CAIB Lessons Learned
Well-intentioned people and high-risk organizations can become desensitized to deviations from standards

- Identified as a major factor in Columbia mishap, much like Challenger disaster
- Vaughan's *The Challenger Launch Decision* called this "Normalization of Deviance"
- "Unexpected becomes the expected which becomes the accepted"
- In both Challenger, Columbia: "The machine was talking, but no one was listening"
- Small anomalies may be symptomatic of looming, larger problems—failure to address could prove disastrous
- System effects take years to develop and cause failures
NASA Normalization

- Orbiter damage from foam/debris confirmed on 82% of its missions, back to STS-1 (1981)—despite a requirement to have no foam damage
- Became less of a concern the more missions landed successfully (shedding "normalized")
- STS-107 decision-makers influenced by previous foam losses, convinced foam could not bring down orbiter and believed any damage would only be just a maintenance turnaround issue
Past successes may be the first step toward future failure

- Past successes can set an organization up for future failure when unresolved or unplanned-for occurrences are left unresolved. Shortcut accepted today may have catastrophic results tomorrow.
- Past successes can expand blind spots, create bureaucratic complacency, and lead to Group Think.
- Understand completely all assumptions before making decisions.
- Schedules need flexibility & realism ... “perfect” scheduling can create unforeseen, unintended decisions.
Lesson 2

NASA Successes

- 111 successful landings while averaging over 100 debris strikes per mission reinforced confidence
  - Most debris strikes classified as minor and only a maintenance burden (no safety of flight risk)

- STS-112 Bipod Foam Event: Foam missed wing, but damaged SRB two missions before STS-107

- Past debris/foam successes led to an attitude of: “it's just foam,” “foam can't hurt the orbiter”

- No higher level leader during STS-107 felt need to investigate damage (ground/space-based images, spacewalk)
Organizations, like people, must always be learning, especially from past mistakes

- Organizations must "institutionalize" lessons learned, regardless of how painful the memory of past failures may be.
- Organizations must acknowledge and learn from "small" incidents (weak signals) -- not waiting until a major catastrophe occurs to deal with "minor" operations issues or safety shortfalls.
Is NASA a Learning Organization?

- CAIB Report examined 80+ past NASA assessments, singling out nine areas: Infrastructure, Comm, Contracts, Risk Management, QA, Safety Programs, Maintenance, Security and Workforce
  - Mishap findings arose in all nine areas during the Columbia investigation

- NASA has no formal training program to learn from past mishaps. Naval Reactors has trained over 5,000 personnel in lessons learned from Challenger accident. NASA has no similar training program.
Poor organizational structure can be just as dangerous to a system as technical, logistical, or operational factors

- Organizational structure can unintentionally create blind spots and promote Group Think.
- Matrixed work forces and complex, geographically separated operations hinder communication
- Leaders must decide whether operations should be designed for efficiency (low cost) or reliability
- External forces/influences can reshape an organization’s goals and objectives
- Organizations evolve unwritten goals (i.e. survival of the institution) that can make it resistant to change, self-protecting, insular, etc.
- Perfect processes do not equate to a safety culture
NASA Organizational Issues

- Columbia Board determined organizational failures were just as causal as technical failures
- Board identified NASA "Culture" as an organizational flaw leading to blind spots and silent safety
- SSP pyramid leadership structure allowed SSP Manager to waive any/all technical requirements
- Organizational structure not conducive for upchanneling concerns over foam/debris strike on launch
- Columbia imagery request denied: MMT failed to realize who needed the imagery
- Security clearances prevented key participants from knowing capabilities available
Leadership training and system safety training are wise investments in an organization’s current and future health

- Leaders create and sustain culture
- Leadership training should be provided as part of every high-risk professional’s career development
  - Decision making, risk assessments, communication, interpersonal skills, system safety, "what if" scenarios
- Decision makers must be forced to resolve problems using tested and fail-safe processes, reducing the chance of process break down in the "fog of war"
- E-Leadership…isn’t (e-mails, PowerPoint fixation, etc.)
- Actions speak louder than words ... i.e., if you’re stressing the schedule versus safety and reliability, the work force will deliver on time no matter the cost
NASA Leadership Training

- Imagery capabilities, and procedures for requesting imagery, not known or understood by MMT
- Operational career progression limited to select few
- Key decisions were made based on abbreviated PowerPoint briefings, not on thorough, data-supported research
- Team had not trained to worst-case scenarios
Leaders must ensure external influences do not result in unsound program decisions

- Leaders must balance program influences (schedule, budget, political pressure, etc.), but keep priorities clear—no "unintended consequences"
- Need leaders willing to stand up and say "No" when tasked to operate without sufficient resources
- External factors can alter organizational goals/objectives if leaders not sensitive to those pressures (e.g., conflicting influences: cost/schedule pressure versus safety, or schedule constraints versus reliability)
NASA Influences

- International Space Station support had an indirect influence on mission preparation for STS-107
  - February 2004 date well-advertised by NASA HQ for ISS "NODE 2 Complete"
- Budgetary constraints limited Shuttle Safety upgrades, imagery capabilities
- Shuttle considered "operational" after fourth flight, but should have been treated as R&D vehicle
- Priorities on importance of STS-107 "Science Mission" influenced MMT imagery decision
Leaders must demand minority opinions and healthy pessimism

- Successful HROs (high reliability organizations) promote and encourage the airing of minority opinions, regardless of (un)popularity
- HRO leaders admit they are uncomfortable when making tough decisions if no questioning opinions
- Leaders must avoid insulating themselves (or giving perception of insulating themselves)
- Avoid over-simplification of problems ... learn to think worst case and develop issues from there
Lesson 7

NASA Tendency

- MMT did not seek out, nor listen to, minority opinions about the foam/debris danger to orbiter
- After STS-107 debris strike, MMT leaders dismissed engineers' concerns; no "what if" questions asked
- Decision-making climate: "prove to me this is safe" before launch to "prove to me it's unsafe" after
- NASA Administrator O'Keefe opined, "Mr. Rocha's experience underscored the need to seek the dissenting viewpoint and ask, 'Are we talking ourselves into this answer?'"
- NASA key leaders listened to forceful personality who had no expertise in the system critical to the decision (he knew tiles, but not foam and RCC)
Lesson 8

CAIB Lessons Learned

Lesson 8

**Stick to the basics**

- All operations, especially high-risk operations, must stick with the basics to ensure consistency of operational procedures, training, risk mitigation techniques and safety practices
- Basic ORM principles must apply
NASA Departure from the Basics

- KSC and United Space Alliance devised an aberrant approach to Foreign Object Damage prevention program--inconsistent with other NASA Centers and other similar programs
  - 18 missing tools lost in processing of Columbia
  - Indeterminate amount of other debris
- Configuration control: every orbiter different but no mechanisms to track differences
High reliability organization safety programs cannot remain silent or on the sidelines—must be visible, critical, empowered, and fully engaged

- The higher the risk, the more critical to have an independent and proactive safety structure
- Safety Professionals must never feel threatened to bring up bad news about safety issues
- Safety leadership must have an equal voice in decision making and authority to stop operations
- Safety must be immune to budget/schedule pressures, independent from program, free from political pressure
NASA Safety Structure

- CAIB identified Shuttle Safety as a "silent safety" program, similar to Challenger findings
- Shuttle Safety organization not conducive to independent safety oversight or inputs
- Key Shuttle Safety personnel worked directly under the Shuttle Program Manager
- NASA Safety Professionals' rank and subordination to SSP hindered honest voicing of dissent
- NASA Headquarters Safety Office too far removed from daily operations (in D.C.)
Safety efforts must focus on preventing versus solving mishaps

- Every high reliability organization needs leadership-driven mishap prevention tools and capabilities
- NASA must actively focus on mishap prevention for the future
- Must avoid a “rush to publish” a mishap report, and ensure opportunities to address board member concerns
NASA Mishap Investigations

- NASA Contingency Action plan insufficient for mishap of this magnitude
- Problems arose early with Board's perceived "independence" from NASA senior leadership and influence
- CAIB lack of Investigating Officer or Chief Investigator impacted investigation efforts initially
- NASA and CAIB needed more time devoted to planning the investigative strategy vs. investigating