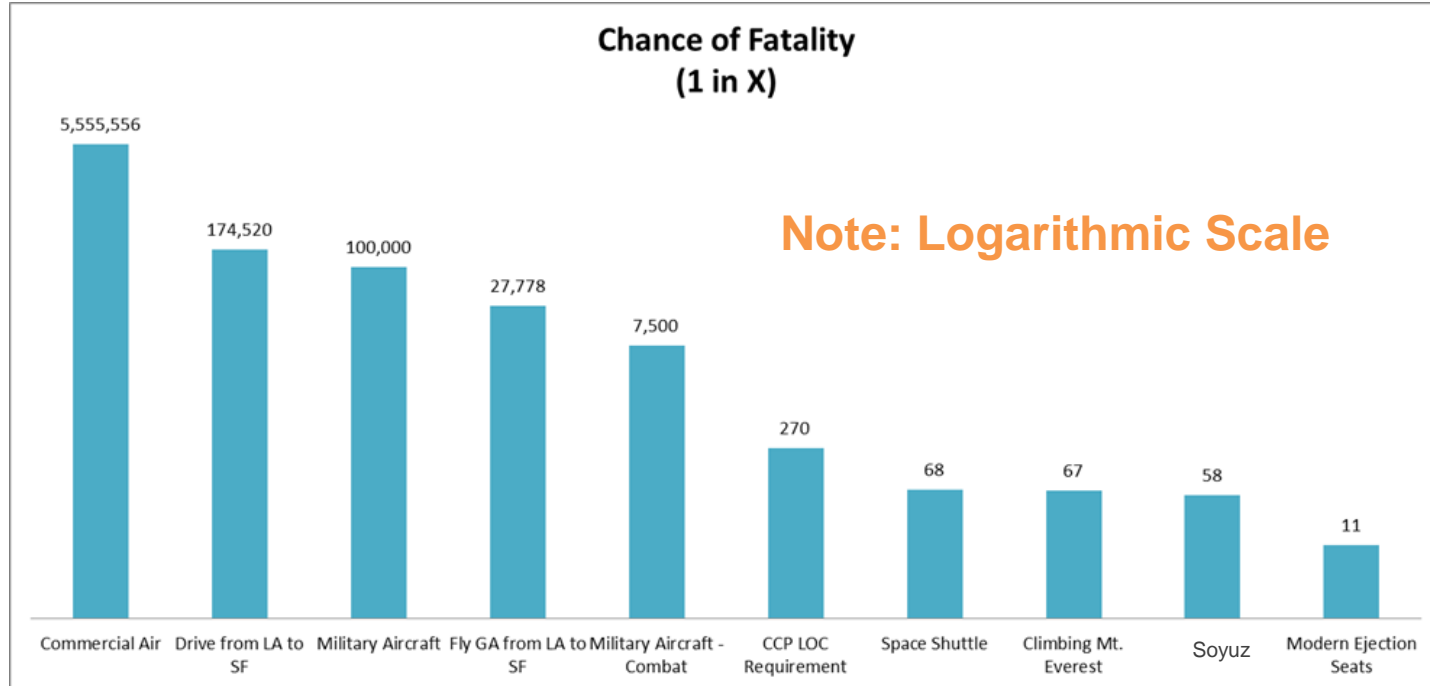


# Spaceflight is fun...but risky



Of the 536 people who have been to space, 21 have died trying.

# What did these tragedies have in common?

## Schedule Pressure

- *Apollo 1* – got to beat the Soviets to the Moon!
- *Challenger* – got to achieve the NASA goal of 24 flights per year!
- *Columbia* – we promised Congress we would complete the core of the International Space Station by 2004!

All projects need healthy pressure from management to control cost and schedule, but when schedule pressure becomes too high – watch out!

# What did these tragedies have in common?

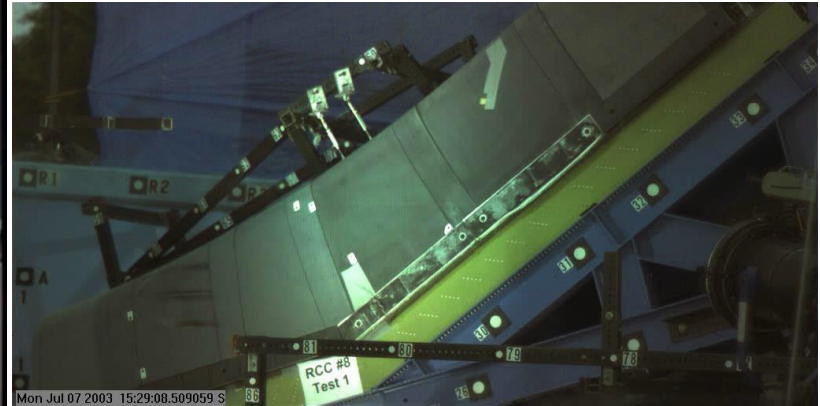
## Normalization of Deviance

- *Apollo 1* – Mercury, Gemini, and several previous Apollo tests all used 100% O<sub>2</sub> at 16.7 psi without incident
- *Challenger* – previous flights showed evidence of O-ring erosion, starting with the second shuttle flight
- *Columbia* – foam had been falling off the space shuttle external tank since the very first flight

Just because you get away with something over and over again, doesn't mean it is not a danger.

# What else can we learn from these tragedies?

None of us is as dumb as all of us.



Decide based on facts and data, not opinions or beliefs

# What else can we learn from these tragedies?

## The importance of free and open communication

- Prior to both the Challenger and Columbia tragedies, critical information was available but it never reached decision makers.
- The engineers who knew better were filtered out at multiple layers of management and at organizational interfaces.
  - *Challenger* – engineers at Thiokol were outvoted by managers who wanted a consensus decision to pass on to NASA
  - *Columbia* – engineers working on the fringe of the hierarchy requested imagery, only to be rejected for not following the proper chain of command.
- Ultimately, the astronauts aboard both Challenger and Columbia were told that there was nothing to worry about.

# What else can we learn from these tragedies?

## The importance of encouraging dissent

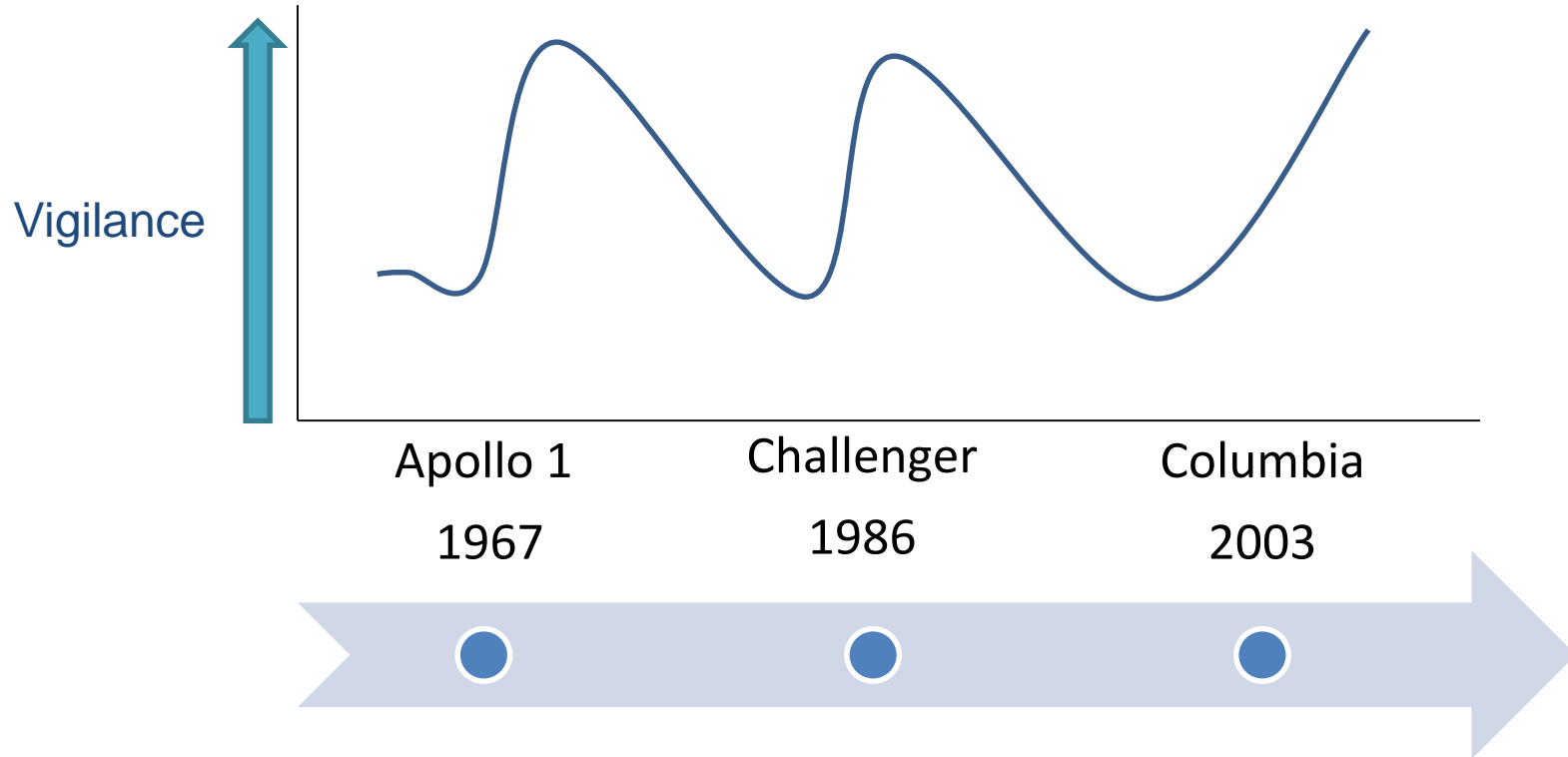
- During technical discussions immediately prior to the Challenger and Columbia tragedies, engineers with dissenting views about safety risk never had a chance.
- In both cases, the engineers who knew there was a serious risk were required to *prove* it.
- In both cases, NASA management telegraphed to the world that they wanted to hear that there was not going to be a problem.

What else can we learn from these tragedies?

Beware the streetlamp effect

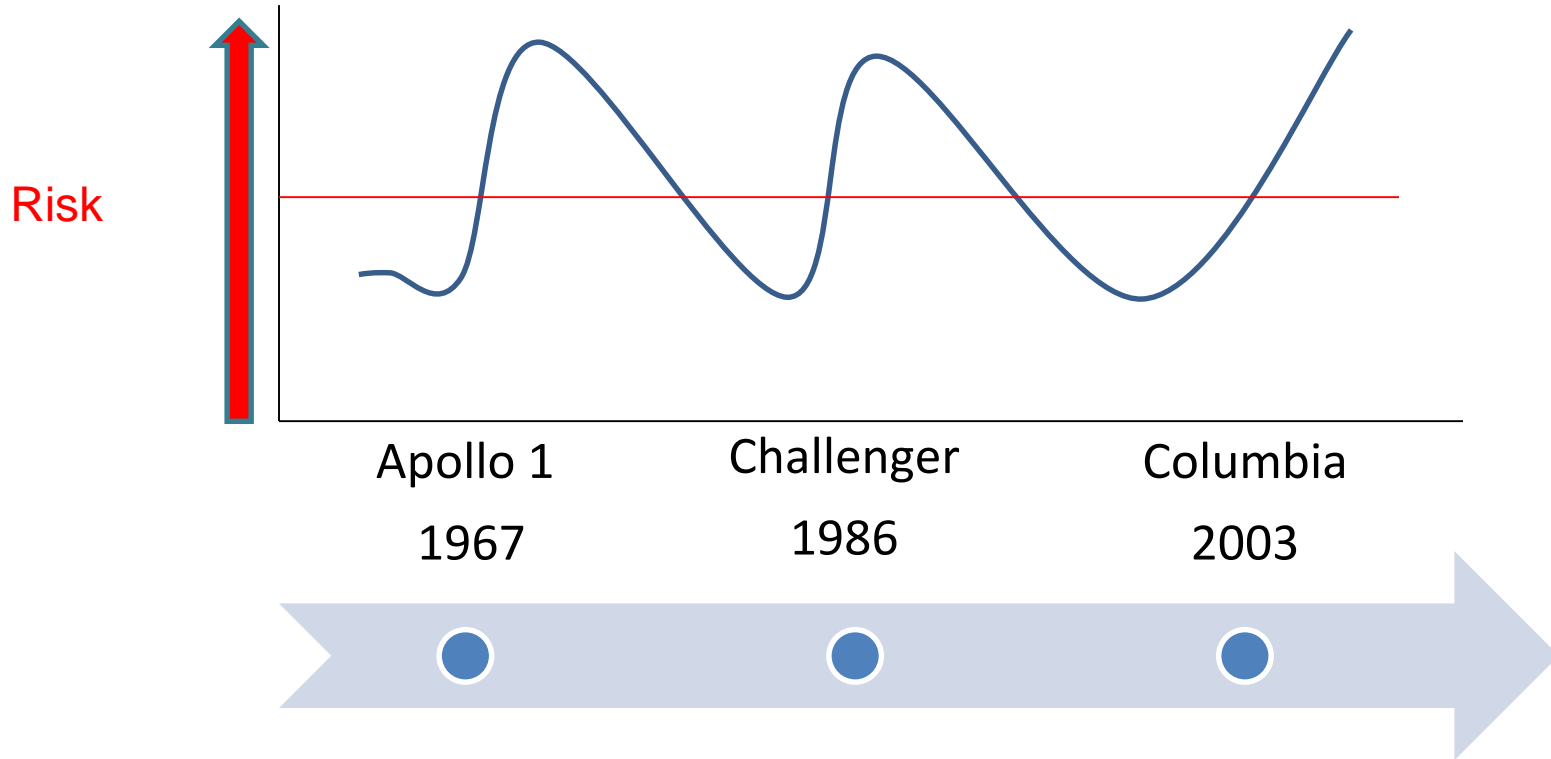


# Pendulum Swing

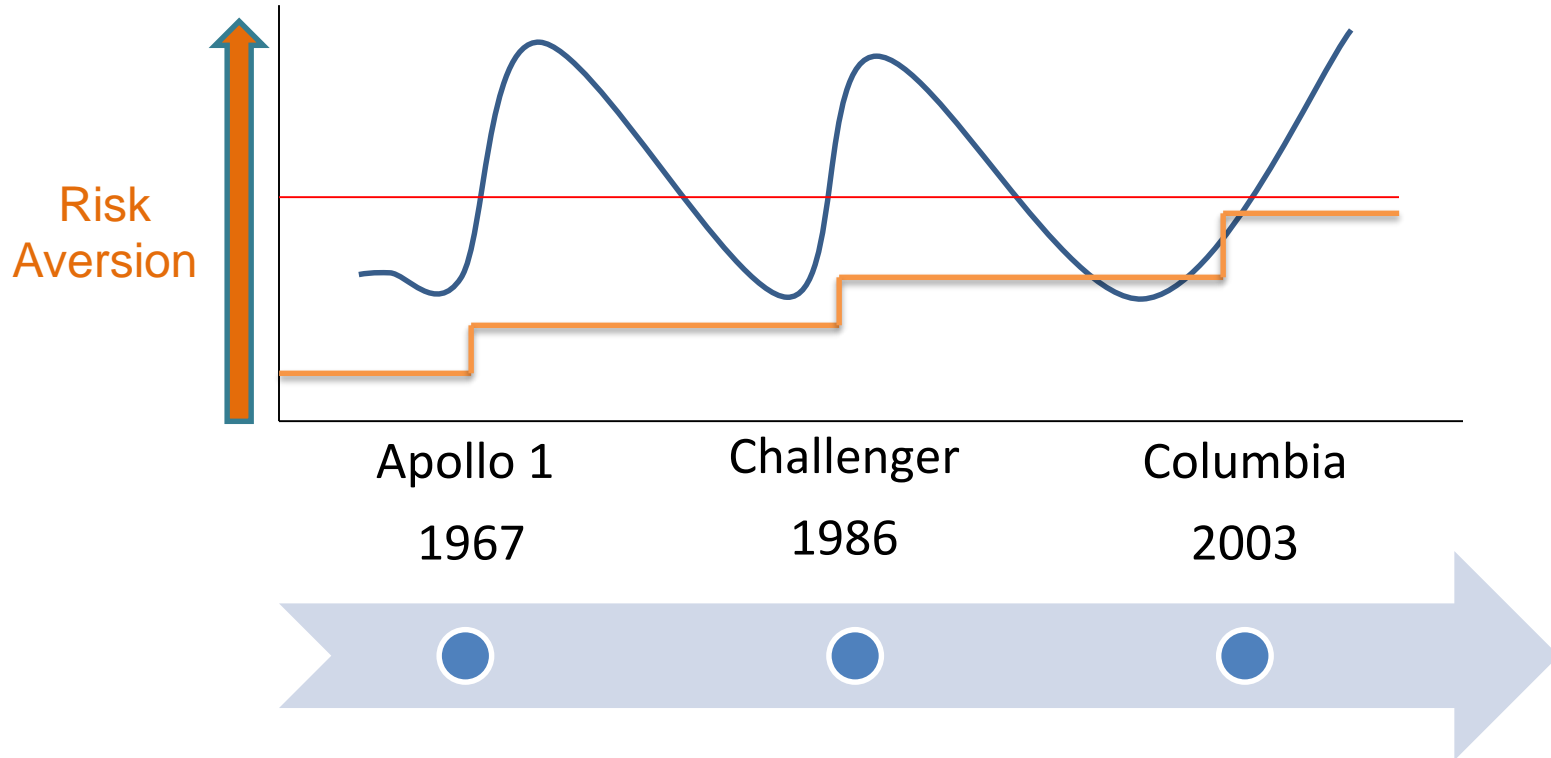




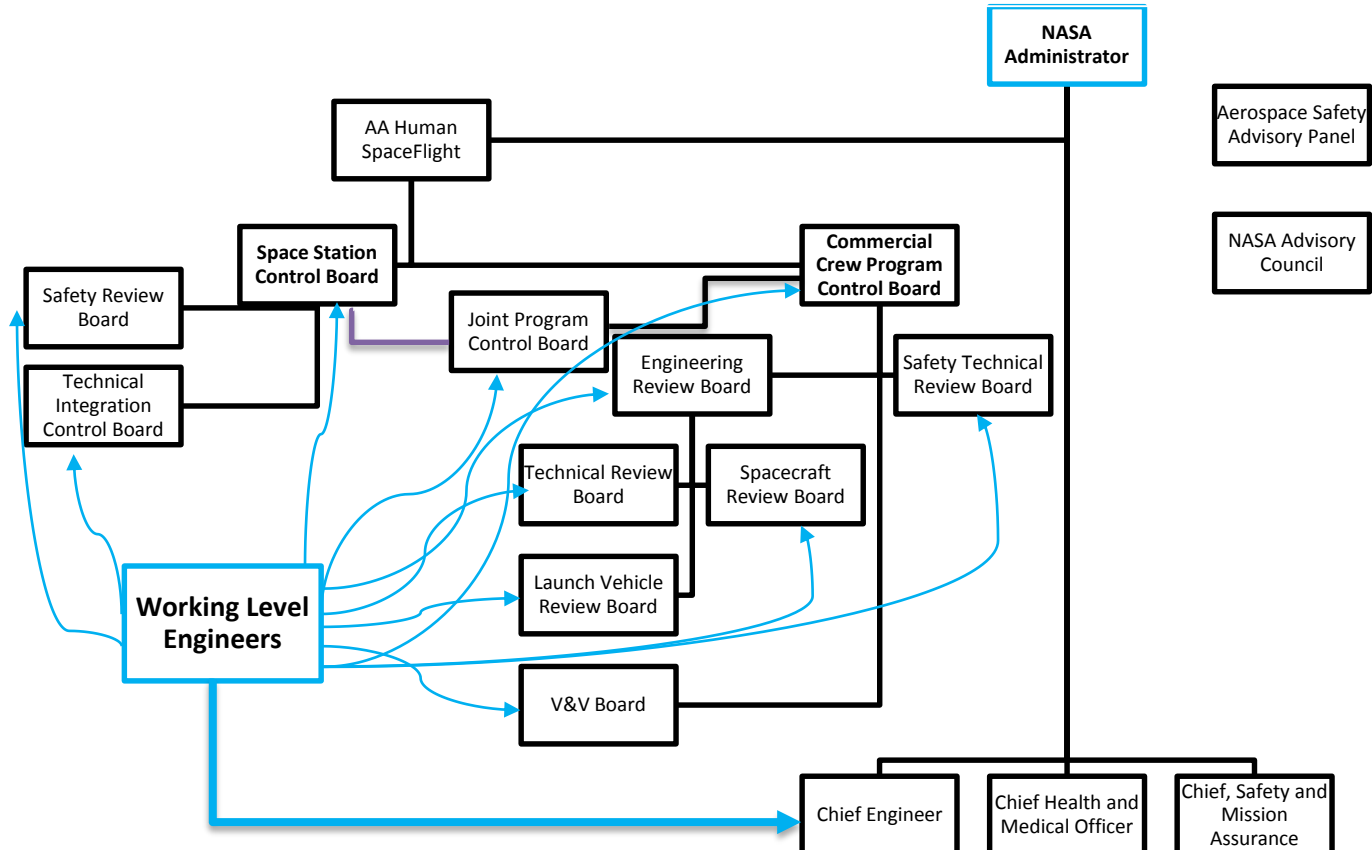
# Pendulum Swing



# Pendulum Swing



# NASA Decision Making Post-Columbia



# What Happens Next?



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