Back into Space with Columbia

Despite long delays and huge cost overruns, the shuttle's first flight was a great success

Johnson Space Center, Houston. The flight of the space shuttle Columbia surpassed the expectations of both its crew and its ground-based controllers. The launch occurred without mishap at 4 seconds after 7:00 a.m. on 12 April 1981. The spectacle of the liftoff—of a giant spaceship somehow reminiscent of those in old science fantasy films emerging from a great ball of smoke—exhilarated the flight team and millions of viewers.

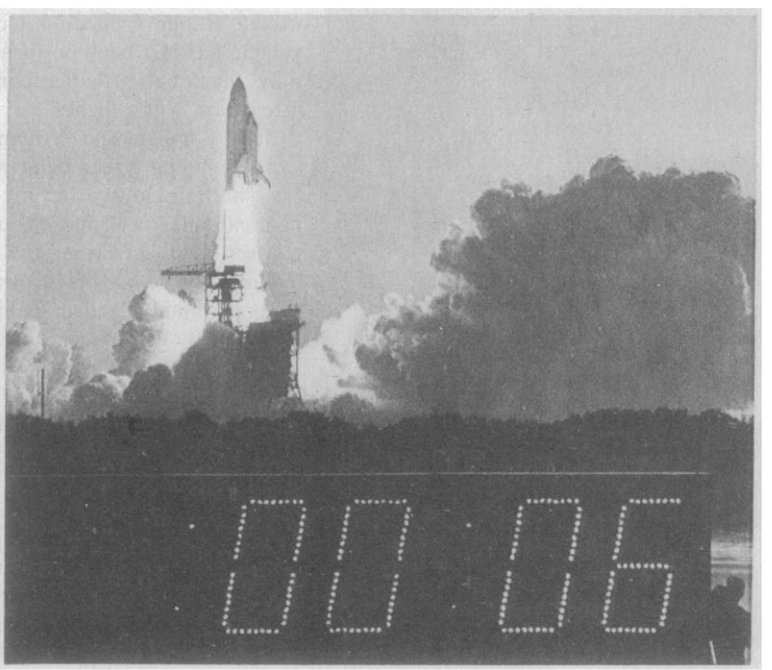
"After having simulated for a couple of years, practicing every malfunction we could possibly dream up, I just kept waiting for something to go wrong and nothing did," said Neil Hutchinson, the shuttle's flight director during lift-off. Launch director George Page added that the shuttle's engine, plagued by technical problems and failures during the shuttle's development, performed even better than expected. The three main engines and the two boosters ignited on time and successfully steered the shuttle through difficult maneuvers during the flight's first few minutes.

The shuttle's delicate skin of silica tiles, another early source of difficulty and delay, behaved less perfectly. One of the tiles, which protect the orbiter and its crew from the heat of atmospheric friction upon reentry, peeled off during the shuttle's launch and at least 15 others chipped or broke in half, apparently while aerodynamic stresses were at their peak. Eight of the chipped tiles were not tested for correct bonding to the shuttle's skin, out of fear that the test would break them. The resultant tile gaps were located on the left and right pods housing the shuttle's two smaller engines, used for maneuvering the craft in orbit. Insulation beneath the tiles remained intact and NASA gave early assurances that neither the crew nor the orbiter would be endangered upon reentry. "We think we took a bigger thermal pulse going up in that area than we're going to take coming back," he said.

The failure of these tiles to hold caused the agency to become concerned that other tiles might also be missing on the plane's more sensitive underside. Because the underside is inaccessible to the astronauts or to their onboard cameras, NASA was forced to ask the Department of Defense (DOD) to film the shuttle from the ground using high-resolution cameras. When NASA announced that DOD cameras located at Melabar, Florida, and Maui, Hawaii, would do the filming, it placed DOD in an awkward position, because the existence of the cameras and their fine resolution was not previously well known. NASA said that two initial DOD attempts were frustrated by inadequate angling of the shuttle in space and by cover, and then refused to confirm whether better views had been obtained from other secret locations or from military reconnaissance satellites. "Further discussion is classified," said Eugene Kranz, NASA's deputy director of flight operations. Flight controllers at Johnson Space Center in Houston also analyzed temperature readings from sensors scattered beneath about a hundred of the most critical tiles on the craft but discovered no signs of additional gaps. Kranz described this procedure as "Sort of like looking for a needle in a haystack."

Hutchinson told a press conference on the second day of the flight that the missing tiles did not unduly concern the mission controllers, "because it's something you can't do a lot about." NASA at one point began to construct a tile repair kit for the astronauts to carry with them on the first four test flights, but abandoned the idea on grounds of bulkiness and expediency. The repair kit would have added 1000 pounds to the weight of the craft, already 25,000 pounds overweight. The difficulty of training the crew to operate the repair tools while floating in space would have required delay of the launch, already 3 years late. The risks of this decision were high: Heat during reentry is about 2700°F, enough to burn through the shuttle's aluminum skin, even if just a few tiles are missing in critical areas. The cockpit itself is protected by heat sinks and insulation blankets, but a burn-through in other areas would lead to failure of equipment and possibly to loss of control. NASA had the option of shutting off some of the equipment that could be endangered during reentry, relying instead on redundant devices elsewhere in the craft, but chose not to do so.

Additional worry was caused by a malfunction of a flight data recorder that



Wide World

Columbia 6 seconds after take-off

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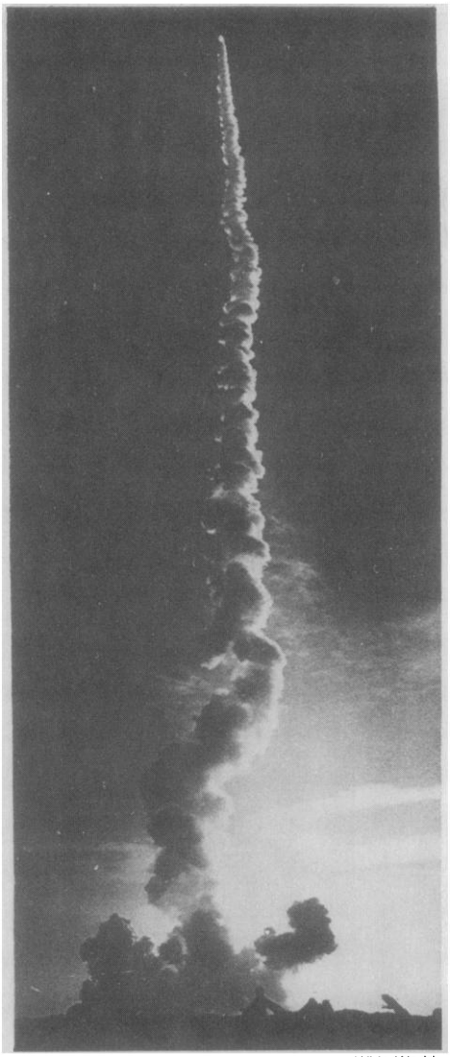

Wide World

The shuttle made a perfect ascent, apart from loss of a few tiles.

monitors temperatures on the shuttle's belly during a critical period of reentry, when atmospheric friction blacks out all communication with the ground. Flight director Donald Puddy said, "The instrumentation that's on this recorder is extremely important to us. That's one reason for flying [this mission]." But NASA was uncertain whether the recording would occur. At best, it would lead to the erasure of other important data gathered during ascent. The crew tried to remove the recorder and exchange it with another, but failed. "Did you ever get one of those nuts or bolts on your car that just wouldn't let loose?" Crippen asked the flight controller. This is what happened.

A less significant malfunction occurred before reentry in a power unit that helps control the landing gear, but NASA was able to circumvent the difficulty. Supplementary monitoring of reentry temperatures was conducted by an airborne transport plane carrying an infrared telescope 45,000 feet beneath the shuttle's flight path. Other aspects of the flight went smoothly. Tremendous up and down vibrations from throttling of the main engines had been expected as the craft cleared the launchpad, but astronaut John Young reported that "It was all very low and you could read the instruments and do all that kind of stuff." The opening of the payload bay doors, necessary for the craft to shunt excessive heat from the spacecraft's systems through reflector panels, was uneventful despite initial concern that the doors might be fused shut by the strain of launch. Use of fuel for maneuvering and electrical power was much less than anticipated. Minor problems occurred with cabin pressure and temperature control; in each case the obstruction was avoided by switching to duplicate equipment. Astronaut Robert Crippen noted that "The vehicle has just been performing beautifully, much better than anyone expected it to do on a first flight."

Both Crippen and Young said they were enjoying spectacular views from the shuttle's low orbit in space (172 nautical miles, as opposed to 200 to 275 nautical miles on earlier U.S. missions). Young's pulse at lift-off was only 80 beats per minute, reflecting his extensive experience in space and prompting Hutchinson to joke that "John was kind of asleep there . . . He's amazing." Crippen, in contrast, experienced his first launch with a pulse of 130 and later took a motion sickness pill.

There was no problem in the early stages of Sunday's countdown as serious as that which forced NASA to abort the launch at the last minute the previous Friday. NASA says the computer failure that caused the delay 30 minutes before the anticipated launch had a likelihood of less than 1 in 1000 attempts. The failure occurred when the shuttle's four primary computers sent routine prelaunch instructions to a backup computer 40 milliseconds late. The backup, which is needed during both launch and reentry in the event of a primary computer malfunction, refused to accept the data and as one official described, "hung up the receiver" causing error lights to flash throughout the mission control room.

The 40-millisecond timing skew happened because the primary computers generated an unexpected internal timing equation needed to synchronize with each other and with the backup. The equation is generated in the most complicated part of a 5000 instruction software package that is in turn the most sophisticated ever developed for use in space, a circumstance that explains why it took the agency's experts about 11 hours to locate the flaw and resolve it. The backup computer was surprised by the forty millisecond skew because it is denied access to the equation. The flaw might be attributed to IBM, which wrote the primary computer program, but it is more likely the result of poor communication between IBM and Rockwell International, which wrote the backup computer program. NASA says it had two different firms write the programs to protect against the possibility of error by either one.

The last minute timing skew, described by a NASA computer expert as "unique and insidious," was circumvented during preparations for the successful launch by synchronizing the computers much earlier than usual and leaving them running. The agency says it is attempting to determine how likely the problem is to occur in the future. If it is more likely than the agency now believes, the primary computer program will have to be revised.

Hutchinson admits that a more rigorous computer testing program would have revealed the problem earlier. NASA previously came under criticism by Congress and some outside engineering and computer experts for not conducting enough testing and electing not to develop a special computer for the shuttle from scratch.

Much like the rest of the flight, the spacecraft's early atmospheric reentry occurred as planned. The payload bay doors closed on schedule, and the orbiter turned its tail forward to successfully fire retro-rockets, slowing the craft from its orbital speed of 17,000 miles per hour. Broad smiles broke out in the control room at Houston as soon as communication was reestablished following the reentry blackout. Landing occurred at 1:21 p.m. EST on 14 April without mishap. "What a way to come to California," Young said.

It is probably too early to determine whether the shuttle's successful performance will revive NASA's sagging budgetary fortunes. Although key congressional and Administration officials expressed enthusiasm during the mission, those who have criticized the shuttle and the space program in the past, including David Stockman, director of the Office of Management and Budget, will undoubtedly continue to do so. It is clear, however, that the agency is enormously encouraged by the shuttle's performance and pleased to once again have captured the public's attention with an adventurous spectacle.

—R. JEFFREY SMITH