The Columbia disaster

It was April 12th 1981. NASA was about to initiate a new era in space transportation. It was kind of an aircraft adhered to a big liquid propellant tank and two solid rocket boosters all of which would be recovered and most of which would be reused.

This first flight was considered as a "Dress Rehearsal" and was meant as a demonstration of the capabilities of this new endeavor. The Space Shuttle was the Columbia and the flight denomination was STS-1.

The whole tracking network was in a "critical support status" and everything, from operations training to equipment maintenance, had been prepared to the maximum possible

Madrid was a "Launch hold criteria Station", which meant that were we not ready for whatever the reason, the launch would be scrubbed. And thus, during the previous two years, we had been getting ready doing operations simulations and performing equipment readiness tests to the maximum extent possible.

STS 1 Launch

The Naval Station Rota, at Cadiz, was also a "Launch hold criteria Station" as the Shuttle could land in there in case of an abort.

After the Columbia had cleared the launch pad, the tracking station at Merritt Island, the first to acquire contact with the ship, had a failure and signal was lost. The whole network stopped breathing……but there was no problem as in a very short time the station at Bermuda, in the Atlantic, would pick up the signal. But, as Murphy would have said, <…*if anything can go wrong...*>, the system responsible for relaying information of distance and velocity at Bermuda failed, and left Houston with no knowledge of whether the craft was in the proper trajectory to attain orbit.

After Bermuda lost the signal, there was a communications blackout of a few minutes until the ship could be picked up by Madrid, and Houston and the whole network were expectant as to the reports from our station.

Everything worked out fine, Madrid acquired the signal at the right moment and in the predicted spatial position and Houston breathed again and so did we. Our

Launch of Columbia (STS 107)

success was crucial in that the decision to push to orbit or abort depended on the information relayed from our tracking.

With the subsequent trouble free launches, the stress gave way and we finally relaxed until that become almost like a routine.

And then, after a two year delay, the 28th launch of Shuttle Columbia (STS-107) took place. It was January 16th 2003 and it was the 113th launch of a Shuttle.

Liftoff took place from launch complex 39-A at the Kennedy Space Center in Florida at 13:59, GMT.

82 seconds later, a piece of foam insulation, the size of a medium suitcase, detached from the main fuel tank and hit the reinforced carbon-carbon (RCC) panels of the port wing of the orbiter. This most likely created a hole 15 to 25 cm in diameter.

The external tank was fully covered with these pieces of foam to protect it from the very low temperatures inheriting to the type of fuel used.

Pieces of foam had detached previously without causing any problems so NASA determined that it was not a risk.

In this case the damage produced was bigger than ever expected but it was difficult to quantify. Speculation, and even a software simulation, didn´t give any valid conclusions.

There were no alternatives, so the mission proceeded per the original plan although the crew, the mission controllers, and even the tracking personnel on the ground feared the worst.

Piece of foam

Columbia was supposed to land on February 1st at 03:16 GMT if the flight plan was followed as predicted.

20:30 GMT January 31st 2003: The Entry Flight Control Team began duty in the Mission Control Center. Their first commitment was to evaluate the weather forecast at the landing site but also worked on the checklists for de-orbit and re-entry.

02:00 GMT February 1st: Mission Control Center Entry Flight Director LeRoy Cain polled the Mission Control for a GO/NO-GO decision for the de-orbit burn.

02:10 GMT: The CAPCOM told the crew that they were GO for de-orbit burn.

03:15:30 GMT: Husband and McCool executed the de-orbit burn.

> The Orbiter was in its 225th orbit, traveling upside down and tail-first over the Indian Ocean at an altitude of 282 km and speed of 28,000 km/h. Burn duration was 2 minute and 38 second and proceeded normally, putting the crew under about one-tenth gravity. Husband then turned *Columbia* right side up, facing forward with the nose pitched up.

03:44:09 GMT: Orbiter begins atmospheric entry over the Pacific Ocean.

> The heat of reentry caused wing leading-edge temperatures to rise steadily, reaching an estimated 1,370 °C during the next six minutes.

03:48:39 GMT: A sensor on the port wing leading edge spar showed strains higher than those seen on previous re-entries. This was only recorded on the Modular Auxiliary Data System (similar to the black box in an aircraft), and was not sent to ground controllers or shown to the crew.

03:49:32 GMT: Columbia executed a roll to the right. Speed: Mach 24.5. Then it began a banking turn to manage lift and limit the Orbiter's rate of descent and heating.

03:50:53 GMT: The craft entered a 10-minute period of peak heating, during which the thermal stresses were at their maximum. Speed: Mach 24.1; altitude: 74 km.

03:52:00 GMT: Columbia was about 480 km west of the California coastline. The wing leading-edge temperatures usually reached 1,450 °C at this point.

03:53:26 GMT: Columbia crossed the California coastline.

03:53:46 GMT: People on the ground saw signs of debris being shed. Speed: Mach 22.8; altitude: 70.2 km.

The superheated air surrounding the Orbiter suddenly brightened, causing a streak in the Orbiter's luminescent trail that was noticeable in the pre-dawn skies over the West Coast. Four similar events were noted during the following 23 seconds.

03:54:24 GMT: The Maintenance, Mechanical, and Crew Systems (MMACS) officer told the Flight Director that four hydraulic sensors in the left wing were indicating "off-scale low". This meant that the reading fell below the minimum capability of the sensor, and it normally indicated that the sensor had stopped functioning.

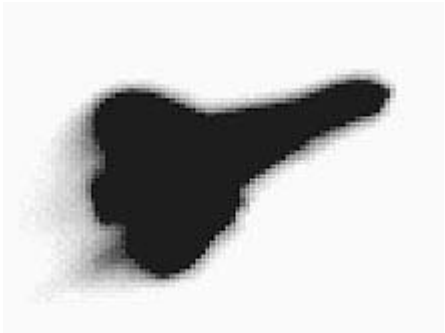
03:54:25 GMT: Columbia entered Nevada airspace. Speed: Mach 22.5; altitude: 69.3 km.

03:55:32 GMT: Nevada to Utah. Speed: Mach 21.8; altitude: 68.1 km.

03:55:52 GMT: Utah to Arizona.

03:56:30 GMT: Began a roll reversal, turning from right to left over Arizona.

03:56:45 GMT: Arizona to New Mexico. Speed: Mach 20.9; altitude: 67 km.



Columbia at about 03:57 GMT. Debris is visible coming from the left wing (bottom). The image was taken at Starfire Optical Range at Kirtland Air Force Base.

03:58:20 GMT: New Mexico to Texas. Speed: Mach 19.5; altitude: 63.9 km.

03:59:15 GMT: MMACS told the Flight Director that pressure readings had been lost on both left main landing-gear tires. The Flight Director told the CAPCOM to inform the crew of the malfunction and that the indication was being evaluated.

03:59:32 GMT: A broken response from the mission commander was recorded: "Roger, uh, bu – [cut off in mid-word] ..." It was the last communication from the crew and the last telemetry signal received in Mission Control.

Five seconds later hydraulic pressure was lost. At that time, the shuttle would have begun to lose control, starting to roll and yaw uncontrollably, and the crew would have become aware of the serious problem.

03:00:18 GMT: Reports by observers on the ground indicated that the Orbiter had disintegrated overhead. In Mission Control there was no sign of any serious problem. Before the orbiter broke up cabin pressure was nominal and the crew was capable of conscious actions. The crew module remained mostly intact through the breakup, though it was damaged enough that it lost pressure at a rate fast enough to incapacitate the crew within seconds.

03:00:57 GMT: The crew module was seen breaking into small subcomponents. It disappeared from view at 03:01:10. The crew, if not already dead, were killed no later than this point.

03:12:39 GMT: After hearing of reports of the shuttle being seen to break apart, Entry Flight Director LeRoy Cain declared a contingency and alerted search-and-rescue teams. He called on the Ground Controller to "lock the doors". When the doors were locked, the mission control room effectively became a crime scene. Nobody was permitted to enter or leave the room, and flight controllers had to preserve all the mission data for later investigation. Two minutes later, Mission Control put contingency procedures into effect.

The crew that lost their lives were: Commander Rick D. Husband, pilot: William C. McCool, cargo commander: Michael P. Anderson, mission specialists: Kalpana Chawla, David M. Brown and Laurel Blair Salton Clark and cargo specialist and first Israeli astronaut Ilan Ramon.

When the Columbia initiated the re-entry into the atmosphere, the damaged leading edge of the port wing let extremely hot gas getting inside its internal structure, this caused extensive wing damage which, in turn, produced instability and, eventually, dismantled the ship.

At 19:04 GMT, President George W. Bush said:

> *This day has brought terrible news and great sadness to our country ... The Columbia is lost; there are no survivors.*

Despite the disaster, Bush said:

> *The cause in which they died will continue....Our journey into space will go on.*

Bush later declared East Texas a federal disaster area, allowing federal agencies to help with the recovery effort.

Obviously, an investigation committee was immediately created. First conclusion was the incapacity of NASA management to admit engineering advice about requesting help from DOD to take images to assess the damage. Senior NASA managers were influenced by their belief that nothing could be done even if damage was detected.

In 2013, retired NASA official Wayne Hale recalled what Director of Mission Operations Jon C. Harpold told him before Columbia's destruction:

> *You know, there is nothing we can do about damage to the TPS [Thermal Protection System]. If it has been damaged it's probably better not to know. I think the crew would rather not know. Don't you think it would be better for them to have a happy successful flight and die unexpectedly during entry than to stay on orbit, knowing that there was nothing to be done, until the air ran out?*

Before the flight NASA believed that the RCC was very durable. Charles F. Bolden, who worked on tile-damage scenarios and repair methods early in his astronaut career, said in 2004 that:

> *Never did we talk about [the RCC] because we all thought that it was impenetrable ... I spent fourteen years in the space program flying, thinking that I had this huge mass that was about five or six inches thick on the leading edge of the wing. And, to find after Columbia that it was fractions of an inch thick, and that it wasn't as strong as the Fiberglas on your Corvette, that was an eye-opener, and I think for all of us ... the best minds that I know of, in and outside of NASA, never envisioned that as a failure mode.*

After the disaster, the Shuttle operations ceased for more than two years.

Several technical and organizational changes were implemented including an on-orbit inspection to determine whether there was any damage and maintain a rescue mission ready.

Except for a final mission to repair the Hubble, all subsequent missions only went to the ISS.

Other factors affecting the mission:

1. A rescue mission could have been launched using the Atlantis as it was ready and Columbia had enough consumables to stay in orbit until February 15th. NASA didn´t consider it.
2. An on-orbit repair could have been tried but….
    a. Columbia didn´t have the Canadarm which would have been necessary to take an astronaut to the wing.

b. They didn´t have a repair kit so they would have had to use whatever was available in the cabin and that would have made the repair questionable.

3. They were not in the orbit of the ISS and didn't have an attach module.

Note. All photographs depicted in this essay are from public Internet publications and, in no way, they will be used to collect any income.