



Columbia Accident Investigation Board Report Lessons Learned

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Well-intentioned people and high-risk organizations can become desensitized to deviations from the norm

- Board identified this as a major factor in Columbia mishap, much like the Challenger disaster
- “Unexpected becomes the expected which becomes the accepted”
- Small anomalies may be symptomatic of larger problems—failure to address could be disastrous
- System effects take years to develop and cause failures
- In both the Challenger and Columbia missions: “The machine was talking to us, but nobody was listening”

NASA Normalization

- Orbiter damage from foam/debris confirmed on 82% of missions dating back to STS in 1981
- Became less of a concern as more missions landed successfully
- STS-107 decision-makers convinced foam could not bring down orbiter and any damage would be a maintenance turnaround issue





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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 unattended. Shortcut accepted today may have catastrophic results tomorrow
- Past successes can reinforce blind spots and create bureaucratic complacency
- Understand completely all assumptions before making decisions
- Schedules need flexibility and realism ... perfect scheduling can create unforeseen, unintended decisions

NASA Successes

- 111 successful landings averaging over 100 debris strikes
- STS-112 Bipod Foam Event: Foam missed wing, damaged SRB
- Past successes led to attitude of “it’s just foam, foam can’t hurt”
- No higher level leader felt need to investigate damage





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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 learn from “small” incidents (weak signals) and not wait until a major catastrophe occurs to deal with operational or safety issues

Is NASA a Learning Organization?

- CAIB Report identified 50 past NASA assessments, singling out nine areas that the Board found mishap factors: Infrastructure, Communication, Contracts, Risk Management, QA, Safety Programs, Maintenance, Security, and Workforce
- NASA has no formal training to learn from past mishaps. Naval Reactors has trained over 5,000 personnel in lessons learned from the Challenger accident. NASA has no similar training program.





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Poor organizational structure can be just as dangerous to a system as technical, logistical, or operational factors

- Organizational structure can unintentionally create blind spots
- Matrixed work forces and geographically separated organizations hinder communication
- Leaders must decide whether operations should be designed for efficiency (low cost) or reliability
- External forces/influences can reshape the goals and objectives of an organization
- Organizations develop unwritten goals that make it resistant to change
- Perfect processes do not equate to a safety culture

NASA Organizational Issues

- CAIB identified NASA “culture” as an organizational flaw
- SSP structure allowed manager to waive technical requirements





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Leadership and system safety training are wise investments in an organization's current and future health

- Leadership training should be provided as part of career development
- Decision-makers must be forced to resolve problems using tested processes to reduce the chance of breakdown
- Leaders create and sustain culture
- Actions speak louder than words – if management stresses schedule versus safety and reliability, the work force will deliver at any cost

NASA Leadership Training

- Imagery capabilities, and procedures for requesting imagery, not known and understood by Mission Management Team
- Endemic use of PowerPoint briefing slides instead of technical papers illustrates problematic methods of technical communication





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Leaders must ensure external influences do not result in unsound program decisions

- Leaders must balance program influences (budget, schedule, politics) but keep priorities clear. No unintended consequences.
- Leaders willing to stand up and say “no” when tasked to operate without sufficient resources or make safety compromises
- External factors can alter organizational goals if leaders not sensitive to conflicting influences

NASA Influences

- International Space Station support had an indirect influence on Columbia mission preparation
- Decade of downsizing and budget tightening left NASA exploring the universe with less experienced staff and older equipment





Leaders must demand minority opinions and healthy pessimism

- Successful organizations promote and encourage the airing of minority opinions, regardless of (un)popularity
- Leaders admit they are uncomfortable when making tough decisions
- Leaders must avoid insulating themselves
- Avoid over-simplification of problems ... learn to think worst case and develop issues from there

NASA Tendency

- MMT did not seek out nor listen to minority opinions about debris
- MMT leaders dismissed concerns about debris strike
- Decision climate changed from situation “safe” to “unsafe”
- NASA key leaders listened to tile expert who had no experience in foam or RCC





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High-risk 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 culture
- 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 have authority to stop operations
- Immune to budget/schedule pressure, free from political pressure

NASA Safety Structure

- NASA had conflicting goals of cost, schedule, and safety
- Safety system lacked the resources, independence, personnel, and authority to successfully apply alternate perspectives to problems
- Overlapping roles and responsibilities undermined system of checks and balances
- Safety representatives were present before both accidents- no participation





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Safety efforts must focus on the “front end” mishaps (prevention) vice the “back end” (investigations)

- Every high-risk organization needs leadership-driven mishap prevention tools and capabilities
- Organizations must actively focus on mishap prevention for the future

NASA Mishap Investigation

- NASA Contingency Action plan insufficient for mishap of this magnitude
- Problems arose early with Board’s perceived “independence” from NASA senior leadership
- “Privileged communication” allowed witnesses to volunteer information and speculate openly about their organizations’ flaws





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NNSA CAIB Lessons Learned

- Oversimplification of technical information could mislead decision-making
- Proving operations are safe instead of unsafe
- Management must guard against being conditioned by success
- Willingness to accept criticism and diversity of views is essential
- Effective centralized and de-centralized operations require an independent, robust safety and technical requirements management capability
- Assuring safety requires a careful balance of organizational efficiency, redundancy, and oversight





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NNSA CAIB Lessons Learned (contd.)

- Effective communications along with clear roles and responsibilities are essential to a successful organization
- Workforce reductions, outsourcing, and loss of organizational prestige for safety professionals can cause an erosion of technical capability
- Technical capability to track known problems and manage them to resolution is essential
- Technical training program attributes must support potential high consequence operations





Noteworthy CAIB Observations

- “**Management practices** overseeing the Space Shuttle Program were as much a cause of the accident as the foam that struck the left wing.” (Page 11)
- “Both *Columbia* and *Challenger* were lost also because of the **failure of NASA’s organizational system.**” (Page 195)
- “In perhaps the ultimate example of engineering concerns not making their way upstream, *Columbia* astronauts were told that the **foam strike was not a problem.**” (Page 202)
- “NASA’s blind spot is it **believes it has a strong safety culture.** Program history shows that the loss of a truly independent, robust capability to protect the system’s fundamental requirements and specifications inevitably compromised those requirements, and therefore increased risk.” (Page 203)





Safety Culture – Management’s Role

Issues

- Effective Safety Program – at the floor level
- Management did not fully understand its safety culture
- Safety blind spots
- Competing responsibilities
- Some manager’s questions were “closed questions” not “open questions”
- Not enough thinking time
- Buying Safety Services





Oversight of Contractors

Issues

- Technical Unfamiliarity
- Contractor and software limitations existed
- Contractor just reorganized
- Computer model validation envelope
- More intensive oversight needed





“Faster, Better, Cheaper” Initiative

Issues

- Inexperienced Project Managers
- Project Manager had split responsibility
- Program constraints increased risk
- Institutional experience was eliminated without compensatory actions
- Contractor was not required to notify NASA of increasing risk
- “Faster, Better, Cheaper” encouraged risk taking

