crew interface.

(continued)

TABLE 7.1: (continued)

Stewart (MS): Entry Flight Control (EFSIG Representative); FSL; entry training; MOCR aerodynamic console STS-1 & 2; support crew STS-4; testing & evaluation of entry flight control system for STS-1; ascent orbit procedures development; payload coordination; Ascent / Orbit Capcom STS-5.

Sullivan (MS): OASTA-1 and OSS-1; WB-57F Crewman (qualified as a systems engineer in 1978) participated in several remote sensing projects in Alaska; flight software (version 16 and 18); STS-2 chase; vehicle integration; co-investigator SIR-B experiment (flown later on STS-41G); software development STS-1 & 2; lead chase photographer for STS-2 launch and landing; Orbiter cargo test, checkout and launch support KSC STS-3, 4, 5 & 6.

Thagard (MS): RMS; SAIL; proximity operations and rendezvous; SPAS.

Van Hoften (MS): Lead Astronaut Support Team (AST), KSC; responsible for Orbiter turnaround, testing and flight preparations.

Walker D. (PLT): Deputy (Acting) Chief, JSC Aircraft Operations Division; CB Safety Officer; STS-1 chase; SAIL; Mission Support Group leader STS-5 & 6.

Williams D. (PLT): SPS engineering development simulations; crew equipment; SAIL (test pilot); vehicle integration; participated in Orbiter test, checkout launch and landing operations support at KSC.

Adapted from an undated NASA document (certainly originating from @ 1980-1982). Copy on file, AIS Archive.

ASTRONAUT SUPPORT ROLES EXPLAINED

For each Shuttle flight, a team comprising a couple of dozen astronauts were assigned to various support roles at JSC in Houston, at the Kennedy Space Center (KSC) in Florida, at key sites across the United States, or at remote locations on the eastern side of the Atlantic Ocean. Some of these were single-mission assignments, others were short tours of duty, but all offered that valuable experience of being part of the 'Shuttle system' and were a key element in the individual's preparation for assignment to a flight crew. Perhaps the most prominent of these, in the eyes of the public, were those astronauts who served at the Capcom console in Mission Control at JSC. However, this was just one of the myriad roles that the astronauts were required to fulfil before progressing to crew assignments, most of which were overlooked in written accounts. They were performed in between their training and flights, and were as important to their flight preparations as the mission training itself.

Below is a selection of these major assignments, described with additional comments from some of the Group 8 astronauts who participated in these roles during the early years of their careers. Between 1966 and 1975, the astronauts had formed a third tier *support crew* for each Apollo mission. They also fulfilled the Capcom roles for Apollo/Skylab and Apollo-Soyuz (ASTP), but with the more

complex Shuttle intended to fly more frequent missions, this new support network had to be much more in-depth than the generally single-mission support of the Apollo-era crews. For Shuttle support, the 'tours' had to be more program orientated rather than flight-specific simply because of the frequency and variation of the missions on offer.

LAUNCH SUPPORT ROLES (KSC FLORIDA)

All 135 Shuttle missions were launched from KSC in Florida and required a small team of astronauts to support the larger workforce at the Cape in preparing each mission and its associated hardware for launch, with the pace increasing as the launch date approached. These roles were developed by the members of the TFNG from the very first Shuttle missions in 1981 and 1982.

Fig. 7.2: Loren Shriver, the first Astronaut Support Person, and suit tech Al Rochford on the aft flight deck of *Columbia* as they observe STS-1 astronauts Young and Crippen. *Columbia* was in the OPF when this photo was taken on October 13, 1979 (Image courtesy of Ed Hengeveld).

Cape Crusaders

For each Shuttle mission, a team of about 5–8 astronauts served as the flight crew's point of contact between JSC and KSC, flying their T-38s between the centers on 90-minute trips each way. Known officially as the Astronaut Support Personnel (ASP), they were also the eyes and ears for the Shuttle vehicle the crew were about to fly. Better known collectively as the "Cape Crusaders" (also known as C-Squared or the C^2s, see sidebar: *Origin of the Cape Crusaders*), their role was a busy one during a nominal year of flight operations, with between 25–35 trips to KSC a year. They were present for the Terminal Countdown Demonstration Test full dress rehearsal, the launch and the landing. The astronauts were assigned to the Crusaders for a 'tour' which could vary depending on flight operations and other assignments or requirements. A typical stay at the Cape could vary between a single night or four days away from home, especially when there were delays to a launch.

"There always was a team of from three to six astronauts assigned," recalled Dan Brandenstein. **[4]** "It was one of the technical assignments, and they were assigned for support down at the Cape. They worked crew-related issues as far as getting the vehicle processed, getting experiments integrated, following the various payloads as they were getting checked out [because] the crew couldn't be down there all the time. We switched from having a support crew supporting one crew. I mean, it was kind of like a support crew for everybody in a particular area, and it was down at the Cape. They're also the ones that helped strap the crew in when they launched, and during the countdown they did all the switch positioning, the prepositioning of the switches and everything for the crew. So it was a real interesting job, in that you got to work on the real hardware, and that's always fun. You got to see a lot of Shuttles launched because you were always down there for the launches and the like. So it was another one of the interesting jobs."

One of Fred Gregory's first technical assignments was to be assigned to KSC as an astronaut liaison. "We had a name; we were called the Cape Crusaders, the C^2s. Every Sunday evening or Monday morning, four of us would fly down to the Cape [Canaveral] and we would stay all week. We would attend meetings. We were always in our blue suit, and one of the privileges was that you would spend a lot of time sitting in the cockpit of *Columbia*. So I was exposed to the hardware in '79 or probably a year, year and a half after I got there, and I stayed through the second launch of the Orbiter, STS-1 and -2. I was there for both of those." **[5]**

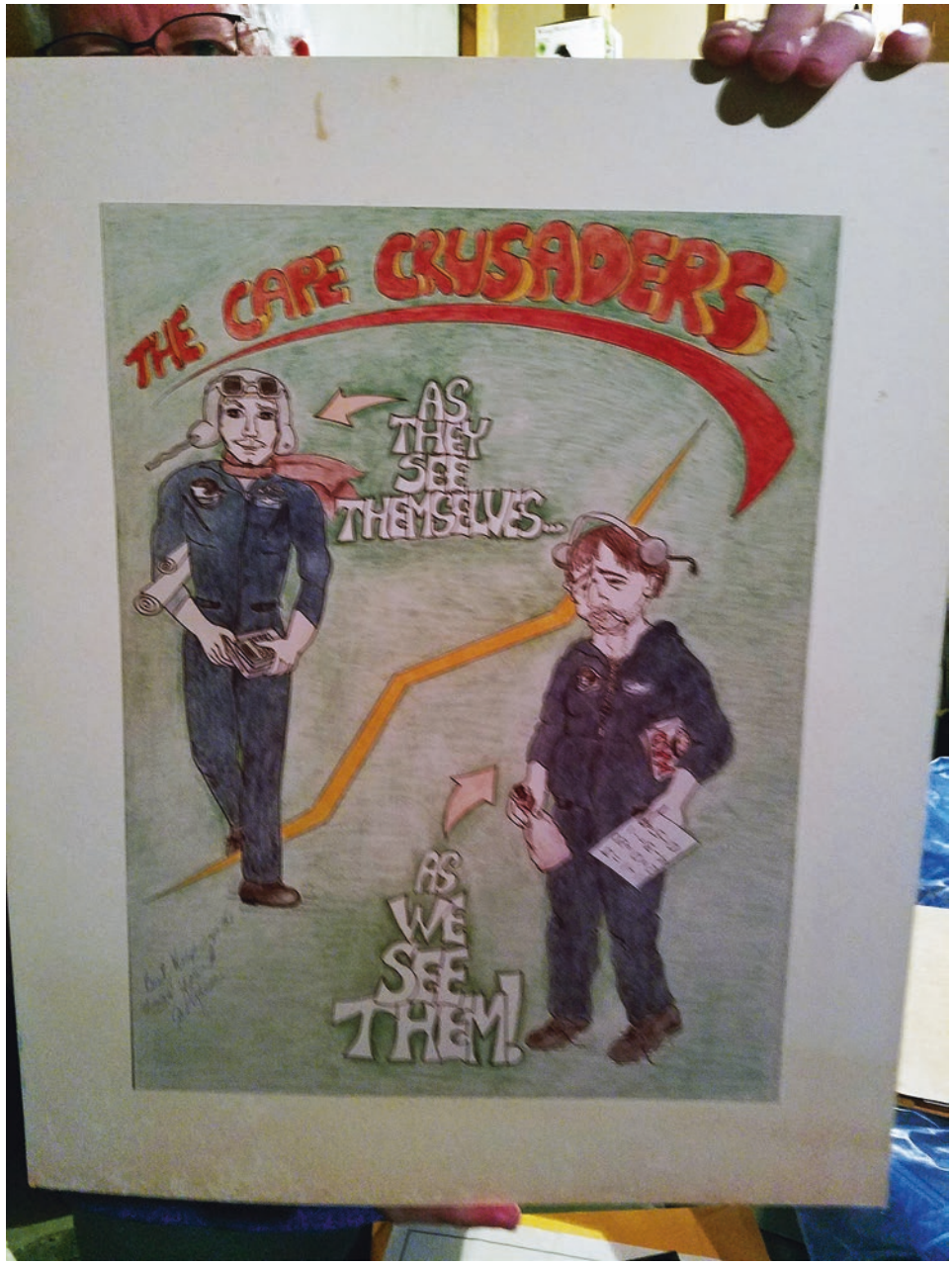

Fig. 7.3: Just one version of a Cape Crusader cartoon (Image from the collection of Steve Hawley, used with permission. Artist unknown).

ORIGIN OF THE CAPE CRUSADERS

According to the dictionary, the term 'crusader' can mean "a vigorous campaigner in favor of a cause." **[6]** The exact origin of the term 'Cape Crusader' in NASA-speak has been lost in time, but appears to come from the early 1980s and the first Shuttle missions. While capturing the Oral Histories for NASA, the JSC team was unable to uncover whether the term had existed during the Apollo era as nobody ever mentioned it.

Unlike Apollo, the Shuttle required a greater astronaut presence at the Cape over a longer timescale, and when the first astronaut support team assigned to STS-1 went to the Cape, they found they were indeed embarking on a "vigorous campaign in favor of a defined cause", namely the first launch of *Columbia.* It was probably Loren Shriver, the first Astronaut Support Person who, recalling the 'caped' superheroes of his youth, suggested a connection to this new astronaut 'crusade' and the location at which they were working – the Cape – hence "*Caped Crusaders*."

Rhea Seddon suggested in her Oral History that "*Batman* was the Caped Crusader, maybe that's where it came from. I recall that there was a little cartoon character [and] that was either their nickname or that's what they were called – *Crusader* somebody [*Crusader Rabbit*, a cartoon which aired through the 1950s]. It came out of comic books or TV, and it was a silly thing. Not that we all took ourselves very seriously." Whatever the origin, the name was certainly apt, and it has stuck ever since.

ASP duties also included responsibility for the *Switch List* positions, which involved ensuring that the Shuttle Orbiter cockpit switches were set correctly for launch, or participating in the communications checks (*Comm Checks*) between the Orbiter, the Launch Control ground control team at the Cape and Mission Control in Houston. They also assisted the ground closeout crew, the handful of technicians who were trained to oversee the pre-launch preparation in the White Room (which was positioned next to the crew side access hatch on top of the launch access tower), assisted the flight crew into their seats, set the switches to launch positions, and set up the seats for each crewmember. After working a few missions, a Cape Crusader could qualify to become the Prime Astronaut Support Person (with at least one back-up ASP), taking the lead for that particular mission, helping the flight crew into their seats, and being one of the last people to see them before the hatches were closed for launch.

As the program unfolded, this became a much practiced and very polished operation, and though the closeout crew knew their jobs inside out, the astronauts, as members of the support personnel, helped with hands-on activities; mainly ensuring that the crew were strapped in, that none of the switches were knocked in the process of getting them into the launch position, and ensuring that the detailed process did not miss a step. All this was made more difficult by the fact

that the Shuttle Orbiter was standing on its tail on launch day, with the crew compartment tiled 90 degrees vertically and the flight crew lying on their backs. The seats that normally would be viewed conventionally on the vehicle flight and middeck floors now appeared to be hanging on the wall. This meant that the ASPs, technicians and flight crew had to be careful where they placed their hands and feet as they climbed through the vehicle to help the crew into their seats.

Being an Astronaut Support Person

Steve Hawley, one of the first ASPs, explained his role on some of the early Shuttle missions: "The ASP was the astronaut who was part of the closeout crew and strapped in the flight crew (along with the suit tech). I was the backup ASP on STS-2 (Ellison Onizuka was prime) and I was prime for STS-3 and STS-4. The ASP was also responsible for representing the crew at KSC meetings or in tests on the vehicle, and for coordinating the astronaut support to the practice and actual countdowns. For example, there was a rule that once the prelaunch switch list was complete, there needed to be an astronaut on board continuously until launch. This was to ensure that no switches were changed without instruction from the LCC [Launch Control Center] and that if any switches were moved, as part of the normal countdown or as part of troubleshooting, they would only be moved by an astronaut. I was also responsible, as part of the closeout crew, to go extract the crew in case of a scrub. I would stay on board in that case until one or two other astronauts relieved me. Those assignments were designated as part of my launch planning. To be clear, the astronauts assigned to KSC were determined by management, but the ASP was responsible for organizing how those guys would be used to staff the different tasks." Hawley recalled that during STS-3 he thought that the unpainted (to save weight) External Tank (ET) looked "kind of weird" in orange instead of the white-painted tanks of STS-1 and STS-2. As the ASP for STS-4, he had to contend with added security as *Columbia* carried a classified payload. "To protect the secrecy of what was in the payload bay," he continued, "there were metal covers locked in place over the aft windows so that no one could look into the payload bay. One of my jobs was to unlock and remove the covers as part of prime crew ingress. I had the key and I was really worried about losing it, which would have meant we couldn't launch. Fortunately, I didn't." **[7]**

Ascent Abort Support Roles

During the early years of the Shuttle program, astronauts were dispatched to remote sites on the west coast of North Africa or in Spain,[1] to support and assist in any abort situation during the ascent to orbit which could have resulted in a

[1] As the odds of actually landing at one of these site were slim, the equipment available there was kept to the minimum. Early sites included Morón (southern Spain), Banjul (Gambia, West Africa) and Ben Guerir (Morocco, North Africa). Dakar (Senegal, West Africa) was also an early site for TAL aborts, as was Zaragoza Air Base (eastern Spain).

landing at one of those sites. Fortunately, these sites were never called upon to be used in an emergency throughout the history of the program.

TAL Sites: Described as a safety net for the Shuttle launch as it arced over the Atlantic, a number of European and African locations were designated Transoceanic Abort Landing (TAL) sites. Here, it would have been possible to land the Orbiter in the event of an abort during the ascent if it had been impossible either to Return To the Launch Site (RTLS – never a preferred option for the crew), or Abort To Orbit (ATO, as in the case of STS-51F in July 1985). Fortunately, it was never necessary to use these sites, but it was always good to have them in reserve. One of the astronaut support roles was to be stationed at the TAL sites in case the stricken Shuttle needed to land there. The role was called TALCOM, for TAL Communicator, and their job was to confirm the weather and landing conditions around the site and communicate directly with the crew, as Capcom in a rapidly changing situation minutes after the mission left the launch pad in Florida. As some of these sites were remote this was not one of the preferred roles, especially during the early days of the program.

AOA Sites: If the Shuttle had been unable to reach a stable orbit but had acquired sufficient velocity to orbit the Earth just once and return to a landing site in the continental USA, then the Abort Once Around (AOA) mode would have been the preferred option. While this was never actually performed during the program, each launch required astronauts to be dispatched to AOA sites such as Edwards or Northrup, in case such an emergency did occur. **[8]**

Launch and Landing Helicopter Physician

For the first few Shuttle flights under the OFT program, it was decided that as many members of the Astronaut Office as possible should be involved in supporting the missions, especially the first launch. Part of this support included assigning medically trained members of the Astronaut Office to the search and rescue teams on standby during launch and landing. One of those assigned was Rhea Seddon, who explained the assignment in 2010: “I guess because of my emergency room work, and [because] Anna [Fisher] was doing something else, [I was asked] to look into that. When we looked at how many helicopters were going to be deployed both at the Cape [Canaveral, Florida], at Edwards [Air Force Base, California], and at Northrup Strip in New Mexico, I think they needed six docs. We had five in the office [Seddon, Fisher, Norman Thagard and, from the 1980 selection, Jim Bagian and William Fisher, Anna Fisher’s husband]. Craig [L.] Fischer was head of medical operations at the time [and] one of the flight surgeons we involved. We talked to the SAR [Search and Rescue] forces and yes, if they were told to do so, they would put us on the helicopters. And yes, they would appreciate our input because they didn’t really know much about the Space Shuttle or about what the suits were that the astronauts would wear or how the escape systems worked, that sort of thing. They needed a liaison with our office so I mapped it all out.

"I said one of the problems is [that] I have done trauma life support, but the other physicians that we're working with were not used to dealing much with trauma. I think Bill and Anna probably had. It was Bill, Anna, me, Norm, Jim, and Craig Fischer. That was six of us. Jim, Norm, and Craig had not had any trauma experience, and Bill, Anna, and I were a few years away from the experience we had. I asked if we could do some additional trauma training. There was a good course in San Diego [California], and then there's an advanced trauma life support course. I said, 'If you want us to do this, we want to be capable of doing it'.

"[They] let us do some additional training, which all of us enjoyed, getting back into medicine. Craig was a pathologist, so he was interested in 'How do I handle emergencies', because pathologists don't have an awful lot of emergencies. We did some additional training, but then we began working. We were each assigned to a different launch site for the first flight and began to work with the crews that were going to man those sites, [to] learn about search and rescue. I didn't know anything about helicopters, about SAR forces, about PJs, the para-jumpers that jump in the water with people. It was fascinating because the helicopter crew that I worked with out at the Cape had been doing search and rescue for years down at Homestead Air Force Base. They had all fought in Vietnam; they were the crazy people that went into the jungle and pulled people out in Vietnam, handled helicopters that were under fire. Getting to know those people and getting to hear what they had done; they were just awesome folks.

"I was assigned a PJ named John Smith, who had absolutely no hair. Big burly guy, and just one of the nicest people around. To look at them you would think they were animals of some sort. The things that they did were just physically awesome. Just very, very nice people. I got some time flying a helicopter, and just had a great time being a part of that, learning the on-scene rescue, evaluation, and treatment of patients.

"I was used to working in an emergency room, where patients all came in with their IVs and their tubes down their throat; their limbs bandaged and splinted, and laid on a table. Now I had to deal with what we do if we get out there and they drag an astronaut in a pressure suit out of a Space Shuttle. At first, John [Smith] deferred to me… 'You do your stuff and tell me what you need'. I came to realize that he was much better at doing the initial evaluation and treatment because that's what he had been doing for years. He was in charge at first, and then I was going to take over on the things that I knew how to do. I could do the follow-up part. We worked really well as a team, and I learned a lot of stuff. I got to see the first launch from the skid strip at the Cape and watched it with those guys. It was a really nice experience.

"When I first got into it I thought, 'This is crazy', but it certainly got us very involved in what was going on. I think we added value because we could say, 'If we get people in this condition we need to take them to this facility. Here's what we're going to have to do if we have to take somebody's helmet off; here's how we

would do this, and here's how we would do that. Here's what the Shuttle can do, here's what all these words meant', so that the rescue forces understood what was going on. We had a number of practices. I think we all learned a lot. Luckily we didn't have to use that, but we were prepared.

"I did have the opportunity, as one of my assignments, to help with the development of the medical checklist that flew and the equipment that was carried in the medical kits. We certainly developed what we were going to do and probably somebody wrote it down as a checklist and put down, 'Here's what you need to do to get people out of the Shuttle'. They had a variety of ways. You could take them out the overhead windows; you could take them out the side hatch; you could saw a hole in the side. There were all kinds of permutations and combinations of how it could happen, and I'm sure they documented all of that. I wasn't in charge of writing the checklist *per se*. The PJs had to wear the SCAPE [Self-Contained Atmosphere Protective Ensemble] suits, the big aluminum suits, because of leaking fumes and stuff like that. I thought they were going to kill themselves in Florida, trying to climb up on the Shuttle model and hoisting people out on a backboard through the overhead windows. John would get back to the helicopter after they'd carried them, and he would just be drenched with sweat. I thought, 'They're going to kill themselves just with the rescue part. I'm going to have to rescue the rescuers'. It was amazing what they could do and what I learned from them." **[9]**

Weather Support

The *Weather Coordinator* provided the link between the Astronaut Office, the Mission Management Team (MMT), the Lead Flight Director (FD) in MCC Houston and the Launch Director at the Cape. In addition, the *Weather Pilots* (known as WX – pronounced 'wex') were senior pilot astronauts who flew the Shuttle Training Aircraft (STA) from KSC in Florida or Edwards Air Force Base (AFB) in California, to report on current weather conditions at altitude immediately prior to a Shuttle launch or commitment for entry and landing at a primary landing site. Information provided by the WX allowed the MMT to decide whether to proceed with the launch or order a delay. The WX pilots were also utilized to provide up-to-date information either to permit or waive-off a landing at primary or alternative sites, prior to committing to the de-orbit burn.

Family Escort

A member of the Astronaut Office was detailed to the immediate families or dependents of the prime crew. Their role was to provide advice, guidance, and support to the families throughout the mission, from preparation for launch at the Cape through the launch and orbital phases to entry and landing. Occasionally, an astronaut was also assigned to the prime crewmembers' extended family groups.

In the early years, according to Mike Mullane, there were no formal criteria for selecting one or more Family Escorts, with the spouses of the crewmembers

putting forward a few names. The Family Escort, assisted by members of the Public Affairs Office (PAO), would be on hand during the day of launch as the families viewed the ascent from the roof of the LCC. In the event of a serious mishap, the family could be isolated from the press and looked after respectfully. Here, the unspoken role of the Family Escort as Casualty Assistance Officer would come into play. The accidents with STS-51L *Challenger* at the Cape in January 1986, and the return of STS-107 *Columbia* in February 2003 proved the most challenging for the Family Escorts, who had to provide immediate support for the families through these tragic losses.

Mike Coats was one of the TFNG who pioneered the Family Escort role. "We were preparing for the first Shuttle mission, and I was personally fortunate to be asked to be the Family Escort. I escorted John Young's and Bob [Robert] Crippen's families during the activities for their Shuttle mission – both for launch and then during the mission, and for landing out at Edwards Air Force Base in California. This was precedent-setting, if you will, and I really enjoyed that. It was fun to be right in the middle of all the 'firsts' that were going on."

Brief HQ Guests

At most launches and landings, there were a (sometimes quite sizable) number of VIP guests invited to attend by NASA Headquarters. As a result, at least one astronaut was designated as 'a briefer', whose role was to respond to any questions these guests might have about the flight or program. Rhea Seddon recalled her unexpected experience in this role: "The end of STS-7 had an interesting story, because they were meant to land at the Cape, and there was this immense crowd of VIPs who were going to be the very first special people to get to meet the now-famous first American woman to fly in space [Sally Ride]. But the STS-7 crew landed at Edwards. As soon as it became clear that they were going to send the vehicle to Edwards, NASA recognized that there was a big problem. There's 2,000 [or so] VIPs in Florida expecting to meet someone really neat and interesting, and she won't be there. Someone went patrolling the hallways in Building 4 and grabbed me. 'We need a pilot, and we need another one of the women, and we need to go placate these people'. They grabbed P. J. [Paul J.] Weitz and they grabbed me. They said, 'Go to the Cape. You're the replacement. You're the designated hitters. Faint substitutes, to be sure, but too bad, you're it'. We flew down to the Cape and walked into this immense sea of people. It was a really interesting moment. [One] thought instantly went through my head, [which was] 'I am really happy that Sally's in California and gets the six or eight hours to just digest what she's just done, absorb it, let it be hers, because it ain't much going to be hers. It's quickly going to become everybody else's'. I was just instantly really happy for her that she had this little hiatus to make her own initial sense of the flight – to enjoy it and bask in the moment."

Crew Transport Vehicle

At KSC, either the Chief of the Astronaut Office or his deputy were *authorized* to ride with the crew in the Crew Transport Vehicle (CTV) as far as the LCC.

MISSION SUPPORT ROLES (JSC HOUSTON)

With the vehicle safely in orbit, the support priority switched from the Cape to Houston for the duration of the mission. The roles here included:

Fig. 7.4: Dan Brandenstein (nearest camera) and Terry Hart at the Capcom console in Mission Control on April 10, 1981, the first launch attempt for STS-1 (Image courtesy of Ed Hengeveld).

Capcom

The term 'Capcom' derived from the early days of the space program during Project Mercury, where those in the control center *COMmunicated* with the lone astronaut in his *CAPsule*, hence 'Capsule Communicator' or 'Capcom'. Though the astronauts never liked using the word 'capsule' to describe their spacecraft, the name stuck and continues to this day in the International Space Station (ISS) Mission Control. Soon after the TFNG completed their Ascan training, a small group of them was assigned to train as Capcoms for the first few Shuttle missions. The first

Shuttle Capcom, for the launch of STS-1, was Dan Brandenstein, with many (though not all) of the group fulfilling the role over the next 30 years. Shannon Lucid, the last TFNG to be stationed at the Capcom console in MCC, was on duty during STS-135, the final Shuttle mission in July 2011. Assigned to a Flight Crew under a Flight Director (FD), the teams were assigned for launch and entry in eight-hour shifts around the clock as Orbit 1, 2, 3 and occasionally Orbit 4, or to the Planning Shift, with members (prime and back-up) manning the Capcom console.

Mike Mullane said that working as a Capcom was a real privilege, "and it's also something that gives you an insight into the best team on the Earth, and that's MCC. I had the greatest admiration for those people. To see them working together. There are times when you're on teams, and usually they're smaller than that, that click really well, but to have a team that large that is that trained and that good, I really felt proud of being part of it, and every astronaut should be a Capcom. Every astronaut should get in there and be part of the Capcom because it is just such a neat view of what NASA's all about. That's the heart of NASA in that MCC."

Steve Nagel recalled the early days at the Shuttle Capcom console for STS-2. "I was sitting next to Rick [Frederick H.] Hauck, who was the entry Capcom. We had it different in those days. Nowadays [he was speaking in 2002], there is a flight control team that works both ascent and entry, and then you have your orbit teams. [Back] Then, they had a separate team for ascent, a separate team for entry, and a separate team for orbit. So I was on the entry team with Rick. I don't know if I ever really even talked on the radio to the Shuttle. I think I just rode sidesaddle with him, learning from him on that one and assisting him. Then, on the third flight, I did it. I was the [prime] Capcom. And I only did it for one flight. Nowadays, these guys go over for assignment and the Shuttle flies often enough that they'll do several flights while they're working over there a couple years. I wound up being there just for two flights, but there was a longer time between flights then. Really, I don't remember much about STS-2 except that I was kind of Rick's assistant and learning from him. It was like OJT [On-the-Job Training]."

"Working as a Capcom during that time, I thought, was just a kick," recalled Pinky Nelson, "I mean, it was an incredible challenge, because we didn't have the TDRSS [Tracking and Data Relay Satellite System] satellites, so we only had the ground sites. So the time that you could communicate was very limited. You'd get a three-minute pass over Hawaii and a two-minute pass over Botswana or something, so you had to plan. Unlike now, when you can talk pretty much anytime, you had to plan very carefully and prioritize what you were going to say, and the data came down in spurts, so the folks in the back rooms had to really plan for looking at their data and analyzing it and being able to make decisions based on spurts of data rather than continuous data. So it was kind of a different way to operate.

"I really liked being a Capcom during that, having to organize what you were going to say; [being] able to say things in a really succinct and precise way and make sure that the language you used was just what they were expecting to hear so that you wouldn't have to repeat things, and to be able to listen. When you went AOS – Acquisition Of Signal – over a site, you would call up and say, '*Columbia*, Houston through Hawaii for two and a half', or something like that, and then you could just tell by the tone of their voice in the answer whether they were up to their ears or whether they were ready to listen. So there was a lot of judgment that had to be made, just in terms of [always having] a pile of stuff to get up. How much of this should I attempt to get up? What has to go up? Do I need to listen instead of talk?

"I found that to be just an interesting experience, a challenging job, and I really liked it. I liked that idea that it's a really high-tech machine. Really, the key communication was so subtle, the voice communication was really subtle and interesting, because there were times during those missions where there are always little things going wrong, and with just two people, it's just incredibly taxed. There were times when you could just tell by the tone of their voice it was like, 'Just knock it off for a while here. We're busy up here'.

"There were a few run-ins. I remember Neil [B.] Hutchinson, the Flight Director, was trying to get me to get a message up and I just wouldn't do it, because I knew that they just weren't ready to act on it. It was important, but wasn't critical or anything. And Neil was ready to kill me, and I just kind of sat there and just said, 'No. They're busy. They don't need to do this now'. So that was fun."

Rhea Seddon worked the Capcom console between her second and third flights, "and it was one of the best jobs that you could have," she recalled. "It really kept you in the loop of what was going on currently with the flying world. I had sort of been out in the science part of the universe and had not been able to keep up with what other people were doing, and what the Shuttle was doing, and engineering changes and all of that, so it was wonderful to be the Capcom. You had to do shift work again, and it was very busy. There was a lot going on, and you would do these sims [simulations] that would last all day, or have to come in at midnight, so that was somewhat difficult."

Seddon was not one of those originally selected for Capcom assignments in 1979 and only later realized that the assignment offered experience in understanding what went on during a flight and how the ground team supported it. "I made a flight or two and I'd worked with people on the ground, but I didn't really fully understand what they did and how they did it. So this was a wonderful experience to get to see that and be part of it, when things went wrong, how people worked on the ground. Of course, I'd been the beneficiary of that, because on our first flight the ground had an awful lot of work to do to put together a flyswatter and an unplanned spacewalk and rendezvous. So it was fun to see how that was done in Mission Control and to be a part of it. As a Capcom, you really got involved. You

were representing the crew, and you had to pull in resources. You couldn't do it while you were sitting there as Capcom in Mission Control, so you had to call in people and think about who the expert was and who could help. Then you were in charge of explaining everything to the crew or explaining the evolution of what was going on. So I gained a lot of appreciation for what went on, on the ground, and I really enjoyed the job."

Anna Fisher's tour as a Capcom gave her experience at both ends of her astronaut career. "When I was a Capcom, it was for STS-9 [in 1983] and it was a very, very different environment," Fisher recalled. "We had all-paper procedures, and everything was done by documenting and paper." Interviewed in May 2011, Fisher noted how things were changing for the ISS program as the Shuttle fleet retired: "I'm just in the middle of my flow for ISS training, so I haven't actually started working on console yet. I'll probably start doing that in about the July time frame. But just from my exposure to what I've seen, it's just a totally different environment, both in the Shuttle and in Station, because everything is so electronic now. Everything's available electronically, and you can be in Mission Control and have your laptop there and be doing e-mail and work. When I was a Capcom [for STS-9] you were in Mission Control, and there was no way other than by the phone to communicate with other people or do anything about your office job. You were just there. That's a pretty big difference, actually, because [now] – just like in everything – you can pretty much stay connected no matter what you're doing.

"The difference in a Shuttle Capcom and an ISS Capcom is [that] a Shuttle mission is just like a sprint, and ISS, as a Capcom, as a crew, is more like a marathon. When you're working a Shuttle mission, everything has to be done rapidly. The biggest difference is you're manned around the clock. You're there for one week or two weeks, and then that flight is over. So what I've seen on the ISS side so far is [that] it's a much slower process. If the crew asks a question, you might not have the right person there to get an answer right away. The habitability aspects, the stowage aspects, keeping track of where things are, just the sheer amount of knowledge you have to have about the systems… The Capcom flow for ISS systems just scratches the surface just so you'll be familiar with the vocabulary and generally how the Station is organized. There's just so much to know. At the same time, other than on certain days, like docking days, undocking days, when a Progress is coming or a Soyuz, other than that, it's a slower pace, I would imagine. That's just kind of my guess, as opposed to when you're in the Shuttle environment."

Flight Data File

The Flight Data File (FDF) was a small library of printed documents (originally) stored aboard the Orbiter, which provided the flight crew with a back-up for checklists and procedures for the different phases of their mission should there be problems in communications or onboard systems. These included nominal and

contingency guidelines for ascent, entry, Extra-Vehicular Activity (EVA), flight plan, orbit operations, Payload Deployment and Retrieval Subsystem (PDRS) operations, photo/TV, post-insertion and rendezvous, and so on. These documents had to be updated and maintained, so one of the early roles for a new astronaut was to track these changes and ensure that the flight crew had the most up-to-date versions.

Fig. 7.5: Training copies of the Flight Data File from a later Space Shuttle mission, located in the mock-up of the Shuttle middeck, Building 5 at JSC (Image from the Astro Info Service Ltd archive).

Flight Simulation Laboratory

Guion Bluford recalled that "In addition to working in the SAIL [Shuttle Avionics Integration Laboratory], I was also assigned to work in the Flight Systems Laboratory [FSL] at the Rockwell International Corporation facility in Downey, California. This facility was used to verify the flight software for deorbit burns, entry, and landing. As part of that job, I was also checked out to fly simulated Shuttle approaches with T-38s on the White Sands Test Facility [WSTF] range in New Mexico. NASA put large speed brakes on the T-38s to simulate Shuttle approaches. This was done to help train pilot astronauts. This was an exciting time for me, because it gave me an opportunity to see and verify the flight software for all flight phases of space operations. I would spend a week in Houston flying

Shuttle ascents in the SAIL and then the following week I would fly a T-38 out to El Paso, Texas, fly simulated Shuttle approaches on the White Sands Test Facility range, and then fly to Downey, California, to fly Space Shuttle approaches in the FSL. I did this for several years as we prepared for the first four flights of the Space Shuttle."

Launch Systems Evaluation Advisory Team

This team, which included an astronaut representative, looked at the loads on the vehicle during launch and the aerodynamic loading and structural limits prior to each launch. A final recommendation was made by the JSC Launch Systems Evaluation Advisory Team (LSEAT) to the KSC launch director at Launch minus 30 minutes. Steve Hawley worked on LSEAT and recalled the sometimes early starts. "We were there for instance at two in the morning, before Shuttle launch at eight."

PAO Support

Astronauts were detailed to support the PAO staff, which included assignments to the large media companies of the United States. In the early 1980s, this meant working with the radio stations or TV broadcasters as the mission progressed (this was in the days long before social media and websites).

"For the early missions, NASA assigned astronauts to the broadcast networks," Steve Hawley explained. "I remember Joe Kerwin worked for one of the networks (I think NBC) for STS-1 and I was really impressed at what he brought to the coverage. I'm not sure that every network wanted someone, but for STS-5, NBC did. I was assigned, although it wasn't a job I wanted. I worked with Jane Pauley on the *Today Show*. We did both launch and landing coverage. My job was to be on air with her and to explain what was going on during launch and landing. We were at KSC together and then we were together at EDW [Edwards Air Force Base, California]. I was on call while the mission was on orbit in case something happened, but I don't recall if they used me. It actually turned out to be a fun assignment and I stayed friends with Jane and her husband for a number of years. I don't recall when we stopped offering astronauts to the networks." **[10]**

Kathy Sullivan was at the Cape during STS-1, assigned as a technical advisor and commentary support to the American Broadcasting Company (ABC). "ABC News, as it turns out, was trying to really boost their competitive advantage on the TV coverage," she recalled in her Oral History. "Gene [Eugene A.] Cernan was ABC's main on-camera commentator for the Space Shuttle Program. They were intrigued with the bookends: last man on the Moon, long hiatus, and first flight of the Space Shuttle. You know, 'A handsome Navy test pilot, this is very cool. He'll be our on-camera presence'.

"I show up, twenty-nine-year-old girl astronaut. I haven't ever flown in space, but I'm friendly. They said, 'Lovely. Glad to have you. Go talk to the radio guys'. So they banished me to radio. 'We paid for *this* guy [Cernan]'. The radio folks were lots of fun. I actually had a really good time with them. We did some work-ups in Houston before everything shifted down, and they flew me down to the Cape with the radio guys. Their plan was to just bring me back to Houston, while Gene would go out and cover the landing, and I was kind of disappointed at that. I thought it would be cool to see a landing, but, you know, I had figured out what the food chain was and where I had been placed on the ABC food chain, so that was kind of understandable.

"We're down at the Cape, and we're in the countdown. They've suited up. Gene is bantering with whoever the commentator was. We get down to the twenty-minute hold when you take the computers over to flight mode, and the radio guys are not trying to fill every single second contiguously, so I'm actually having time to listen to the technical loops. I know where we are, I know what's supposed to happen. I'm following the countdown flow [and] I hear 'Crip' [Robert L. Crippen, STS-1 Pilot, inside *Columbia* on the Pad] say, 'BFS [Backup Flight Software] didn't follow the pass'. I know right away we're not going anywhere. There's no way. The very first launch, when the crew took the BFS to Ops 1, if it didn't synch up and track the primary flight set, I just absolutely knew there was no way [we would launch]. I couldn't imagine that anyone was going to come up with enough of a diagnosis in ten minutes that we're going to launch STS-1 when the BFS didn't follow the pass. This was just not going to happen. We're going to stop and really look deeply at this. I'm convinced.

"We go into a hold. I'm listening to the chatter on the loops and it's clear that the way people are thinking this through, the launch will be scrubbed. I can just tell from the way the Launch Director and the NASA Test Director are talking; their heads are about where my head is. There's no reason to hurry up and push through this. Twenty-four hours doesn't hurt a thing. Let's really know what we're doing here. Forty-eight hours doesn't even really hurt a thing; let's know what we're doing.

"The hold just keeps extending and extending, and the agency's not saying anything yet about what's going on or what the intentions are, because it's more important to stay focused on the technical stuff. I tell the radio guys, 'This ain't going today' [and they reply] 'No, they just said they're in a hold'. [I said] 'Well, I know, but they've only said that because…', and I'm explaining to them. 'But trust me; we're not going anywhere today'. Gene, meanwhile, is up there, and they're getting 'Stretch it, stretch it. We need more fill. We don't know when it's launching. Come on', from the editors. And they start asking Gene more and more detailed questions about what exactly is happening with the computers here, and he starts giving answers. They might have been Apollo system answers, but they weren't accurate Shuttle system answers. So I listened to a couple of these, and he

kept getting further off the ranch. At some point, I tugged the radio producer's sleeve and said, 'Does it matter that he's not giving correct answers?'

"Whoom! The whole booth goes sort of nuts, and the next thing I know I'm on camera. It's radio, so I've got grubby jeans on. Nobody's seeing me. The next thing I know, they're going, 'Get that girl up here', and I'm yanked up and plunked onto the TV desk. Now the challenge is, how do you start giving answers without discrediting an accomplished astronaut? I didn't know Gene Cernan at all then. I still don't know him super well, but, you know, this is a really accomplished guy and he flew to the Moon and all that cool stuff. I'll confess I probably had my feelings hurt a little bit that I didn't get any attention by the TV guys.

"But I had no desire to come across as, 'What an idiot! Let me tell you what really happened'. So how do I finesse the transition? 'What the captain meant to say was…', and then start giving the better answers. So I sort of helped them out of that. [I] Ran up to New York and gave a speech at the Explorers Club of New York the next day. I was one of first female members of the Explorers Club. [I] Raced back and skidded out to the launch site again to cover for radio the next morning. Well, then they flew us back to Houston, and we're covering a little bit of the mission. The fun part of all of that was what I had done, and how I had done it. The radio guys and the TV guy I had bailed out went to bat with the executive producer and said, 'Take her to the landing site. We want her at Edwards Air Force Base'. I'm good on my feet. I follow things. I'm a good commentator. I'm a great explainer… they've now seen all of that. But I haven't been to the Moon; I'm not a Navy test pilot. 'But she actually speaks well and makes it understandable in human terms. Get her to the landing site'. So I did end up going out to the landing site for STS-1. That was a fun story, and Gene never said anything. I think I must have finessed that little transition reasonably well. As far as I could tell, he didn't have any cause to take offense."

By 1984, in-depth coverage of each Shuttle launch was being curtailed by the major U.S. networks, as Ox van Hoften recalled during the lead up to STS-41C: "Pinky and I had dinner with the ABC anchorwoman Lynn Shearer, who sat there and said, 'Well, I just want you guys to know that this is the last flight we're going to cover live. All the rest of them [TV networks] are just going to have a death watch here'. That's exactly what she told us. We said, 'Well, that's great, Lynn. Thank you so much for that'. That was a pretty amazing comment, I thought. And they did. After that, they didn't have quite the same hype that we had down there."

Spacecraft Analysis

In addition to conducting mission simulations and operations with flight controllers, provisions were made for key NASA engineering and scientific personnel, along with representatives of the major contractors, to support each mission.

This increased presence strengthened the problem-solving capabilities of the MCC team. The spacecraft program office support team occupied what became known as the Spacecraft Analysis Room, or 'SPAN'. JSC and industry engineering teams supported missions in this little room, just off to the side of the Flight Control Room (FCR) in the MCC.

This arrangement enabled immediate contact with key JSC engineering and industry representatives when any assistance was required in resolving technical anomalies that might arise during missions. Throughout a mission, SPAN was operated in consecutive 12-hour shifts by a group of astronauts and other support personal assigned to a particular phase or flight day. The group supported the mission by analyzing data returned from the Orbiter, and offered real-time support in the event of malfunctions and/or equipment failures.

Shuttle Mission Simulator

There were two Shuttle Mission Simulators (SMS) in Building 5 at JSC. They were supported by the Guidance and Navigator Simulator (GNS) in Building 35. Support astronauts used these devices to replicate flight issues, and to explore contingency and workaround tasks, assisting the crew on orbit in real-time. Many of the astronauts rotated to assignment in the SMS at some point in their careers before flying in space. "After that initial orientation of NASA acronyms and locations and things, then we began some initial training in the Single-System Trainers [SST] that they have and in the Shuttle Mission Simulators," recalled Fred Gregory. "We did not interface with [the simulator engineers] daily, though they were kind of our super dads down there to make sure that everything was prepared for us."

Hoot Gibson recalled how little simulator training the group received at first. "We were being trained on Space Shuttle systems and Space Shuttle flight dynamics, although not deeply into it. The training organization over at JSC was pretty heavily involved in training for the first four STS flights. Of course, you just had two-person crews, so each of those two guys on those first four flights had to learn everything. They had to learn how to do spacewalks; they had to be able to go outside and winch the doors closed if you couldn't close the doors electrically. We weren't seeing much at all in the way of simulator training. At that time, I think we had the second simulator, what we called the mission simulator. We had the Motion-Base [simulator], and then the mission simulator also got called the Fixed-Base Simulator. I think that one came on a little later, so we really weren't doing a whole lot of training in the simulators. They brought us in when they did, I've been told, because they believed we were within six months of the first launch, and it actually turned out to be almost three years. We didn't train a whole lot after our initial training."

"We [eventually] got simulator training in several different Space Shuttle simulators," explained Guion Bluford. "These included the Single-System Trainer, and the Shuttle Motion-Base and Fixed-Base Simulators. We learned how to use the Space Shuttle Flight Data File. This included the various checklists and cue cards used by the astronauts to fly the Shuttle. Simulator training gave us valuable exposure to how the Shuttle flies in space and how the Space Shuttle systems work. Mission Specialist candidates were also trained in the RMS [Remote Manipulator System] simulator. This trainer was in Building 9 and it was used for procedure development and camera coordination. The best RMS training occurred in the SMS, in which the RMS was simulated by computer graphics."

"Back then, we didn't get much simulator time. They do nowadays," recalled John Creighton. "When they get in, as a part of that, they'll start getting in the simulator fairly soon, but back then, all the simulator time was being taken up by the first couple of crews that were getting ready to fly the Space Shuttle, John [W.] Young and [Robert L.] Crippen, and [Richard H.] Truly and [Joe H.] Engle."

Dan Brandenstein explained that "[we] got a full set of briefs on each system on the Shuttle, so you knew how the electrical system worked and how the hydraulic system worked and how the computer worked, and you got some time in simulators. You didn't get time in the upscale simulators, the moving base or the fixed-base. They had what they called Single-System Trainers, where you kind of go in and you just learn one system at a time. The cockpit didn't move, but it had the basic displays and things. A lot of the switches, in a Single-System Trainer… that weren't used in the level of classes you were getting, were just pictures of the switches that you needed to operate to learn the system you were working with, [that] you actually operated. So, yes, you got quite a bit of time doing that. Once again, it was the first time through, and you got a pretty good understanding of it, but it isn't until you really got further down the line in the real mission training that you really get to understand a lot of the subtleties of the Shuttle."

Shuttle Avionics Integration Laboratory

Located in Building 16, the Shuttle Avionics Integration Laboratory (SAIL) was a mock-up of the Shuttle cockpit and payload bay, designated OV-095. All the instruments and controls were linked to flight-standard cabling, and used the same software that the General Purpose Computers (GPC) used on the operational vehicles. Several computer systems were linked up to simulate the operational environment without ever leaving the ground. One computer simulated the atmosphere, a second simulated the engines, and a third simulated the aerodynamics and equations of motion. Astronauts then 'flew' simulated ascent and entry profiles, deliberately stressing the systems to ensure that they would work as designed on a real flight, with the simulator staff inserting different abort and contingency scenarios into nominal operations.

Fig. 7.6: [main] The cockpit of the Shuttle Avionics Integration Laboratory (SAIL) later in the Shuttle Program (showing the upgraded glass cockpit displays. [inset left] An exterior view of the SAIL. [inset right] The wiring feeds in the mock-up payload bay.

Several astronauts worked in SAIL as a round-the-clock activity. "We'd work a different shift every week, which made us exhausted a lot of the time, but back then we were young and we could do that," Mike Coats recalled in his Oral History. "Steve Hawley and I seemed to be on the same shift a lot, and it was fun because Steve was a scientist. In the simulator there in the SAIL facility, which was a cockpit of the Shuttle, they have a technician in there all the time as well. We were supposed to be the crewmen.

"The technician was Hispanic, and he'd be talking Spanish to other technicians that were on the headset listening in, and unbeknown to them Steve spoke Spanish. He'd just come from Chile, where he'd been an astronomer down there observing, and he spoke good Spanish. We were in there probably a month, and this guy would be joking about us or saying things about us in Spanish, and Steve would

Fig. 7.7: A youthful Steve Hawley looks in on the SAIL facility circa 1979/1980 (Image from the collection of Steve Hawley, used with permission).

tell me later what he was saying, and we were enjoying that. Then one day Steve lets out a sentence in perfect Spanish, and this guy's face just turned white. You could see all the blood drained out of his face, and he's trying to remember all the things he'd said about these two young astronauts. He never said another word on the simulator. Steve enjoyed that a lot."

Working in SAIL was disruptive to a normal routine at times, as Coats explained: "You were supposed to work three shifts at SAIL, so you'd work a shift, but you'd have to get there an hour ahead of time for a brief and then a debrief afterwards. So it was 10 hours there, and then you'd go over to the office and try to get whatever work done there. You might have a class or something like that. Then you'd be working Saturdays and Sundays. It was about 12 hours a day, sometimes seven days a week. You thought it was important because you were getting ready for that first Shuttle flight, but it was hard on the families."

Don Williams said that he learned far more about the Shuttle systems from SAIL than from other training devices. "It was actually pretty exciting. I learned a lot about the systems, particularly the computer systems and data systems in the Shuttle, during that time, a lot more than perhaps I learned later on. But it gave me a good foundation and a lot of familiarity with how the software is put together and how it interacted with the hardware, and how the crew interacted with the computer systems on the Shuttle." He also noted that the work could be demanding: "Working midnight to 8:00 in the morning every third week wasn't too much

fun, and the other two you'd work from 8:00 in the morning until 4:00 [in the afternoon, or] 4:00 [pm] until midnight. Every week you'd switch to a different shift. It was seven days a week for a while. It was a tough schedule."

Steve Nagel went further, stating that working in SAIL "was kind of dog work… the average number of formal runs per day was seven. So [it's] not like [you're running a lot], there [was] a lot of preparation time for each run. Then you make the run, then there's a lot of time afterwards. So things moved pretty slowly, but you really got to know the software, from a personal standpoint, and how it all played together with the avionics there. You learned a lot. It just took a long time to learn it. But, yes, we were doing good work there. It was a good place to work. I wound up working there three times, so three different assignments. I think I paid my dues in SAIL."

"One job that we had to do was to review all the test procedures that would get printed," recalled Robert Gibson, "and virtually every day in our in-basket there would show up what was called TCPs, Test and Checkout Procedures. So one astronaut would be assigned to TCP review for the whole week. It was your job to get over there, and sometimes it could be a mountain of paper that was in that inbox. You had to go through and review it for accuracy. We always wound up making little changes to it and corrections to it. Another astronaut would be assigned to the TCP review meetings, because they would get together when they had one and everybody would provide their inputs to it, and then from there it would go to a final TCP. Then you could run it in the simulator. The really wonderful thing about the SAIL lab was that it wasn't simulated equipment, it was real hardware. You had the real Space Shuttle computers, you had real rate gyros, and you had real accelerometers. You even had the cable trays, so you had the cables that ran from the nose section of the Orbiter. We had an Orbiter cargo bay with all the electrical wires and things running back to the aft avionics compartment as well, which is where a lot of the electronics that controlled the main engines and the fuel lines and a lot of stuff would be located. We wanted to have all the cable lengths because that can make a difference in the electric signals getting through. It was a fascinating place to work."

Not everyone in the office looked forward to working in SAIL, mainly due to the hours and the schedule. Steve Hawley originally did not want to do it, "but off I went, and I found [that] you really learn a lot [there]. So that was really helpful to me because I learned a whole lot about the software. This is before STS-1 when I worked over there, and by helping develop the test cases and running the test cases in the simulator and evaluating the results that came from the test cases, you learned a lot about how the software works. I didn't realize how important that would be later to me going through training as a crewmember, but for five flights one of the things that really helped me was I had a good solid understanding of how the software works, which is critical to how the whole Shuttle performs.

"It was a kind of an inefficient way to spend your time. You'd sit around and wait for two or three hours, and then you'd hurry up and run a test case, and maybe then go off and wait two or three more hours before you ran another test case…

My experience over the twenty-five years has always been [like] that. I was in the second group of astronauts that ever went over to do that job. The first group of astronauts [who worked SAIL], all I remember them talking about is 'What a waste of time this is. It's so inefficient'. So all of us in the second bunch that went over were telling people 'Man, this is great. You learn a lot about the software. You learn how the Shuttle works'. [Suddenly] everybody wants to go to SAIL.

"I was assigned to SAIL, the software verification facility, for STS-1. As it turned out, I had the job of trying to reproduce the BFS tracking problem that caused the scrub of STS-1 on April 10 [1981]. It took loading the software into the GPCs something like 175 times before we could get the problem to recur. I probably still hold the record for most times 'IPL-ing the GPCs [Initial Program Loading the General Purpose Computers]'. One other thing I remember is that the day before launch, the facility allowed some media to visit. One of the local TV reporters talked to me while I was sitting in the simulator. I remember he asked me 'When is your flight?' I told him 'Tomorrow – we're all flying tomorrow'." **[10]**

Weightless Environment Training Facility

The Weightless Environment Training Facility (WETF) in Building 29 at JSC was operated between 1980 and 1998. Building 29 originally housed the centrifuges used during project Apollo, but for the Shuttle era it was repurposed as a water tank to train the astronauts for Shuttle-based EVAs. Measuring 78 ft (24 m) by 33 ft (10 m) and 25 ft (7.6 m) deep, the WETF pool proved too small to hold the mock-up Hubble Space Telescope (HST) or elements of the ISS and was replaced by the Neutral Buoyancy Laboratory (NBL) in the Sonny Carter facility. Originally built to support EVA training for Space Station *Freedom*, the NBL began operational use in 1997 to support ISS operations.

For the TFNG, the original WETF was the main water tank for both EVA training and water egress training from the Shuttle. During each mission, whether an EVA was planned or not, an EVA astronaut support team stood by for any contingency EVA requirements. Such contingency occurred during STS-41C, 51A, 51D and STS-49, where real-time situations necessitated a quick simulation of any new procedures, prior to the flight crew conducting the EVA in space.

Because of the limited dimensions of the WETF pool, it became necessary to utilize the tank in the Neutral Buoyancy Simulator (NBS) building at Marshall Space Flight Center (MSFC) in Huntsville, Alabama to train the astronauts for servicing HST, and later to demonstrate space station assembly techniques, until the NBL facility was ready in the late 1990s. The NBS had been built in 1967 to support Apollo Applications Orbital Workshop (AAP, later Skylab) EVA development. **[11]**

Chase Plane Team

During the first few Shuttle missions, several of the TFNG crewed T-38 jets to support the final stages of a mission. One or more aircraft would be airborne as the Orbiter descended towards the landing site, providing additional guidance to the

flight deck crew regarding the descent, landing conditions and the state of the Orbiter, in particular confirming that the landing gear had lowered, the condition of the aerodynamic surfaces and the integrity of the thermal protection system after entry. They also positioned the aircraft high enough to view and film the ascent of the Shuttle from the pad at launch.

"I just thought it was just an amazing experience, being on the chase team," said Pinky Nelson. "We did a lot of training. I got a tremendous amount of terrific airplane-flying experience, going out to the range at Edwards and practicing rendezvousing with the Shuttle and chasing it down."

"I was a chase pilot for STS-1 and STS-2," recalled Hoot Gibson. "I was Chase-1 for STS-2, so I did what they did. I was down at the Cape for launch and then made my way out to Edwards. It was supposed to be a five-day mission. We were really looking forward to five days out at Edwards because we would [only] have been on alert during the crew's awake time. When the crew went to bed for the night, we weren't going to be on alert anymore, so we didn't have to hang around out at the flight line. We were going to have a great time running because Edwards is a great place to go running. We were going to get to enjoy the gym and go running and all of those great things. [Then] they had a fuel cell failure, and they came down in two days. I only got to enjoy Edwards for two days, once again."

The chase teams were referred to as the Chase Air Force, with their own embroidered patch, "Yes, we did have a patch," Gibson explained. "In fact, I still have one of my jackets that has a patch that Dick Gray [of the Aircraft Directorate] actually developed. It has a T-38 joined up on a Shuttle, and it says Shuttle Chase Team on the patch. We got a little bit notorious on STS-1 because Jon McBride and Dave Walker really liked to be off practicing chase, so we did a lot of it. Since we were support for the upcoming mission, we had the highest priority for getting T-38s, and we wound up doing probably a whole lot more flying than we needed to.

"We got really hammered by the office and because we did so much practicing, we had over-flown our T-38 budget. We the pilots, the individual pilots, all four of whom were Navy pilots. Jon McBride, Dick Gray (former Navy), Dave Walker, and myself, were Chase-1, -2, -3, and -4. All former Navy and we got beat up. In fact, George Abbey sent out a note to all of us that said, 'You guys are walking until you make your time for the six months come out to your allocated flight time', which was normally 15 hours a month of T-38 time. I think because we were mission support for STS-1, we could have 20 hours a month. We over-flew that. We went well beyond our 20 hours a month, so he sent us out a memo that said, 'All of you boys are walking', basically. 'Make your time for the six months come out to…' six months times whatever our number of hours was supposed to be. I think I was the only one that actually abided by that. I think the rest of the boys said, 'Ah, phooey, I'm not doing that'. I think I was the only one that did that."

Tower

During the early stages of the program, an astronaut was assigned to the control tower (TWR) at the landing sites, though this assignment did not continue for long once the first few landings had provided confidence in the system. "If I remember correctly, Dave Walker was in the tower at the SLF [Shuttle Landing Facility, KSC] for the STS-7 landing," recalled Steve Hawley. "I was waiting for the landing in the O&C [Operations & Checkout] building listening to the chatter on the loops. MCC kept asking if the STA was airborne yet since it was time to make the weather observations according to the timeline. I think it was Dave [Walker] who told them the STA couldn't take off because it was too foggy. MCC kept asking for status reports since they needed the weather observations. I recall being amused that somehow it didn't register that if it was too foggy for the STA to take off, it was too foggy to land the Shuttle. [So] STS-7 went to Edwards." **[12]**

Center Operations Directorate [COD]

The Center Operations Directorate (COD) is responsible for the day-to-day running of JSC. One of the roles of the COD during a mission was to be in contact with the local police department that provided security for each crew member's family and home when the mission was in flight. During a mission, one member of the Astronaut Office was given a concurrent assignment to be the point of contact between the Office and the COD, representing the interests of the flight crew.

EOM Exchange Crew

The End Of Mission (EOM) Exchange Crew was formed occasionally by members of the Cape Crusaders, to provide an 'astronaut crew' on hand at the end of a mission to de-configure the Orbiter after its flight when the prime crew had departed the Orbiter. The ground crew would secure the vehicle and supervise its transport to the Orbiter Processing Facility (OPF) if it landed at the Cape, or prepare it for ferry flight if it landed elsewhere.

"Sometimes, but not always," explained Steve Hawley, "the ASP/Cape Crusaders were also assigned as the EOM exchange crew. Those were the guys who relieved the flight crew after landing and stayed with the vehicle through the power down. Dan Brandenstein and I were the exchange crew for STS-3. We were at White Sands Space Harbor [New Mexico] for the only landing there in the history of the program. That was a memorable experience for many reasons. The weather was marginal due to winds and the gypsum dust was blowing everywhere. Dan and I were cleaning dust out of the Orbiter the whole time we were on board. I was told that the KSC guys were also trying to clean up gypsum after the vehicle got back to Florida." **[7]**

Crew Recovery Team

In the event of a Shuttle landing outside of the continental United States, the Flight Crew Operations Directorate (FCOD) at JSC would have dispatched a KC-135 aircraft from Ellington Field to the landing location with the aim of returning the flight crew to the United States as soon as possible. In the event of injury to a member of the flight crew, they would have been evacuated by appropriate means to the nearest U.S. military base for treatment prior to repatriation to the U.S. Fortunately, this type of contingency was not required during the Shuttle program, but members of the senior management at NASA (including positions at the FCOD fulfilled by senior Group 8 management astronauts) remained on standby during a mission if required.

Fig. 7.8: Members of the JSC astronaut corps, Vehicle Integration Test Team (VITT) and other personnel at the completion of a countdown demonstration test (CDDT) at Launch Pad 39A, Kennedy Space Center. The participants are (from left): Wilbur J. Etbauer, engineer with the VITT; MS and TFNG astronaut James D. van Hoften; Terri Stanford, engineer from JSC's Flight Operations Directorate; MS and TFNG astronaut Steven A. Hawley; astronaut Richard N. Richards (Class of 1980); astronaut Michael J. Smith (Class of 1980); Richard W. Nygren, head of the VITT; MS and TFNG astronaut Kathryn D. Sullivan; astronaut Henry W. Hartsfield Jr., STS-4 Pilot; Mark Haynes, a co-op student participating with the VITT; astronaut Thomas K. Mattingly II, STS-4 CDR; and TFNG astronaut Donald E. Williams. (Image courtesy Ed Hengeveld.)

MANAGEMENT SUPPORT ROLES

During the extensive 1986 Presidential Commission investigation into the *Challenger* accident, they found that there had been a departure from the philosophy set up in the 1960s and 1970s which saw astronauts assigned to management positions. These astronauts brought their experience and a keen appreciation of flight safety and operational procedures to the role. The Commission recommended that "NASA should encourage the transition of qualified astronauts into agency management positions," and that "the function of the Flight Crew Operations Director should be elevated in the NASA organization structure." It was also recommended that a representative from the Astronaut Office should be assigned to the Shuttle Safety Panel, and that the mission commander (CDR), or their designated representative, should "attend the Flight Readiness Review, participate in the acceptance of the vehicle for flight, and certify that the crew is properly ready for flight." **[13]** This was seen to be implemented during the 1990s, when several former Group 8 astronauts moved from the Astronaut Office to more senior managerial positions in the Shuttle program.

FCOD Management Support

The FCOD were members of the senior management chain at NASA JSC, and were on hand to assist the FD at MCC in making decisions that had no mission safety consequences but which could have cost or public perception consequences. They could not overrule the FD during a mission, but merely advise them. During a mission, an astronaut was assigned to the Operations Support Room (OSR), which was an annex to the MCC, or down at KSC, as Steve Hawley explained: "OSR was staffed by technical people and program representatives. [It] often did some leg work for the MCC [such as] notifications, coordination, perhaps setting up some testing or sims if necessary. We had [an astronaut] rep [there] to make sure that crew interests were represented, who could find astronauts to do tasks [such as flying a part to a contractor, or to KSC, or running a sim], and for the purpose of making sure FCOD management was aware of what was going on." **[14]**

Contingency Action Center

In the event of a mishap occurring during a mission, the manning of action centers and communication networks followed predetermined guidelines and included a representative of the MMT. After the *Challenger* accident, this would often, but not always, mean a veteran or senior managerial astronaut. These centers were located at NASA HQ, MSFC, KSC, and JSC.

Mishap Representative
This was a member of the FCOD senior management, on hand to assist the Mishap Investigation Team dispatched to a contingency site near to where a mishap occurred. Usually, a senior astronaut was on hand to support this position.

READY TO EARN THEIR ASTRONAUT WINGS

From 1979, members of the 1978 astronaut selection provided the various support roles for the early Shuttle missions flown by *Columbia* under the OFT, as well as the first two 'operational missions' by *Columbia* and the inaugural space flight of *Challenger*. With four years of NASA astronaut experience and training behind them, they were now eligible to be assigned to their first missions and undertake the next step in their career. The Shuttle crew training program would finally lead each of them into space. With only 5–7 flight seats to fill, the TFNG could not all possibly fly on the first Shuttle mission available, which was STS-7, nor fully crew the next five missions as rookies. NASA systems demanded that a veteran CDR should lead each mission, but as many as possible from the 1978 group would be assigned over the next 14 missions. Some of these seats would be taken by veteran astronauts as CDR and MS, as well as the first Payload Specialist (PS) selected for the program. For the TFNG, the next step was to qualify from the Shuttle mission training program, another challenge in their new chosen career. This is explored in the next chapter, mainly in the context of the early to mid-1980s, during which all 35 flew their first missions.

References

1. *What do Astronauts Do?* unsigned Astronaut Office handout dated April 3, 1986, on file AIS Archive.
2. Mike Mullane, NASA Oral History, January 24, 2003.
3. Guion Bluford, NASA Oral History August 3, 2004.
4. Dan Brandenstein, NASA Oral History, January 19, 1999.
5. Fred Gregory, NASA Oral History, April 29, 2004.
6. **The Concise Oxford Dictionary**, 1991 edition.
7. Email to author David J. Shayler from Steve Hawley, January 28, 2019.
8. *NASA Shuttle Abort Modes*, in **Space Rescue, Ensuring the Safety of Manned Spaceflight**, David J. Shayler, Springer-Praxis, 2009, pp. 216–224.
9. Rhea Seddon, NASA Oral History, May 20, 2010
10. Email to author David J. Shayler from Steve Hawley, January 29, 2019.
11. **Walking in Space**, David J. Shayler, Springer-Praxis, 2004; **Hubble Space Telescope** and **Enhancing Hubble's Vision**, David J. Shayler with David M. Harland, Springer-Praxis, 2016, and **Linking the Space Shuttle and Space Stations**, and **Assembling and Supplying the ISS**, David J. Shayler, Springer-Praxis, 2017.
12. Email to author David J. Shayler from Steve Hawley, January 22, 2020.
13. *Report of the Presidential Commission on the Space Shuttle* Challenger *Accident*, June 1986, Recommendation II, p. 199, and Recommendation V, p. 200.
14. Email to author David J. Shayler from Steve Hawley, January 23, 2020.