# Reflection on Twenty Years Since the Loss of the Columbia

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Well before the loss of Columbia, the NASA Office of Technology Assessment wrote, "Shuttle reliability is uncertain, but has been estimated to range between 97 and 99 percent. If the Shuttle reliability is 98 percent, there would be a 50-50 chance of losing an Orbiter within 34 flights … The probability of maintaining at least three Orbiters in the Shuttle fleet declines to less than 50 percent after flight 113," (1989, CAIB Vol. 1).

The Crew of STS-107 (see Fig. 1) launched aboard the Columbia on a beautiful Florida day, January 16th, 2003, with blue sky, cool 60° F air, and winds of max. 12.3 mph. At 81.7 seconds, a piece of foam protecting the left bipod strut detached due to sudden wind shear and collided with the left-wing leading edge of Columbia (see Fig. 2). The relative velocity of the foam at impact was nearly 490 mph and damaged a panel.

*Fig. 1. STS-107 crew in orbit. (NASA)*

Following ground observations, the NASA Debris Assessment Team used models to estimate damages. They concluded that only slight damage had occurred to the reinforced carbon-carbon paneling and that Columbia would only suffer localized heating during reentry. The limited damage estimates were due in part to poor image angles of the launch and denied requests for high-resolution ground images from the Department of Defense.

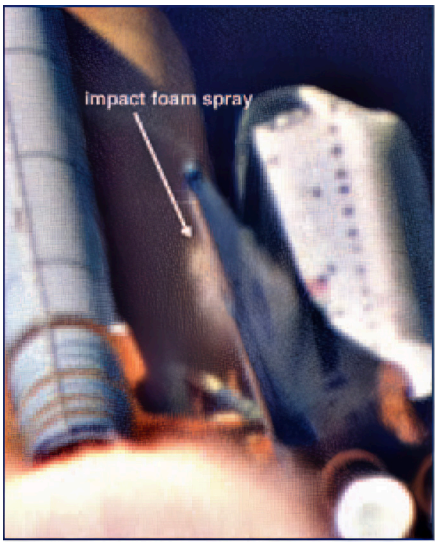


*Fig. 2. Foam impact and subsequent spray pattern (CAIB vol. 1, NASA).*

Astronauts Colonel Rick Husband; Lt. Colonel Michael Anderson; Commander Laurel Clark; Captain David Brown; Commander William McCool; Dr. Kalpana Chawla; and Colonel Ilan Ramon (Israeli Air Force) conducted three major tasks during the mission: SpaceHab Research Double Module, the Orbital Acceleration Research Experiment, and an Extended Duration Orbiter pallet. Each experiment was concluded and stowed successfully. It was now time for reentry.

Reentry of Columbia began at 8:44 AM, on Feb. 1, 2003. At 7,000 m/s (15,660 mph or Mach 24) and approximately 75 km altitude, heated air entered the breached panel and into the leading wing segment. Inside, flows reached an estimated 2,600 m/s (5,816 mph) at 6,000 K (10,340° F), causing a rapid burn-through of the left wing. This event led to the disintegration of Columbia via left wing detachment. As the scheduled landing time of 9:16 AM approached, the realization that Columbia and crew were lost became unavoidably apparent to the American public.

The president addressed the country at 2:04 PM that same day, "… The cause in which they died will continue. Mankind is led into the darkness beyond our world by the inspiration of discovery and the longing to understand. Our journey into space will go on…" One might ask, what is acceptable risk? This is a question the second author often asks his students through these case studies.

The original ideas of the NACA's spaceplanes have not been forgotten, but commercial and government space agencies still pursue more capsule-based entry and descent. Undoubtably, the loss of Challenger and Columbia strengthened the original approach for spaceflight pioneered by the Mercury and Vostok (USSR) programs. Capsules eliminate risk of thermal protection system damage during launch, a lesson learned from the Columbia disaster.

Today, the loss of Columbia is used as a design, risk, and ethics case study in aerospace departments internationally. The choice to develop novel spacecraft or spaceplanes beyond the capsule concept will be up to the students graduating from aerospace programs today. The choice is their generation's to make and will be guided by our legacy.

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