Lessons of History:

Organizational Factors in Three Aviation Mishaps

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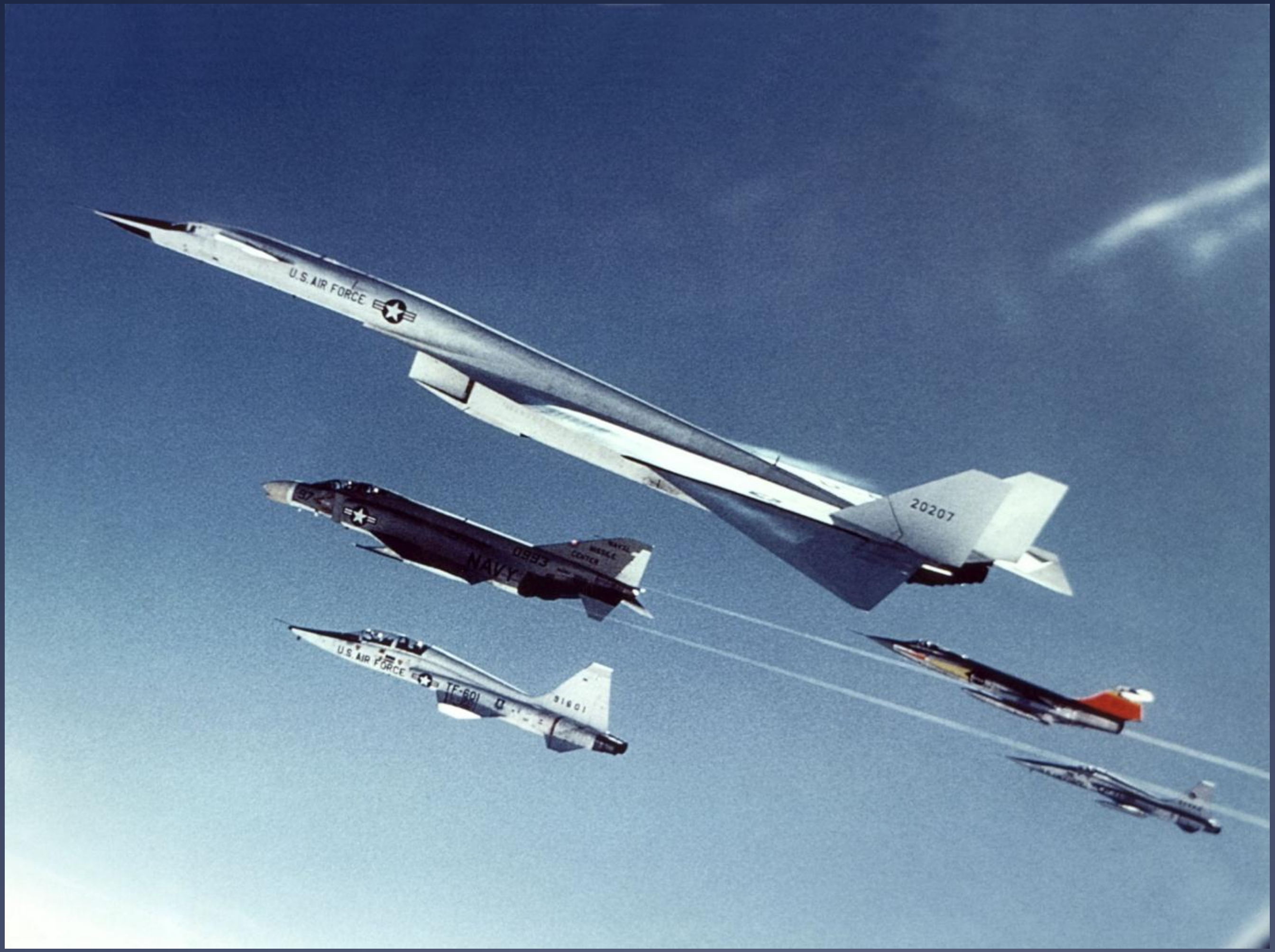
Decision Chains and Organizational Factors

- Many people are involved in flight planning/execution
  - Administrators
  - Mission planners
  - Maintainers
  - Flight crew
- Coordinated efforts of personnel are required
  - Standards and procedures
  - Supervisory policies
  - Communications paths
- A weak link in the chain can lead to disaster

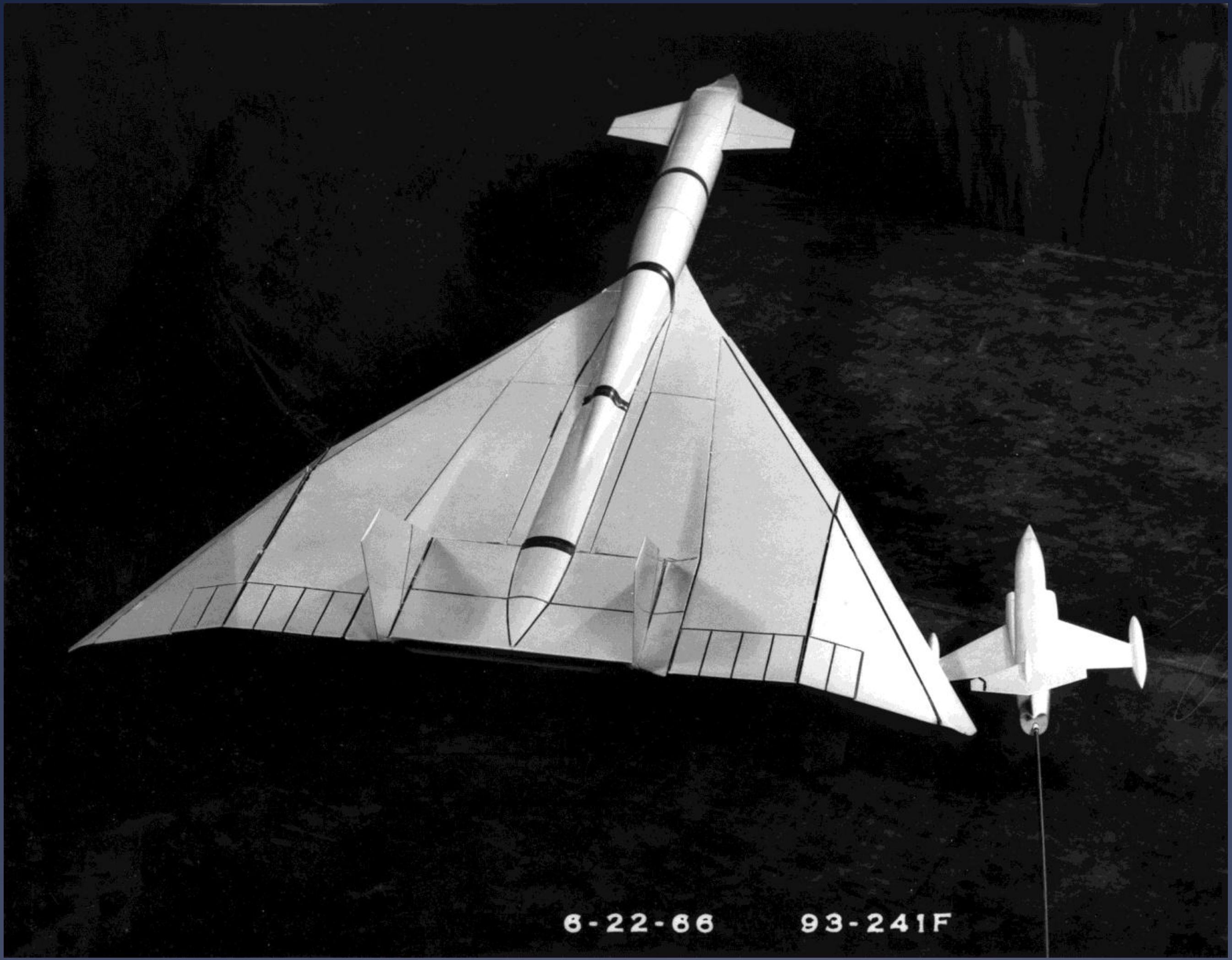
Case Study 1

XB-70/F-104 Mid-air Collision

8 June 1966



F-104 drifted into contact with XB-70 wingtip, possibly due to inadvertent stick input



Casualties: Two experienced test pilots dead, one injured

Materiel loss: F-104 ($1,133,053), XB-70 ($219,500,000)

What went wrong?

Planning

Photo session approved by AF XB-70 Test Force Director despite initial objections from NAA

Test Force director did not seek approval from higher headquarters

XB-70 program director did not voice any objection to plans for the formation flight

Execution

Weather conditions led to change in altitude, route, and direction of flight from those briefed

Photo plane not equipped with UHF (communications had to be relayed through a ground station)

Extended time in formation; planned 30 minutes extended to 45 minutes (pilot workload)

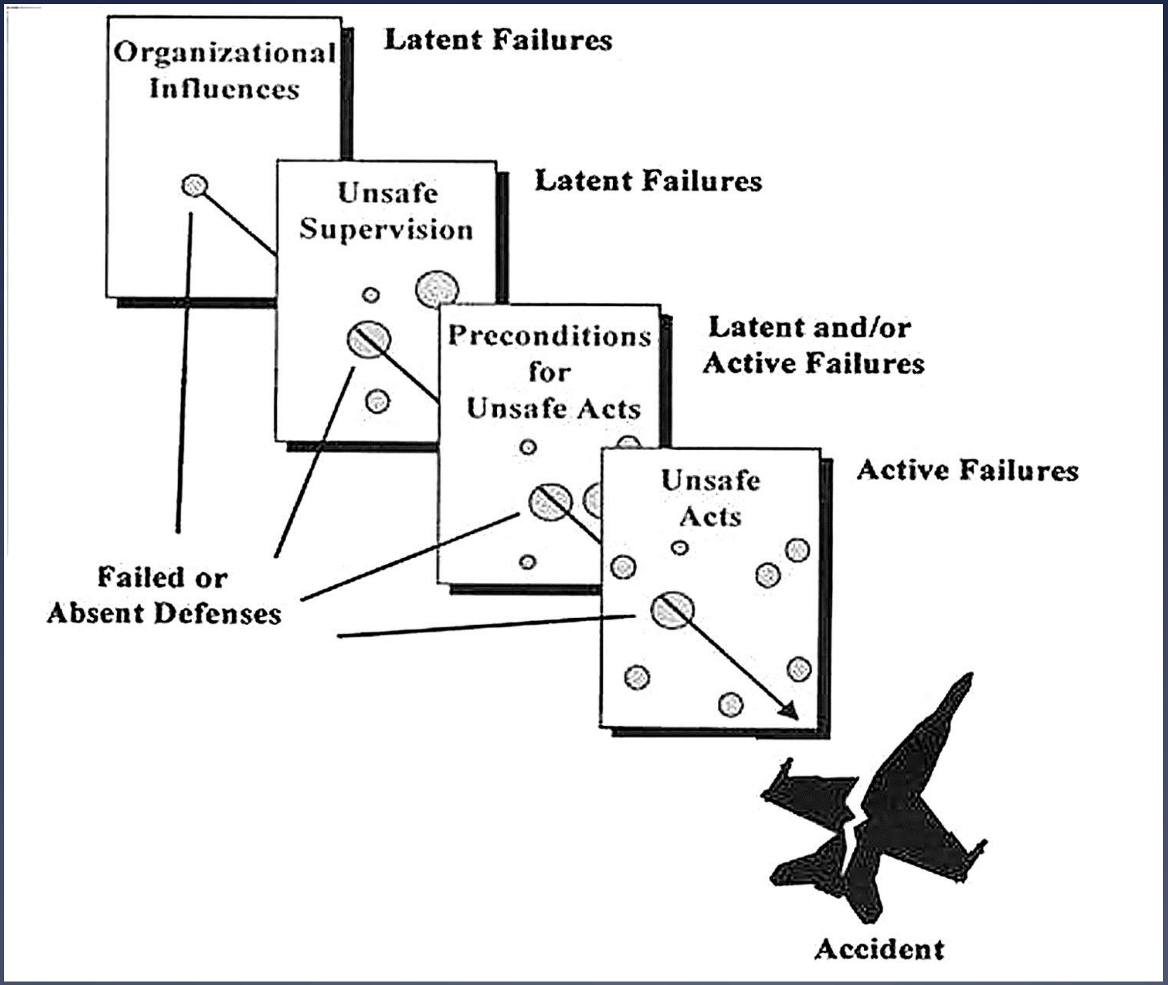
F-104 pilot did not have good visual references to judge distance from XB-70

Distraction due to other air traffic (B-58 in supersonic corridor)

Afterward, the Air Force made numerous administrative changes to improve operational procedures, starting with correction of supervisory and procedural weaknesses within the responsible test organization.

Reason's "Swiss Cheese Model"

Post-accident analysis revealed a classic example of Prof. James Reason's model of safety vulnerabilities in highly technical and complex organizations in which areas of vulnerability are "holes" in the layers of defense guarding against error.



Case Study 2

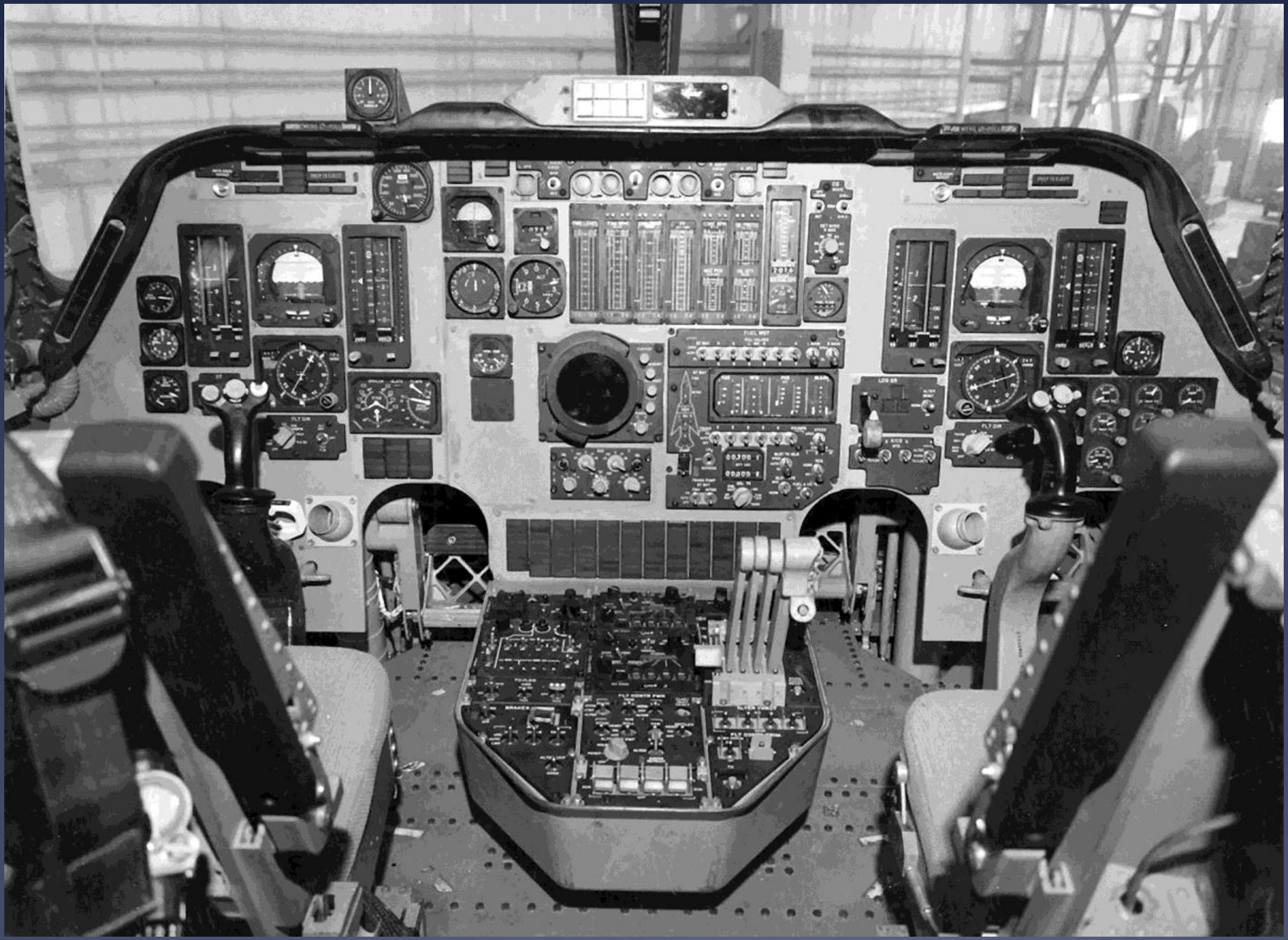
B-1A low-altitude stall/spin

29 August 1984

"Warning Fatigue"

Warning lights on the Master Caution panel occasionally illuminated throughout the flight. Because the situations most often were not serious, the pilot simply reset the Master Caution each time.

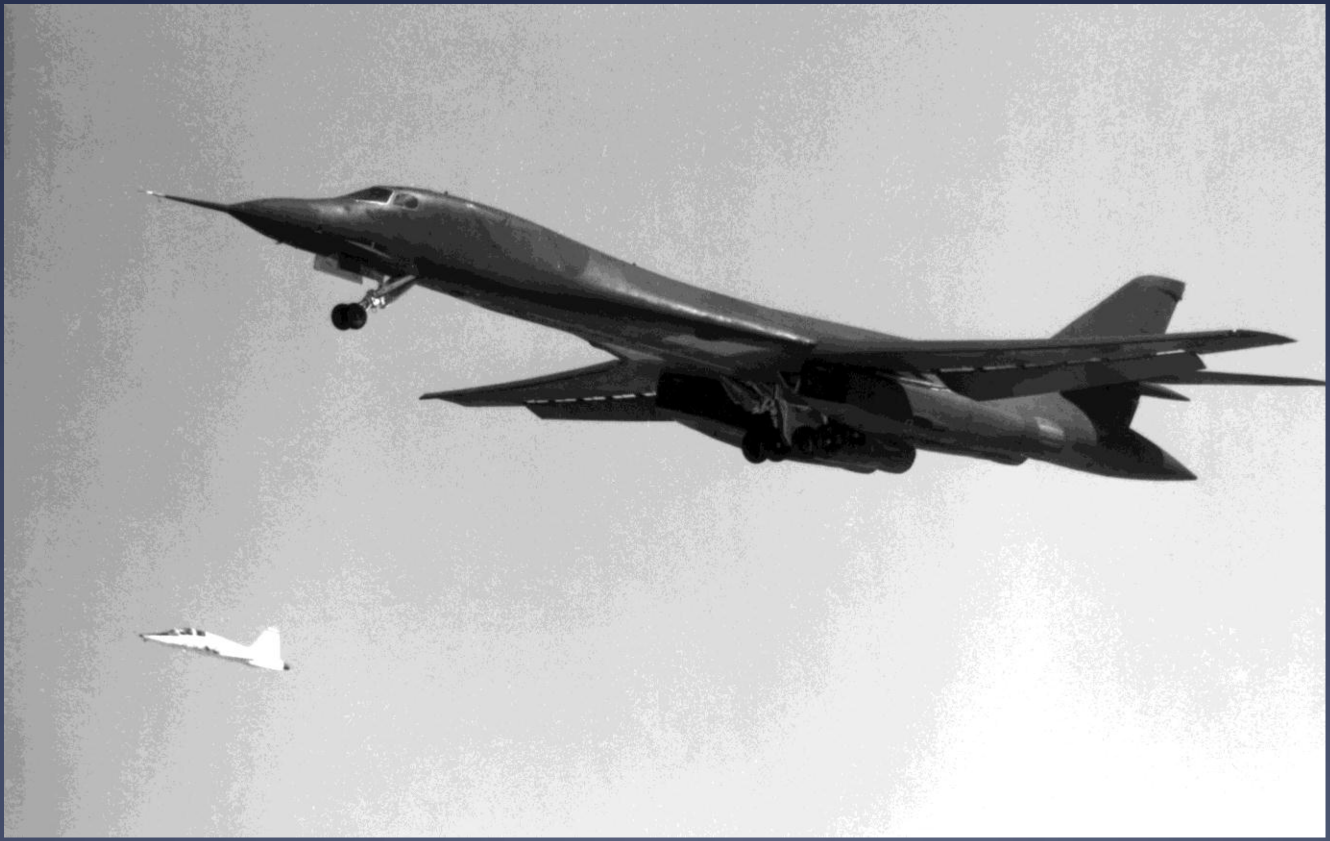
The crew gradually became anesthetized to the alarms, ignoring vital information.



Dynamic minimum control-speed test conducted at 300 knots CAS, below 10,000 feet MSL, with wings swept forward, flaps extended and gear down. Actual altitude was 4,000 feet AGL.

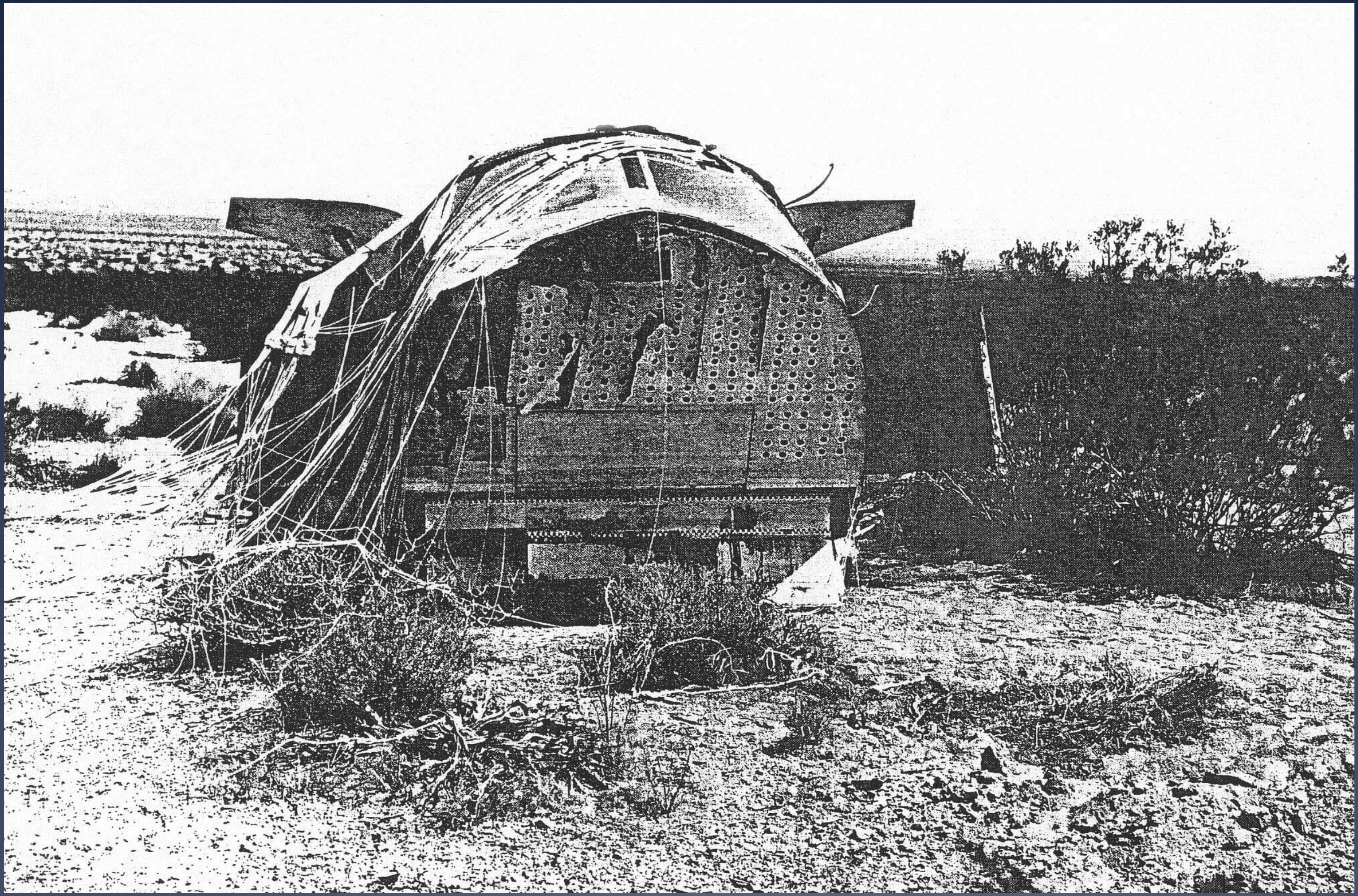
Pilot swept wings in one continuous motion despite being advised to do so in stages. C.G. change.

Control Room personnel turned away from their strip charts and began discussing the quality of the data received during the previous test points. Nobody was monitoring the data.



Casualties: One experienced test pilot killed, two injured

Materiel loss: B-1 ($325,000,000)



What went wrong?

Mission planning

Change in personnel; relatively inexperienced mission planner replaced "Jedi Master"

Test points at full-aft/clean and full-forward/dirty configurations were scheduled without an intermediate test point.

Crew resource management

Mixed experience. Pilot-in-Command had less than 14 hours in the B-1. Co-pilot was described as "probably the most experienced and knowledgeable B-1 pilot in the world." Deference led to "silent incapacitation."

Crew failed to manually transfer fuel during wing-sweep, resulting in out-of-trim condition

Crew anesthetized to alarms on Master Caution panel; ignored an important warning

Mission control

No indicators to highlight unsafe aircraft parameters

No coordination between Control Room personnel and aircrew regarding A/C center of gravity

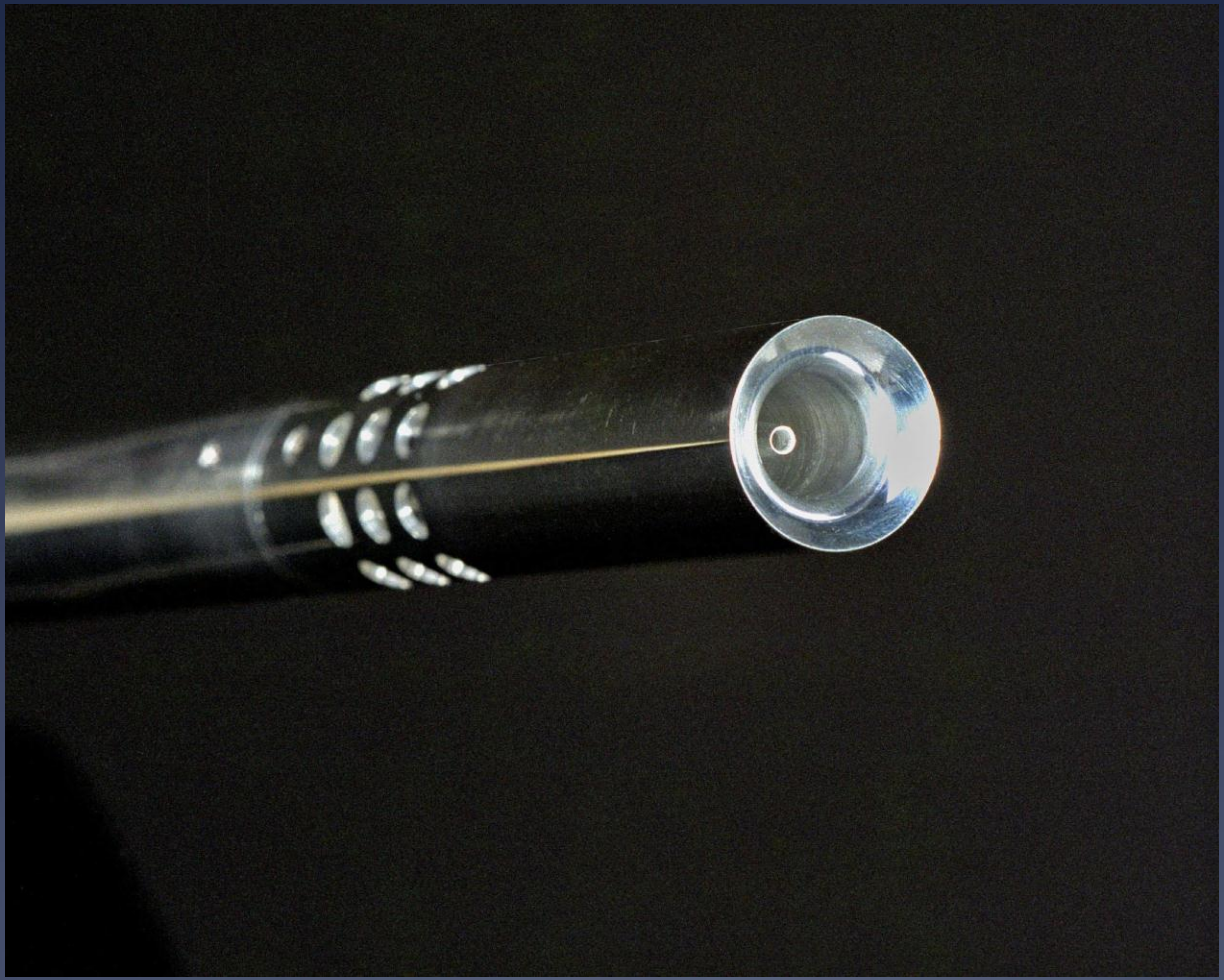
Control Room personnel not monitoring flight during critical phase

Need for cockpit discipline, adherence to protocol, and attention to detail.

Case Study 3
X-31 loss of control
19 January 1995

Kiel probe is susceptible to icing (Venturi effect)

Not equipped with heating system

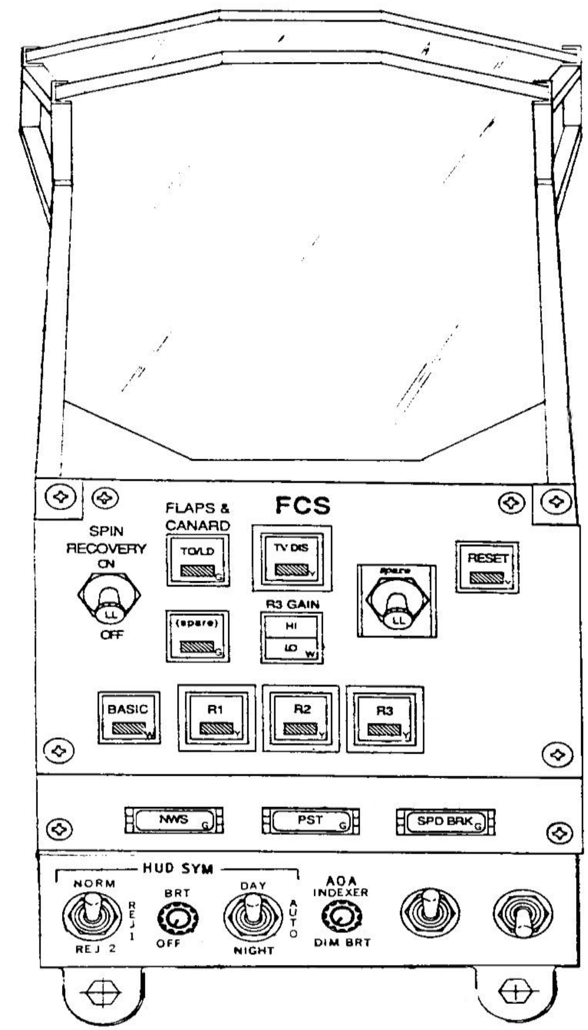


Casualties: One experienced test pilot injured

Materiel loss: X-31 (Approximately $80,000,000)

Reversionary Flight Control Modes

At any time prior to loss of control, the pilot could have activated the R3 mode



Head-Up Display (HUD)

What went wrong?

Automation bias

Catastrophic consequences of pitot-static system failure discovered in simulation but failed to lead to corrective action

Reliance on Flight Control System warning annuciators

Lack of configuration awareness

Change from Rosemount probe (heated) to Kiel probe (unheated)

Kiel probe susceptibility to icing was not known to all project personnel

Pitot heat switch not placarded as inoperative

Poor communications

System safety analyses failed to identify potential catastrophic consequences of failure in pitot-static system

Configuration control process failed to disseminate condition of pitot heating system

Majority of test team was unaware of inoperative condition of switch

Crew resource management

Complacency in control room

Pilot's lack of situation awareness

Lack of information sharing

Need for improved configuration awareness, communications, and CRM

Why is this important?

Case studies provide valuable lessons for understanding the interaction of people with aircraft systems and with each other during flight operations.

Organizations should archive and review case studies of disasters and near misses in order to avoid repeating errors.

Joe Walker

Carl Cross

Doug Benefield

Resources

For additional information, see ***Breaking The Mishap Chain***, a collection of case studies highlighting human factors in aerospace accidents and incidents.

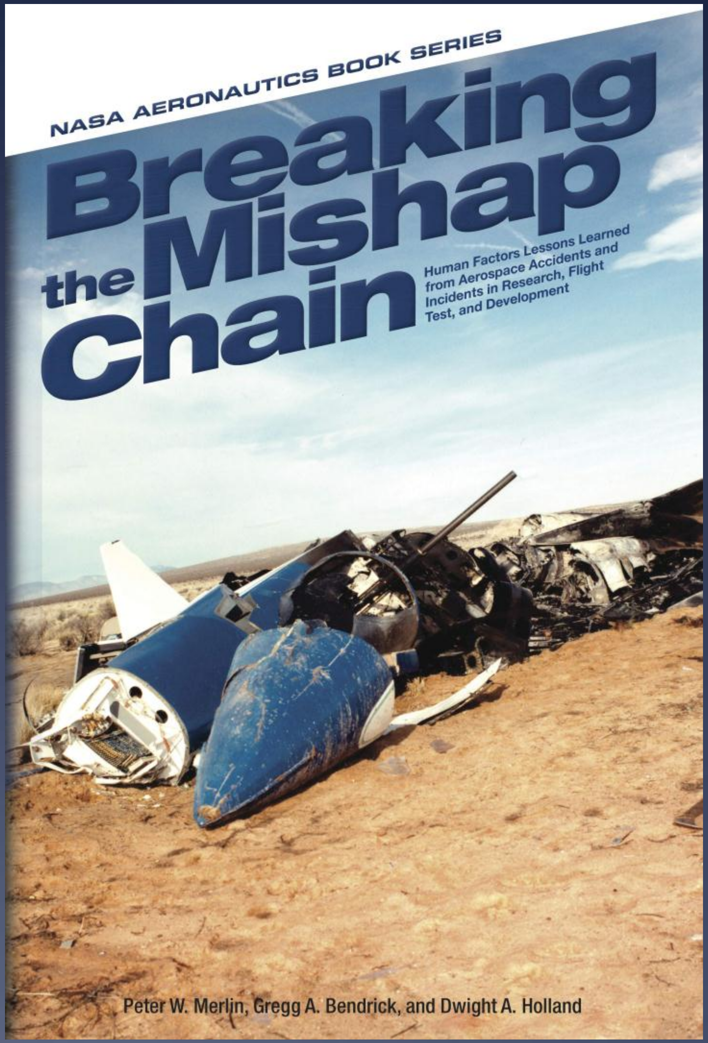
Design factors

Physiological factors

Organizational factors

Hard copies available from the U.S. Government Printing Office bookstore: http://bookstore.gpo.gov/

E-book available for free download: http://www.nasa.gov/connect/ebooks/break_mishap_chain_detail.html.



Questions?