Space Shuttle Columbia disaster

Introduction

In this project we will analyze the whole incident of The Space Shuttle Columbia disaster which occurred on February 1, 2003, when Columbia disintegrated over Texas and Louisiana as it re-entered Earth's atmosphere, killing all seven crew members.

Main motive

At the time, the shuttle program was focused on building the International Space Station. However, STS-107 stood apart as it emphasized pure research.

The seven-member crew — Rick Husband, commander; Michael Anderson, payload commander; David Brown, mission specialist; Kalpana Chawla, mission specialist; Laurel Clark, mission specialist; William McCool, pilot; Ilan Ramon, payload specialist from the Israeli Space Agency — spent 24 hours a day doing science experiments in two shifts.

They performed around 80 experiments in life sciences, material sciences, fluid physics and other matters.

STS-107

STS-107 was the 113th flight of the Space Shuttle program, and the disastrous final flight of Space Shuttle Columbia. The mission launched from Kennedy Space Center in Florida on January 16, 2003, and during its 15 days, 22 hours, 20 minutes, 32 seconds in orbit conducted a multitude of international scientific experiments.

Disaster

During the launch of STS-107, Columbia's 28th mission, a piece of foam insulation broke off from the Space Shuttle external tank and struck the left wing of the orbiter. A few previous shuttle launches had seen minor damage from foam shedding, but some engineers suspected that the damage to Columbia was more serious. NASA managers limited the investigation, reasoning that the crew could not have fixed the problem if it had been confirmed.
When Columbia re-entered the atmosphere of Earth, the damage allowed hot atmospheric gases to penetrate and destroy the internal wing structure, which caused the spacecraft to become unstable and slowly break apart.

After the disaster, Space Shuttle flight operations were suspended for more than two years, similar to the aftermath of the Challenger disaster. Construction of the International Space Station (ISS) was put on hold; the station relied entirely on the Russian Roscosmos State Corporation for resupply for 29 months until Shuttle flights resumed with STS-114 and 41 months for crew rotation until STS-121.

Analysis

About 82 seconds after launch from Kennedy Space Center's LC-39-A, a suitcase-size piece of foam broke off from the External Tank (ET), striking Columbia's left wing reinforced carbon-carbon (RCC) panels. As demonstrated by ground experiments conducted by the Columbia Accident Investigation Board, this likely created a 6-to-10-inch (15 to 25 cm) diameter hole, allowing hot gases to enter the wing when Columbia later re-entered the atmosphere. At the time of the foam strike, the orbiter was at an altitude of about 66,000 feet (20 km; 12.5 mi), traveling at Mach 2.46 (1,870 miles per hour or 840 meters per second).

The Left Bipod Foam Ramp is an approximately three-foot (one-meter) aerodynamic component made entirely of foam. The foam, not normally considered to be a structural material, is required to bear some aerodynamic loads. Because of these special requirements, the casting-in-place and curing of the ramps may be performed only by a senior technician. The bipod ramp (having left and right sides) was originally designed to reduce aerodynamic stresses around the bipod attachment points at the external tank, but it was proven unnecessary in the wake of the accident and was removed from the external tank design for tanks flown after STS-107 (another foam ramp along the liquid oxygen line was also later removed from the tank design to eliminate it as a foam debris source, after analysis and tests proved this change safe).

Bipod Ramp insulation had been observed falling off, in whole or in part, on four previous flights: STS-7 (1983), STS-32 (1990), STS-50 (1992) and most recently STS-112 (just two launches before STS-107). All affected shuttle missions completed successfully. NASA management came to refer to this phenomenon as "foam shedding". As with the O-ring erosion problems that ultimately doomed the Space Shuttle Challenger, NASA management became accustomed to these phenomena when no serious consequences resulted from these earlier episodes. This phenomenon was termed "normalization of deviance" by sociologist Diane Vaughan in her book on the Challenger launch decision process.

Theory

1. **Define the Problem:** They wanted to dp experiments in life sciences, material sciences, fluid physics and other matters. So overall the main motive is to do science experiments in outer space.
2. **Collect the information:** Construction began on Columbia in 1975 at Rockwell International's principal assembly facility in Palmdale, California, a suburb of Los Angeles where all the resources were provided.
3. **Specify your requirements:** Crew was the most important thing for this mission and later one team was formed consisting of 7 members. Money was also required for the construction of space ship including all the materials.
4. **Brainstorming process:** There were many successful launches which were made before STS-107 and every time data was collected and upgradation were made.
5. **Choosing best data:** Best data was collected for RCS, Auxiliary power, weight etc
6. **Prototype orbiter:**

   Weight:

   As the second orbiter to be constructed, and the first able to fly into space, Columbia was roughly 8,000 lb (3,600 kg) heavier than subsequent orbiters such as Endeavour, which were of a slightly different design, and had benefited from advances in materials technology

   Thermal Protection System:

   Externally, Columbia was the first orbiter in the fleet whose surface was mostly covered with High & Low Temperature Reusable Surface Insulation (HRSI/LRSI) tiles as its main thermal protection system (TPS), with white silicone rubber-painted Nomex – known as Felt Reusable Surface Insulation (FRSI) blankets – in some areas on the wings, fuselage and payload bay doors. FRSI once covered almost 25% of the orbiter; the first upgrade resulted in its removal from many areas, and in later flights it was only used on the upper section of the payload bay doors and inboard sections of the upper wing surfaces. The upgrade also involved replacing many of the white LRSI tiles on the upper surfaces with Advanced

Flexible Reusable Surface Insulation (AFRSI) blankets (also known as Fibrous Insulation Blankets, or FIBs) that had been used on Discovery and Atlantis.

Markings:

Until its last refit, Columbia was the only operational orbiter with wing markings consisting of an American flag on the port (left) wing and the letters "USA" on the starboard (right) wing. Challenger, Discovery, Atlantis and Endeavour all, until 1998, bore markings consisting of the letters "USA" below an American flag on the left wing, and the pre-1998 NASA "worm" logo afore the respective orbiter's name on the right wing.

SILTS pod:

Another unique external feature, termed the "SILTS" pod, was located on the top of Columbia's vertical stabilizer, and was installed after STS-9 to acquire infrared and other thermal data. Though the pod's equipment was removed after initial tests, NASA decided to leave it in place, mainly to save costs, along with the agency's plans to use it for future experiments. The vertical stabilizer was later modified to incorporate the drag chute first used on Endeavour in 1992.

Other Upgrades:

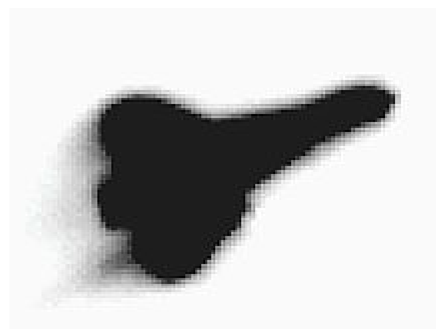
Columbia was also originally fitted with Lockheed-built ejection seats identical to those found on the SR-71 Blackbird. These were active for the four orbital test flights, but deactivated after STS-4, and removed entirely after STS-9. Columbia was also the only spaceworthy orbiter not delivered with head-up displays for the Commander and Pilot, although these were incorporated after STS-9. Like its sister ships, Columbia was eventually retrofitted with the new MEDS "glass cockpit" display and lightweight seats.

7. **Testing:** It was success many time and with many launches, so many upgrades were for the next one to gain more data.

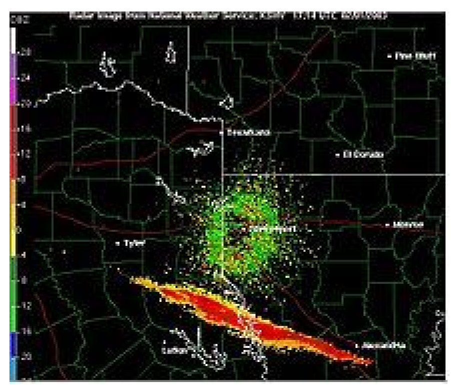
8. **Communicate:** After testing many Space shuttle were launched and each time it was a success. But after STS-107 launch, it got disintegrated because of some error.
9. **Result:** After STS-107 launch the result was not good and it was a great shock for everyone and specially for NASA. Later one team was build up to analyze the whole incident and to point out the error so that they can avoid such type accident later in future.

Changing the data

During the crew's 16 days in space, NASA was investigating a foam strike during launch. About 82 seconds after Columbia left the ground, a piece of foam fell from a "bipod ramp" that was part of a structure that attached the external tank to the shuttle. Video from the launch appeared to show the foam striking Columbia's left wing.()



Several people within NASA pushed to get pictures of the breached wing in orbit. The Department of Defense was reportedly prepared to use its orbital spy cameras to get a closer look. However, NASA officials in charge declined the offer, according to the Columbia Accident Investigation Board (CAIB) and "Comm Check," a book about the disaster.



It was later found that a hole on the left wing allowed atmospheric gases to bleed into the shuttle as it went through its fiery re-entry, leading to the loss of the sensors and eventually, Columbia itself.
CAIB recommended NASA ruthlessly seek and eliminate safety problems, such as the foam, to help astronaut safety in future missions. It also called for more predictable funding and political support for the agency, and added that the shuttle must be replaced with a new transportation system.

Redesigning the prototype

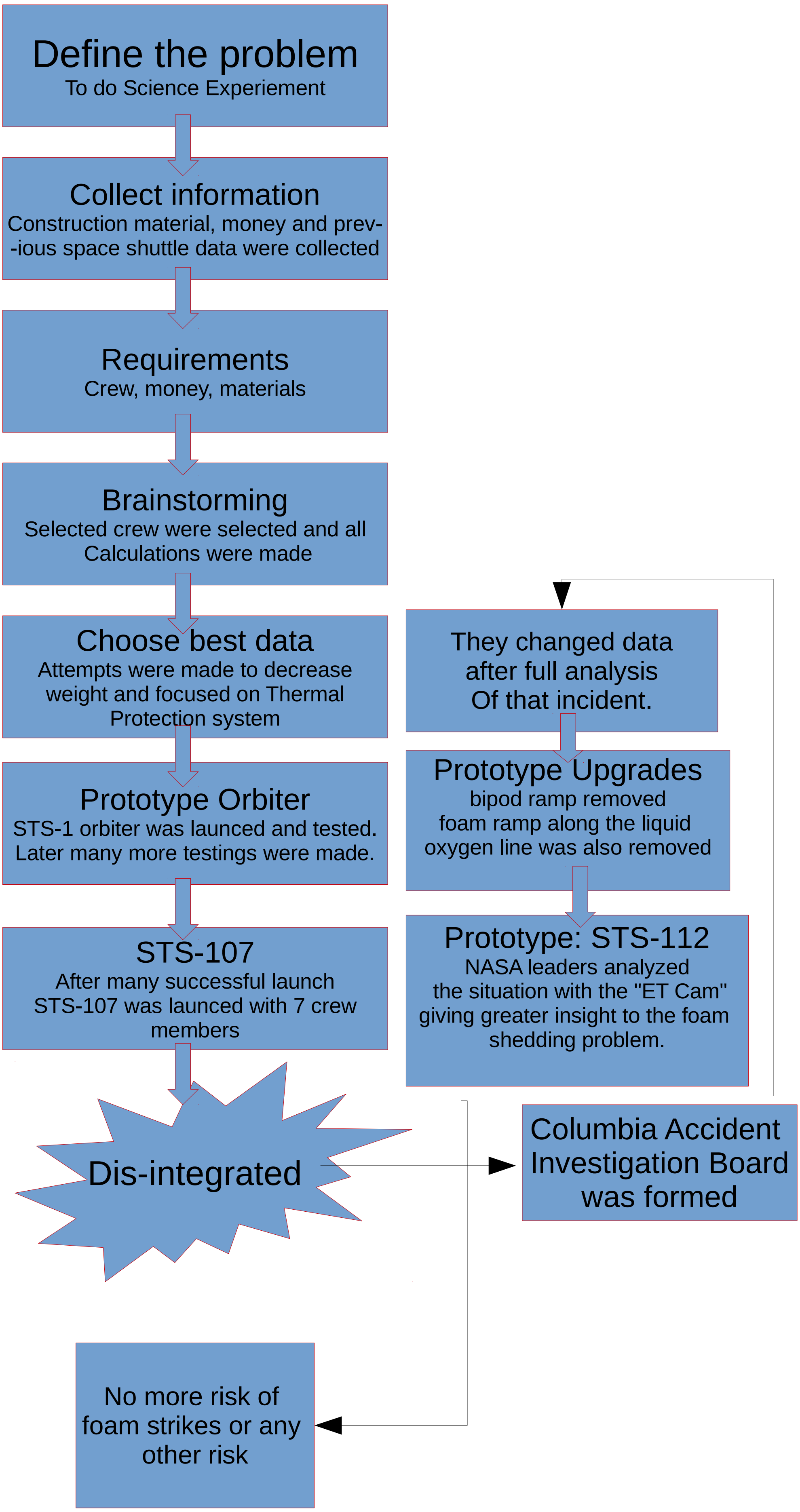
The shuttle's external tank was redesigned, and other safety measures implemented. In July 2005, STS-114 lifted off and tested a suite of new procedures, including one where astronauts used cameras and a robotic arm to scan the shuttle's belly for broken tiles. NASA also put more camera views on the shuttle during liftoff to better monitor foam shedding.

Due to more foam loss than expected, the next shuttle flight did not take place until July 2006. After STS-121's safe conclusion, NASA deemed the program ready to move forward and shuttles resumed flying several times a year.

Conclusion

On August 26, 2003, the CAIB issued its report on the accident. The report confirmed the immediate cause of the accident was a breach in the leading edge of the left wing, caused by insulating foam shed during launch. It concluded the organizational structure and processes were sufficiently flawed and that a compromise of safety was expected no matter who was in the key decision-making positions.

One thing we must note is that, few previous shuttle launches had seen minor damage from foam shedding but they were neglected by the engineers but in case of ST-107 those damage were serious which result in this incident. If there were some perfect safety measure and correct data analysis with good testing then we might have tackled that situation at that time only.


Define the problem
To do Science Experiement
Collect information
Construction material, money and prev-
-ious space shuttle data were collected
Requirements
Crew, money, materials
Brainstorming
Selected crew were selected and all
Calculations were made
Choose best data
Attempts were made to decrease
weight and focused on Thermal
Protection system
Prototype Orbiter
STS-1 orbiter was launced and tested.
Later many more testings were made.
STS-107
After many successful launch
STS-107 was launced with 7 crew
members
Dis-integrated
Columbia Accident
Investigation Board
was formed
They changed data
after full analysis
Of that incident.
Prototype Upgrades
bipod ramp removed
foam ramp along the liquid
oxygen line was also removed
Prototype: STS-112
NASA leaders analyzed
the situation with the "ET Cam"
giving greater insight to the foam
shedding problem.
No more risk of
foam strikes or any
other risk