

Learning Hard Lessons from Columbia Decisions



“We are convinced that the management practices overseeing the Space Shuttle Program were as much a cause of the accident as the foam that struck the left wing.”

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Why is this Important?

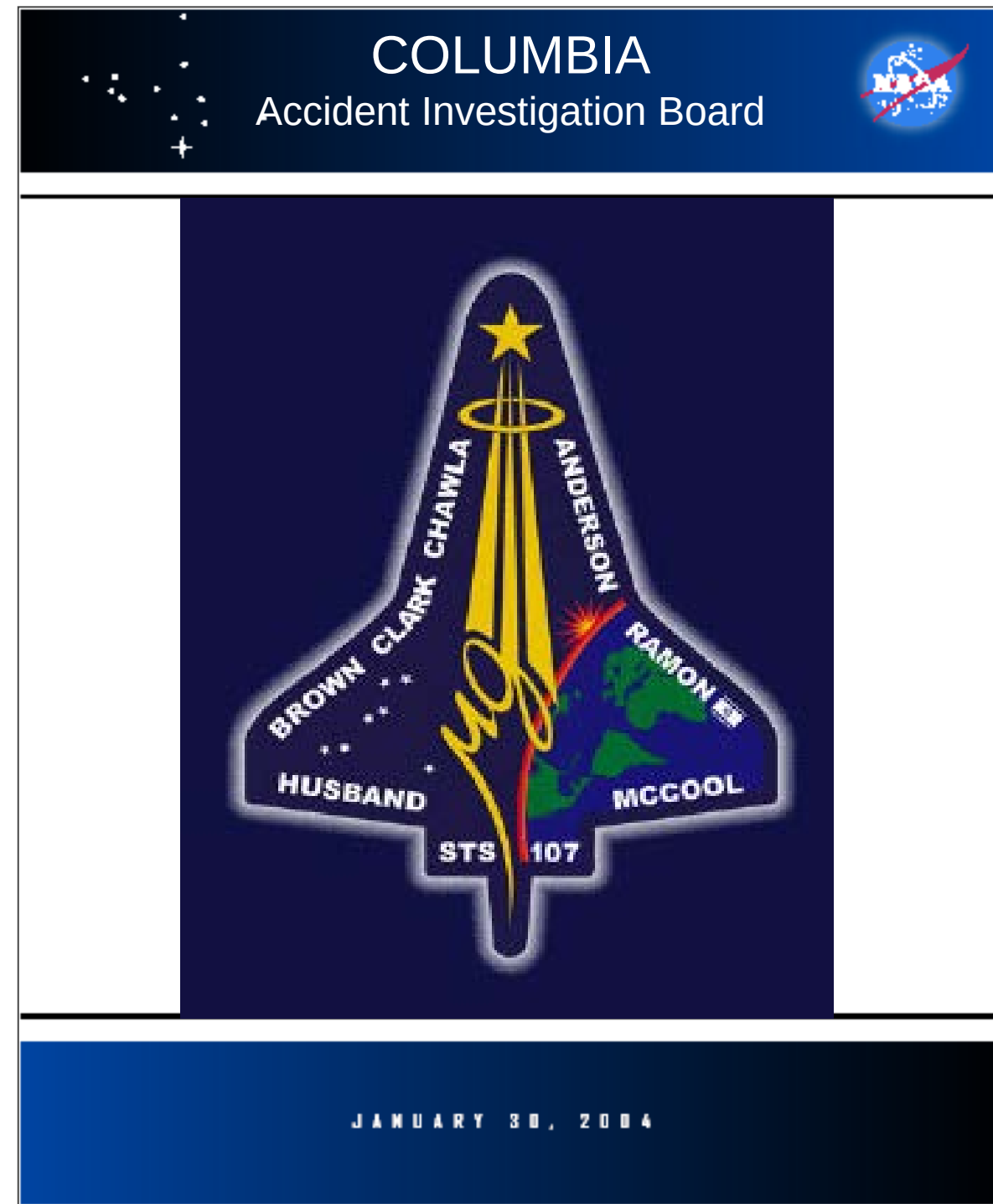
1. If you don't understand how you made a decision you have little chance of learning anything from it.
2. If you don't learn much, you will probably think you're more rational than you really are.
3. If you think you're rational you're making yourself more vulnerable to your own biases.
4. If you making biased decisions you won't understand why things don't work—see number 1 above.

Columbia- The Organizational Culture

- Foam comes off the tank and strikes the orbiter during launch.
- Actual impact site is out of camera view so on-orbit imagery was needed to characterize the damage.
- NASA failed to hear dissenting opinions and views and it did not seem plausible that foam could damage the wing.
- Management concluded there was nothing that could be done anyway.

“In our view, the NASA **organizational culture had as much to do with this accident as the foam.”**

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The Expert Opinion

- ❖ Thermal Protection Expert
 - ❖ Gave an ‘early opinion’
 - ❖ Had access to MMT
- ❖ Delivered the message Mgmt wanted to hear
 - ❖ Set a new thresh-hold for other viewpoints
 - ❖ DAT couldn’t even get approval to *get data*

Making Use of Experts

- ❖ Misuse of Experts as “Tool of Convenience”
 - ❖ Can pick and choose experts to get ‘correct answer’
- ❖ Introduces hidden decision making risks:
 - ❖ Wrong expertise being applied
 - ❖ Human factors (wanting to please)
 - ❖ Anchoring of decision maker opinions
 - ❖ Ignores or downplays further information
 - ❖ Looks for ways to justify desired opinion
- ❖ NASA Management leaned on an expert opinion early
- ❖ Undermined the perceived authority of the DAT

Decision Making Using Data

- ❖ If your conclusion would be the same either way then
 - ❖ You aren't really making a data driven decision
 - ❖ You may have simply confirmed your biases
- ❖ You are most likely worse off (decision wise)
- ❖ Better to not have data than to have bad data
 - ❖ Very DIFFICULT to RESIST this TEMPTATION

The CRATER Model

$$P = \frac{0.0195 (L / d)^{0.45} (d) (p_f)^{0.27} (V - V^*)^{2/3}}{(S_t)^{1/4} (p_t)^{1/6}}$$

P Penetration depth (Dependent variable)

L Length of foam projectile

d Diameter of foam projectile

p_f Density of foam

V Foam velocity (right angle component)

V^* Velocity required to break through tile coating

s Compressive strength of tile

p_t Density of tile

0.0195 Empirical constant

Why Use an Invalid Model?

- ❖ Empirical data based model
 - ❖ For small pieces of foam striking tile
 - ❖ Foam block was 400-640 times larger
 - ❖ Didn't know where it hit (was really a TILE model)
- ❖ Extreme extrapolation of model
 - ❖ Invalid application (correctly dismissed)
 - ❖ Should have confirmed 'UNCERTAINTY'

Believing What You Want to Be True

- ❖ Foam Can't Hurt the RCC (intuitive engineering)
- ❖ There isn't much we can do about it.
- ❖ Accept a lousy rationale
 - ❖ Haven't had any safety of flight issues in 112 flights
 - ❖ Haven't changed anything so...
 - ❖ Risk is the same so...
 - ❖ ET is safe to fly with no added risk.

Lessons in Decision Making

- ❖ Dealing with ambiguous information requires a careful approach to decision making.
- ❖ Know (choose consciously) HOW you should make the decision and then follow through:
 - ❖ Gut instinct (time is of the essence or routine)
 - ❖ Experience based (similar to previous experience)
 - ❖ Conduct study/ test since data is different/ new
 - ❖ Ask an expert (similar but unfamiliar)

Tough Words to Say

“I don’t know.”

The Take Away

- ❖ Understand how you have made decisions
- ❖ Learn from the decisions you have made
- ❖ Be in control of your decision making processes