



Organizational and Cultural Lessons Learned from Challenger and Columbia

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Lessons Learned...Why Bother?

*No one wants to learn by mistakes, but
we cannot learn enough from
successes to go beyond the state of
the art.*

Henry Petroski

To Engineer is Human

Human Spaceflight Mishap Investigations



- Apollo Fire
 - NASA Investigation
 - NASA Follow-up Advised RTF
 - Congressional Investigation
- Challenger
 - Independent Board / NASA Investigation
 - NASA Follow-up Advised RTF
- Columbia
 - Independent Board / Mixed Investigation
 - Independent Oversight of RTF (“intent of the board”)

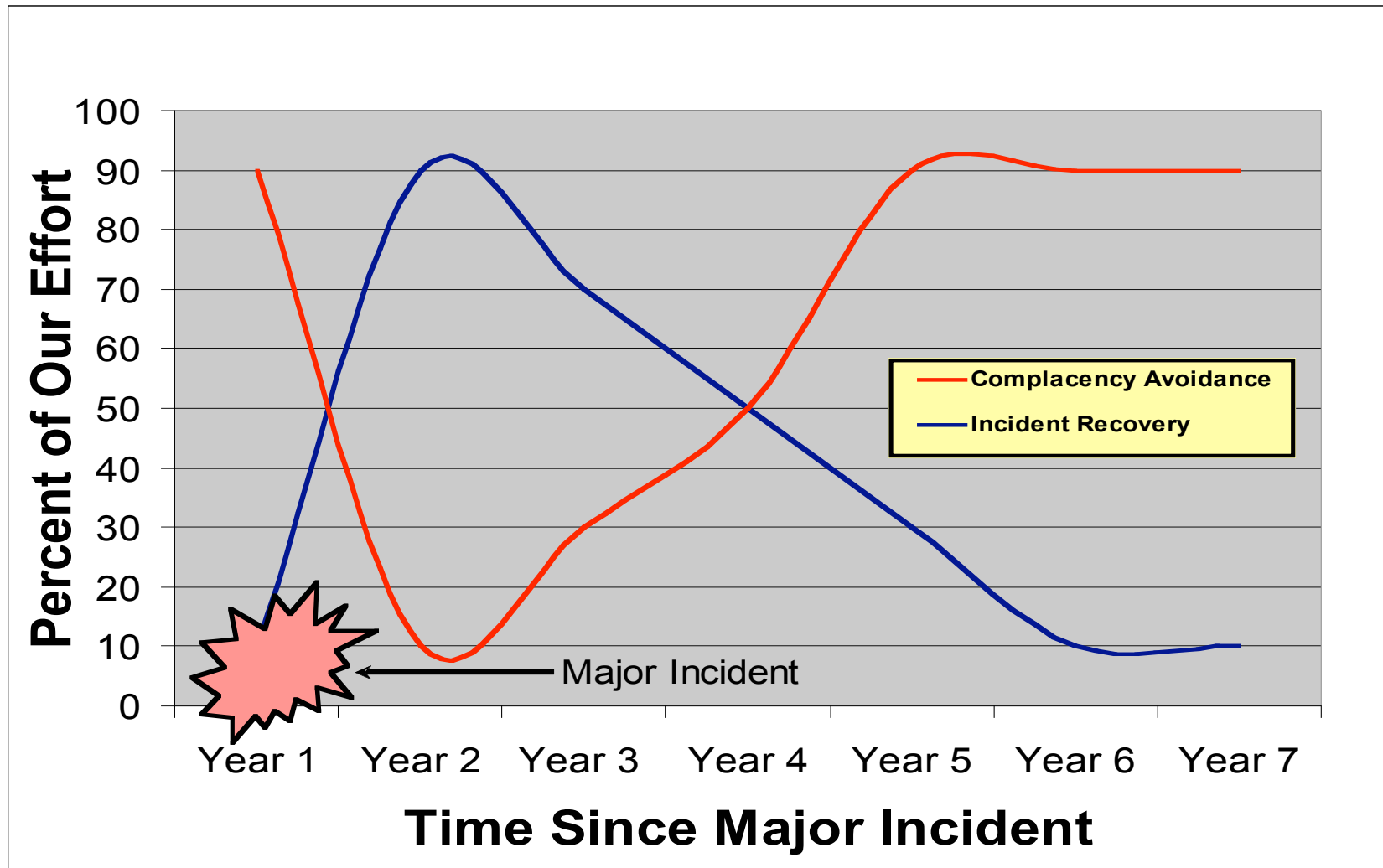
Human Spaceflight Mishaps Common “Root Causal Factors”



- **Communications**
- **Systems Engineering and Integration**
- **The “Silent Safety Program”**
- **Operational vs. Flight Test Mentality**
- **Governance**
- **Mission Relevance**



The Two Modes of Mishap Prevention





Reacting to a Major Failure

Once harm has been done, even a fool can understand it

Homer, The Illiad, Book XVII,
1.32



The Challenge of Success

*Success breeds complacency,
complacency breeds failure,
only the paranoid survive.*

Andrew S Grove
Former CEO and Chairman of Intel



Fighting Complacency

*One should expect that the expected
can be prevented, but the unexpected
should have been expected*

Augustine's Laws, XLV

Human Spaceflight Safety Recipe (per O'C)



1 part Shared Values (culture/comm)

1 part Organization (governance, people)

1 part Requirements (CM, lessons learned)

2 parts Risk Management (still in infancy)

and,

A dash o'luck

NASA's Core Values



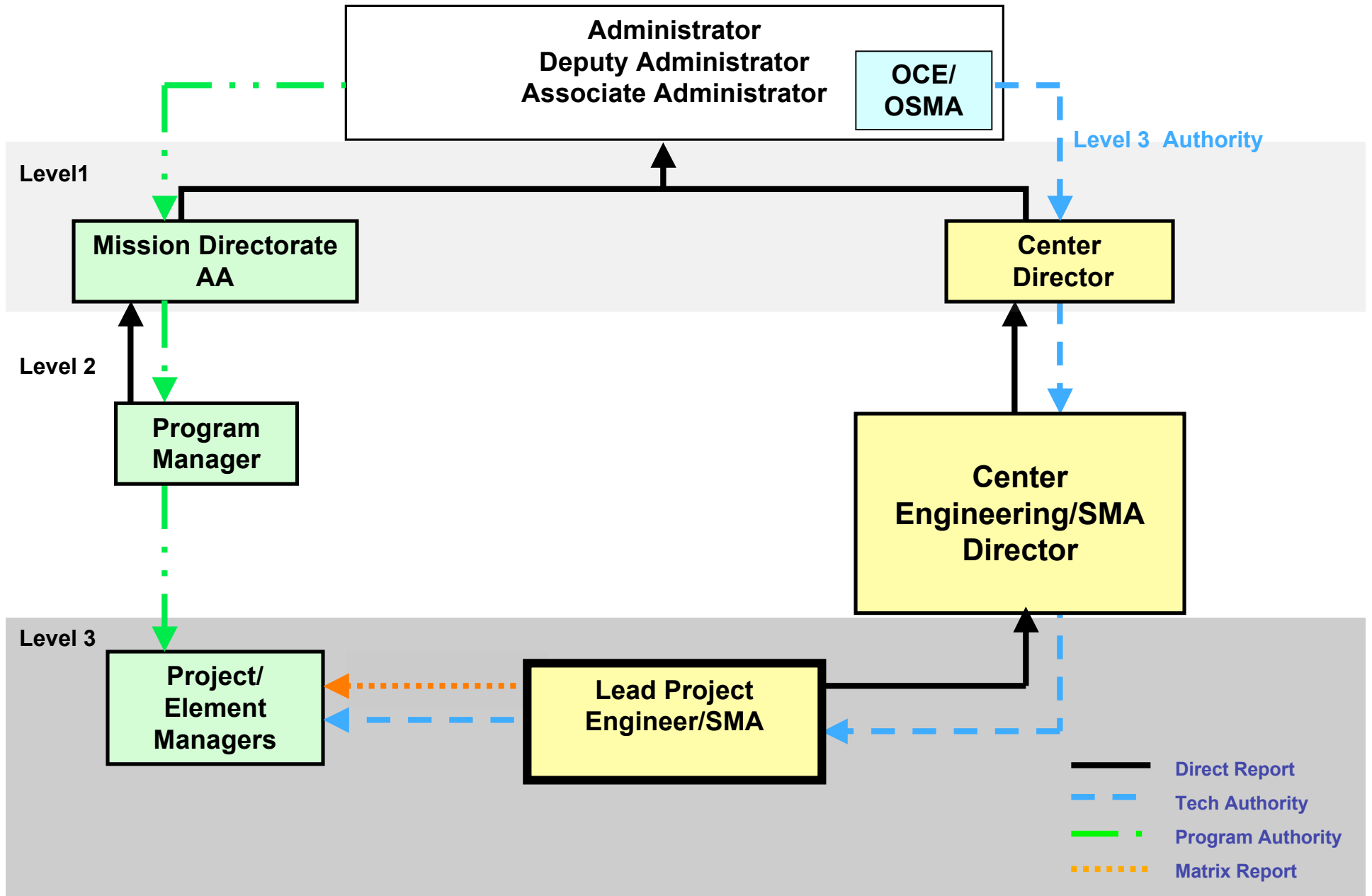
Safety

Teamwork

Excellence

Integrity

NASA Project Technical Governance



High Residual Risk* Acceptance at NASA



- Tech Authority (relevant tech requirement owner) approves based on technical merit, and
- Safety Tech Authority approves based on risk acceptability, and
- Risk Taker (and supervisory chain of command) volunteers to take the risk, and
- Only then does Program or Ops Manager get to “accept the risk”

***Residual risk is that extra level of risk over and above that inherent in the design requirements**



Safety Accountability (Per O'C)

“Everybody is responsible for safety”

But

Is everybody accountable for safety?

Accountability = Responsibility x Authority x Capability

Responsibility:

Everybody has it, no exceptions

Authority:

Per policy: leadership has more than workers, but even the lowest have the authority to speak up about a hazard

Capability:

Per assigned resources, qualifications, experience, etc.

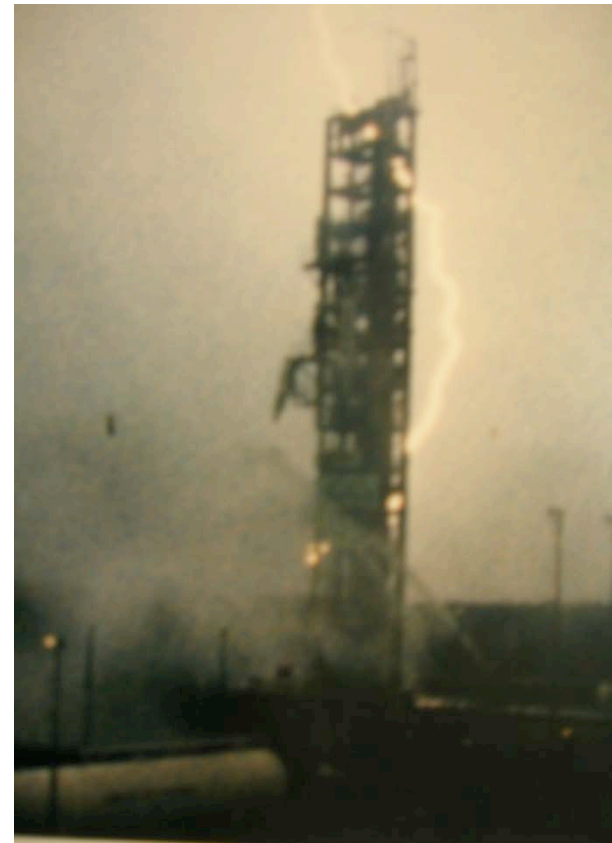
Important note: There is no such thing as delegation of accountability, only authority

Requirements are our Lessons Learned

AC-67 Example

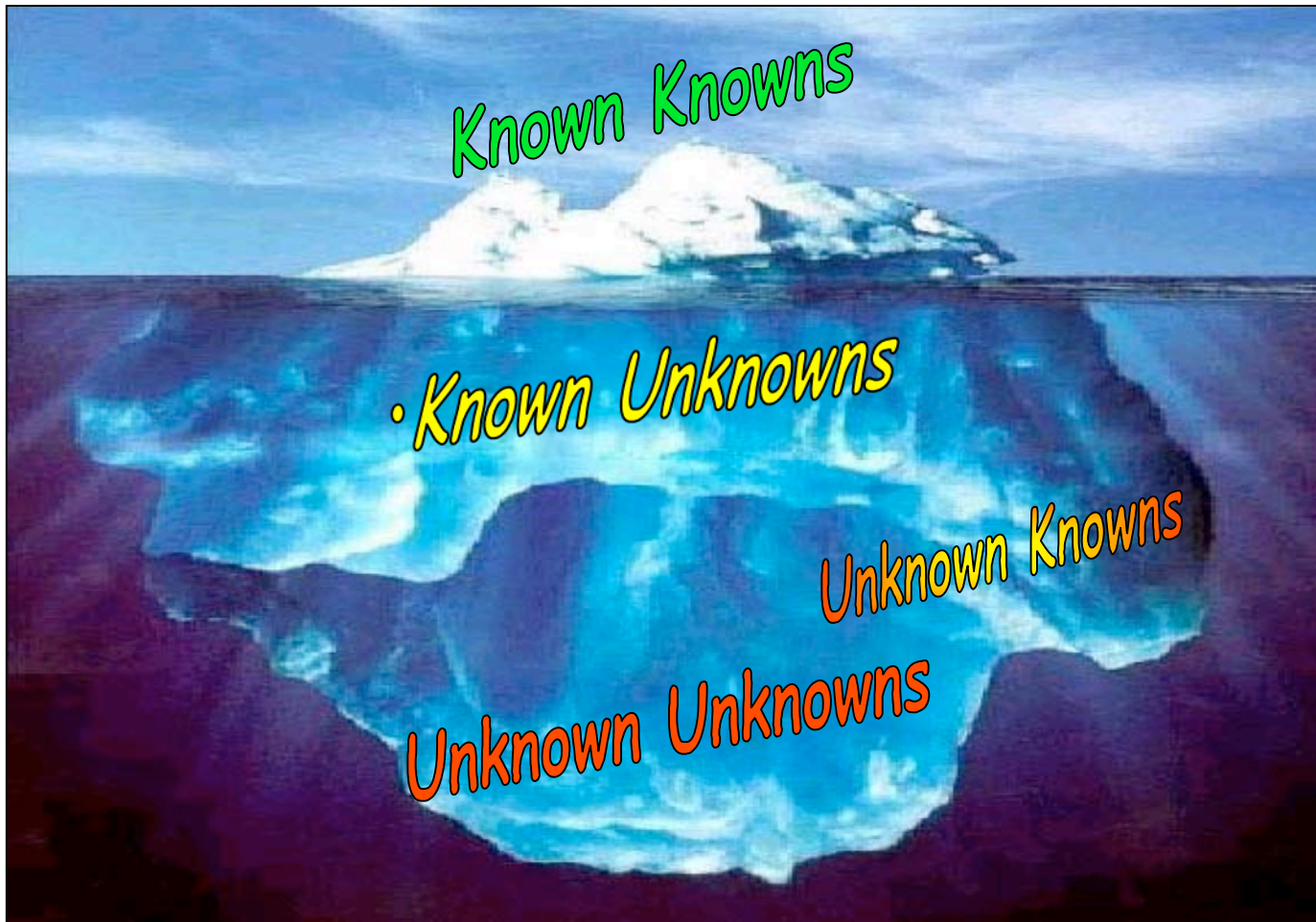


- Good: ops team questioned LCC* rationale
- Bad: absent right rationale, ops team manufactured wrong rationale
- Mishap Board recommended team training and updating LCCs
- Corrective action plan called for inserting rationale next to LCCs
- JSC Mission Ops follow up: insert rationale with flight rules for real time access



* Launch Commit Criteria

The Risk Iceberg



Risk Management for Human Spaceflight



- *Known Knowns: (Systems Engineering and Program Management)*
 - Disciplined program and mission **management processes and people**
- *Known Unknowns: (Continuous Risk Management)*
 - **Reduce uncertainties** with analysis, ground and flight test
 - Manage **residual risk** (including uncertainty) with conservative procedures and contingency plans...and **tell them why, not just what!**
- *Unknown Knowns: (Continuous Process Improvement)*
 - **Communications , Communications, Communications**
 - Improve data **analysis** tools and techniques (e.g. trending)
- *Unknown Unknowns: (Continuous Research, Test and Eval)*
 - Exercise **Engineering Curiosity**
 - Continuously **challenge assumptions**, models and analyses





Characteristics of a Great SR&Q Professional

- **Technically credible**
- **Embued with “Engineering Curiosity”**
- **Courageous and of high integrity**
- **Solid knowledge of requirements and rationale**
- **Good communication skills (verbal & written)**
- **Experienced in applicable field**
- **Humble yet engaged**
- **Persistent yet pragmatic**
- **Energetic and creative (“Yes if...”)**
- **Thick skin and a sense of humor (for longevity)**

GITTERDUNN...

