Engineering Ethics: The Challenger Disaster and the Story of "The Five Lepers"

An Online Continuing Education Course for Engineers

Course Number: ET-1035

Credit: 1 Hour / 1 PDH / 1 CPD

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Prologue

> "Instead of having to prove it was safe, these engineers had to prove it was unsafe--management shifted the criteria… From an engineering standpoint, that's unpardonable."-- Seymour Melman, professor of industrial engineering at Columbia University[1]

"Allan McDonald, director of Morton Thiokol's (Thiokol's) shuttle solid rocket booster (SRB) project near Brigham City, was at Kennedy Space Center for the launch. He and other engineers worried that cold weather would compromise the O-rings.

The summer before, he'd briefed NASA (National Aeronautics and Space Administration) bigwigs that the O-rings were the biggest safety issue on the shuttles. He wanted a redesign — a proposal rejected for being too expensive.

That January, McDonald, Roger Boisjoly and other engineers argued that any launch at a temperature below 53 degrees F would be dangerous. During the early morning hours of Jan. 28, ice coated parts of the launching pad.

So McDonald and other Morton Thiokol engineers and scientists met with NASA program directors late on January 27. In the end, McDonald's boss recommended going ahead with the launch. NASA wanted the recommendation in writing.

"It was the smartest thing I ever did. I refused to sign it," McDonald said Tuesday. "I forced my boss to sign it."

The next morning, it was 38 degrees outside.

"We expected it to blow in the [launch] tower," he said. "It happened 73 seconds later.""[1]

Introduction

Flight STS-51L from the Kennedy Space Center (KSC) on January 28, 1986 was the 25th Space Shuttle mission and the 10th launch of the Space Shuttle Challenger.

In the worst accident in the history of the U.S. space program, the fuel tank of the space shuttle Challenger burst into flames shortly after launch. At 46,000 feet and flying at Mach 1.92, about twice the speed of sound, the shuttle was completely enveloped in flames and the orbiter disintegrated into several sections. The fragments flew upward to about 65,000 feet, propelled by the momentum of the spacecraft.[2] Flaming debris plummeted to the ocean below and continued falling for more than an hour, hindering search and rescue vessels.[3]

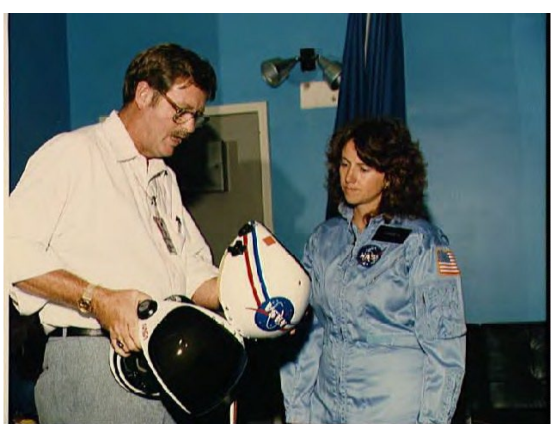
CNN was the only television network to carry the launch live, but cable news was in its early days and was not widely available. Other networks taped the launch for later broadcast. NASA had provided many primary and secondary schools with a live feed of the mission and many students watched from their classrooms around the country.

Thousands of spectators were gathered along the Florida coast to view Challenger's launch from KSC. Among the audience were the husband and family of crewmember Christa McAuliffe and hundreds of her students, colleagues, and friends.[4] Television news replayed scenes of their horrified expressions as they realized what they had just witnessed.

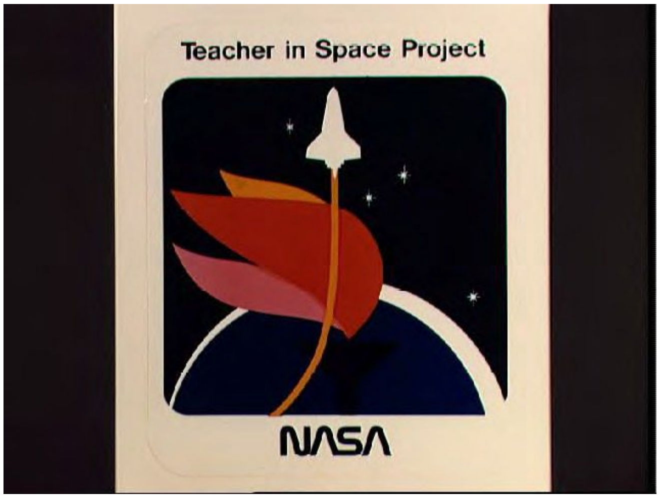
Two minutes and 45 seconds after the break up, the shuttle hit the ocean surface, traveling at a speed of about 200 miles per hour.[5] There was no escape plan and the crew was trapped. They are believed to have been alive at the time of impact, although they may have been unconscious. Francis R. (Dick) Scobee; the pilot Comdr. Michael J. Smith of the Navy; Dr. Judith A. Resnik; Dr. Ronald E. McNair; Lieut. Col. Ellison S. Onizuka of the Air Force; Gregory B. Jarvis; and Christa McAuliffe were killed in the disaster.

This Challenger's mission had been extensively promoted. As part of NASA's Teacher in Space Project, the crew included McAuliffe, a New Hampshire high school teacher selected to be the first non-astronaut launched into space. NASA chose her from more than 10,000 applicants and assigned her the role of payload specialist.

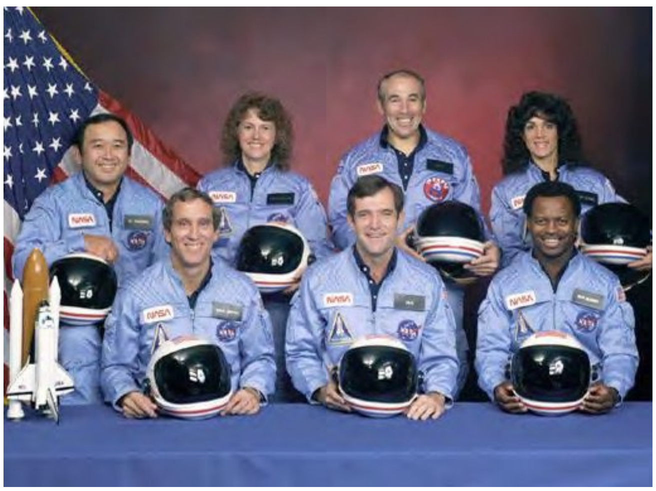
McAuliffe and the mission were media sensations. In the weeks prior to the launch, television and print media carried daily reports on the mission and McAuliffe's image dominated NASA's photo releases. Teachers built weeks of lesson plans around Challenger and the Teacher in Space.

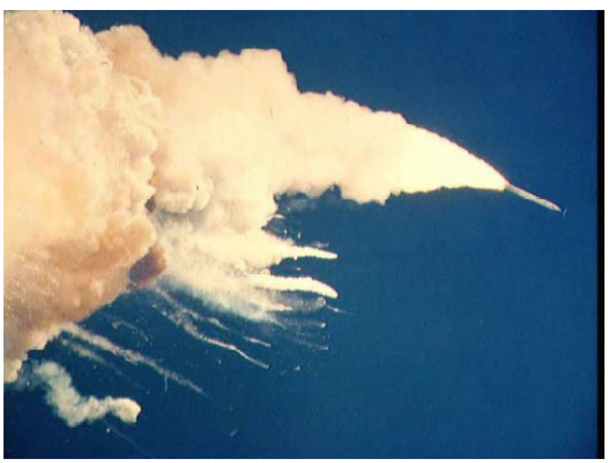


Payload specialist Christa McAuliffe briefed on launch/entry helmets. Source: NASA.



Source: NASA.


Space shuttle Challenger crew. Source: NASA


Sections of the Challenger broke off and disintegrated. Source: NASA.

The disaster lead to a federal investigation chaired by William P. Rogers, a former secretary of state. The Rogers Commission (Commission) report, Report of the Presidential Commission on the Space Shuttle Challenger Disaster, concluded that "The specific failure was the destruction of the seals that are intended to prevent hot gases from leaking through the joint during the propellant burn of the rocket motor. The evidence assembled by the Commission indicates that no other element of the Space Shuttle system contributed to this failure."[6]

A faulty O-ring caused the explosion and the loss of seven lives and put a two and a half year halt to what the Commission called "one of the most productive engineering, scientific and exploratory programs in history."[7]

Course Objectives

The Thiokol engineers who worked on the solid rocket booster (SRB) were well aware of the flaws in the O-ring and the associated launch risks. They had repeatedly made their concerns known to their supervisors and NASA and actively opposed the January 28 launch. Later, they testified before the Rogers Commission.

This course will examine the ways in which some engineers adhered to their ethical responsibilities, as outlined in the NSPE Code of Ethics, while others compromised safety because of cost and schedule pressures.

The material will rely heavily on the findings of the Rogers Commission and media reports. These sources are not without critics. The book "Power to Explore: History of Marshall Space Flight Center" is critical of the media coverage and faults the Rogers Commission for an "interpretation (that) oversimplified complex events"[8]. Readers who are interested in a detailed discussion of the design, engineering, management decisions, and interaction between contractors and NASA from a different perspective may wish to read Chapter 9 of the book.

Relevant Sections of the NSPE Code

I. Fundamental Canons

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.

II. Rules of Practice

1. Engineers shall hold paramount the safety, health, and welfare of the public.

a. If engineers' judgment is overruled under circumstances that endanger life or property, they shall notify their employer or client and such other authority as may be appropriate.

b. Engineers shall approve only those engineering documents that are in conformity with applicable standards.
f. Engineers having knowledge of any alleged violation of this Code shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required.

Morton Thiokol

Based in Utah, Thiokol is the largest manufacturer of solid rocket motors in the United States. On November 20, 1973, NASA selected Thiokol from among four proposals to design and build the SRBs. The booster was the largest solid rocket motor ever built in the U.S. and Thiokol's cost-plus-fee contract was worth an estimated $800 million.[9] It was also the first solid motor program managed by NASA's Marshall Space Flight Center in Huntsville, Alabama (Marshall).

NASA's Source Evaluation Board rated Thi… development and verification factor; sec… oduct support factor; second on Missio… e selection board's primary considera…

The Commission ci… e noted that the board's analysis of c… omical job than any of the other propose… the program; and that, accordingly, the… or would be the lowest."[11]

The selection board w… O-rings. "'The Thiokol motor case joi… abling a simple leak check without pres… is innovative design feature increased… ndicating good attention to low cost (de… tion.'" [12]

Challenger fire after launch. Source: NASA