CAIB Lessons Learned

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Lesson 1

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

CAIB Lessons Learned

Lesson 1

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

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Lesson 2

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

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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)

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Lesson 3

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

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Lesson 3

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.

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Lesson 4

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

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Lesson 4

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

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Lesson 5

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

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Lesson 5

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

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Lesson 6

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)

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Lesson 6

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

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Lesson 7

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

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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)

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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

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Lesson 8

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

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Lesson 9

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

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Lesson 9

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.)

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Lesson 10

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

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Lesson 10

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