

ETHICS LECTURES

The Space Shuttle Challenger Tragedy – An Overview

MAE 175a
1st ethics lecture

Sources: <http://www.tsgc.utexas.edu/archive/general/ethics/shuttle.html>
<http://www.engineering.com>
Presidential commission report
<http://www.aerospaceweb.org>
<http://onlineethics.org/moral/boisjoly/RB-intro.html>



NASA Marks 25th Anniversary of the Challenger Disaster



By Leslie Horn

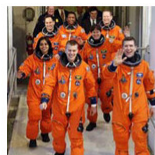
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NASA is remembering three major tragedies in its history this week, starting with the 25th anniversary of the explosion of the Space Shuttle Challenger on Friday.

"This year marks the 25th anniversary of the loss of the Challenger—a tragedy that caused us to completely rethink our systems and processes as we worked to make the shuttle safer," NASA Administrator Charles Bolden said in an AFP report.

Along with deputy administrator Lori Garver, Bolden honored the lives of those lost in Apollo 1 and space shuttles Challenger and Columbia by laying a wreath at Arlington National Cemetery in Virginia Thursday morning.

"The nation will never forget Jan. 28, 1986, nor its indelible images," Bolden added.

Challenger's entire crew was killed when the shuttle exploded just 73 seconds after its launch, 46,000 feet in the air. The explosion was broadcast on live television.



In 2003, a faulty heat shield caused Columbia to disintegrate as it re-entered the earth's atmosphere, killing seven astronauts. A fire aboard Apollo 1 proved fatal for the vessel's crew of three in 1967. This mission was the first of NASA's manned trips to the moon.

Since 1964, 24 people have been killed in a NASA mission, but NASA says it has learned since then.

"Safety is the number one priority at NASA and the shuttle launch schedule does not drive discussions or decisions when issues arise," a NASA spokesperson told PCMag. "That is reiterated often and is apparent in media events about the issues."



Contents of ethics lecture

- Discussion of engineering ethics
- Ethics in the `high-profile' NASA shuttle program
- Unfortunate events:
 - Challenger explosion, January 28, 1986
 - Columbia re-entry disintegration, February 1, 2003
- We will material from the Challenger explosion to discuss engineering ethics
- Discussion based on videos and other material presented.

Engineering Ethics

- Notion of ethical engineering practice has long moved beyond ad-hoc decision making processes
- Engineering practice has evolved into:
 - Set of fundamental values
 - Approved by most professional engineering societies

Fundamental values are referred to as
Fundamental Canons

Engineering Ethics

One such set of **Fundamental Canons** is formulated by the National Society of Professional Engineers (NSPE):

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

1. Hold paramount the safety, health and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically and lawfully so as to enhance the honor, reputation and usefulness of the profession.

Engineering Ethics

Fundamental Canons formulated by the National Society of Professional Engineers (NSPE) gives guidelines on Engineering Ethics

- **Seems self-evident, their actual application in real engineering practice may not be so clear cut!**
- **An ethical dilemma may be due to a conflict between two or more of the canons.**
Example: responsibility to employer may conflict with responsibilities to customers or public...

Ethics at the University

Statement of Ethical Values

We are committed to:

- **Integrity**
We will conduct ourselves with integrity in our dealings with and on behalf of the University.
- **Excellence**
We will conscientiously strive for excellence in our work.
- **Accountability**
We will be accountable as individuals and as members of this community for our ethical conduct and for compliance with applicable laws and University policies and directives.
- **Respect**
We will respect the rights and dignity of others.

Ethics at the University

Standards of Ethical Conduct at UCSD:

- **Fair Dealing**
- **Individual Responsibility and Accountability**
- **Respect for Others**
- **Compliance with Applicable Laws and Regulations**
- **Compliance with Applicable University Policies, Procedures and Other Forms of Guidance**
- **Conflicts of Interest or Commitment**
- **Ethical Conduct of Research**
- **Records: Confidentiality/Privacy and Access**
- **Internal Controls**
- **Use of University Resources**
- **Financial Reporting**
- **Reporting Violations and Protection from Retaliation**

Case study:

- **We will see conflicts in Engineering Ethics in a case study based on the NASA shuttle program**
- **Challenger explosion, January 28, 1986**
- ➔ **Technical problems**
- ➔ **Communication problems**
 - Concerns from engineers
 - Assessments by managers
- ➔ **Pressures to successfully launch**

Context and history of the space program

- **Space Shuttle vehicles are the most complex vehicles ever designed**
 - Multi-mission
 - Reusable
- **In contrast to Apollo, they lack a specific goal**
 - Apollo put man on the moon
 - Shuttle envisioned to do “everything”
- **Original plan – part of a 3-legged tripod of NASA assets**
 - Shuttle, Space Station, Mars trip
 - Other portions delayed due to cost

NASA forced to make concessions to keep Shuttle program alive

- **Reduce R&D needed to make Shuttles truly reusable**
 - e.g. traditional solid rocket boosters instead of liquid rockets
- **Teaming with Air Force brought DOD influence but also DOD requirements**
 - Shuttle payload bay required to meet Air Force size requirements
 - Takeoffs from Vandenberg AFB further limited vehicle weight
 - Result: elimination of airbreathing engines on Shuttles, requirement for “one-pass” landing

Shuttles had neither clear nor consistent backing

- **Apollo mission had clear “man-on-the-moon” imperative**
 - **Shuttles were political footballs between Democrats and Republicans**
- “The ultimate design was shaped almost as much by politics as physics.” -Texas Space Grant consortium**
<http://www.tsgc.utexas.edu/archive/general/ethics/shuttle.html>
- **19 launches in 1985, but recent delays had encouraged Air Force to consider expendable launch vehicle**
 - **French Arianespace developed very low cost booster**

Flight of Space Shuttle Challenger, Mission-51L



Francis R. Scobee, Michael J. Smith, Ronald E. McNair,
Ellison S. Onizuka, and Judith A. Resnik, Gregory B. Jarvis,
Christa C. McAuliffe

Ethics lecture focus: Challenger Disaster, Mission-51L

Showing of 1st video

Ethics lecture focus: Challenger Disaster, Mission-51L

Wrap up after 1st video

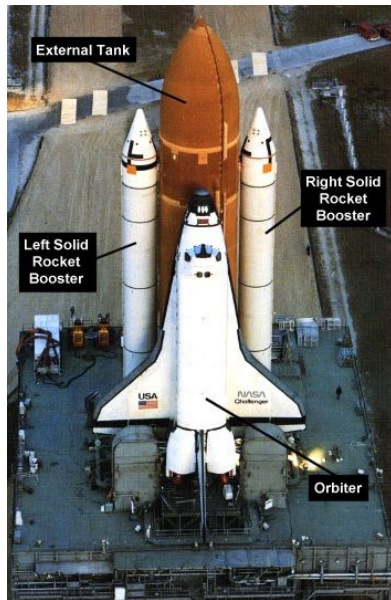
Challenger the morning of its 10th and final launch

- **NASA had a very tight launch schedule for 1986**
 - “Fly out the manifest”
 - This was to be the year that proved the shuttles
- **Publicity: “Teacher in Space”**
 - Christa McAuliffe was to teach her class from space
- **Upcoming State of the Union speech**
- **Need to launch Challenger quickly to prepare for Columbia launch of Haley’s comet probe**



Presidential Commission Report, p. 112

The Challenger on the morning of its final launch. (1) The External Tank. (2) The Solid Rocket Boosters.



Delays on the launch pad

- **January 26:** threat of storms forces cancel (weather turned out fine)
- **January 27:** Defective hatch closure switch, stripped bolt, and later, high winds
- **January 27, evening:** Forecast record cold temperatures ~ -6°C (20 °F)

The issues with the cold

- Many subsystems were not designed to withstand cold temperatures
- NASA's Launch Commit Criteria stated that no launch should occur at temperatures below 0°C (31 °F)
- Variances were required to be signed off for individual subsystems that were sensitive
 - This had been repeatedly done in the past
- Fire hoses turned on, warm water circulated through critical subsystems, anti-freeze put in fire ponds
- Particular concern: O-rings, ice on the launch pad damaging shuttle tiles

Roger Boisjoly

- **Roger Boisjoly and four other colleagues warned that elastic seals on the boosters tended to stiffen and unseal in cold weather.**
- **In an interview with NPR three weeks after the incident Boisjoly said "We all knew if the seals failed, the shuttle would blow up"**
- **Roger Boisjoly passed away Jan. 6, 2012 in Utah at age 73.**

