

Managing The Unexpected

**Jacksonville Florida
February 28, 2005**



MICHIGAN
ROSS SCHOOL OF BUSINESS

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What is Reliability?

“Reliability depends on the lack of unwanted, unanticipated, and unexplainable variance in performance”

-Eric Hollnagel, 1993, p. 51

Reliability at Diablo Canyon

- “(1) The major determinant of reliability in an organization is not how greatly it values reliability or safety per se over other organizational values, but rather how greatly it *disvalues* the mis-specification, mis-estimation, and misunderstanding of things;
- (2) All else being equal, the more things that more members of an organization care about mis-specifying, mis-estimating, and misunderstanding, the higher the level of reliability that organization can hope to attain”

-Paul Schulman, 1997

Examples of High Reliability Organizations

- Nuclear power-generation plants
- Naval aircraft carriers
- Chemical production plants
- Offshore drilling rigs
- Air traffic control systems
- Incident command teams
- Wildland firefighting crews
- Hospital ER/Intensive care units
- Investment banks

Basic Message

“Mindful updating is facilitated by processes that focus on failures, simplifications, operations, resiliencies, and expertise.”

Lapses in Reliability at the Union Pacific Railroad



Preoccupation with failures:

- Inadequate reporting of slowdowns in yards.

Reluctance to simplify:

- If you want to classify freight cars, then you do that in a classification yard.

Sensitivity to operations:

- Management team stays at headquarters, intimidates those who bring 'bad news.'

Commitment to resilience:

- Workarounds evolved by the Southern Pacific are labeled as incompetent; fire people and remove slack.

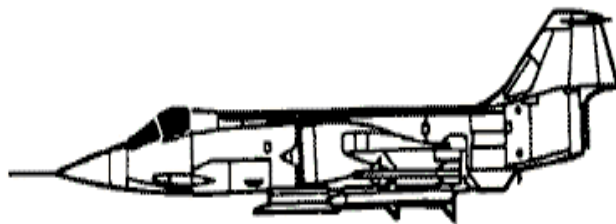
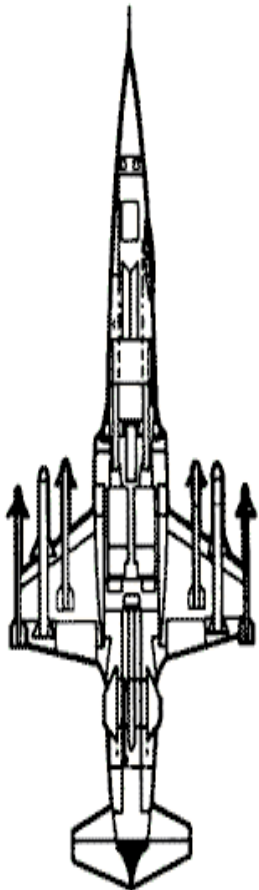
Deference to expertise:

- Top down decision-making by the authorities, not the experts.

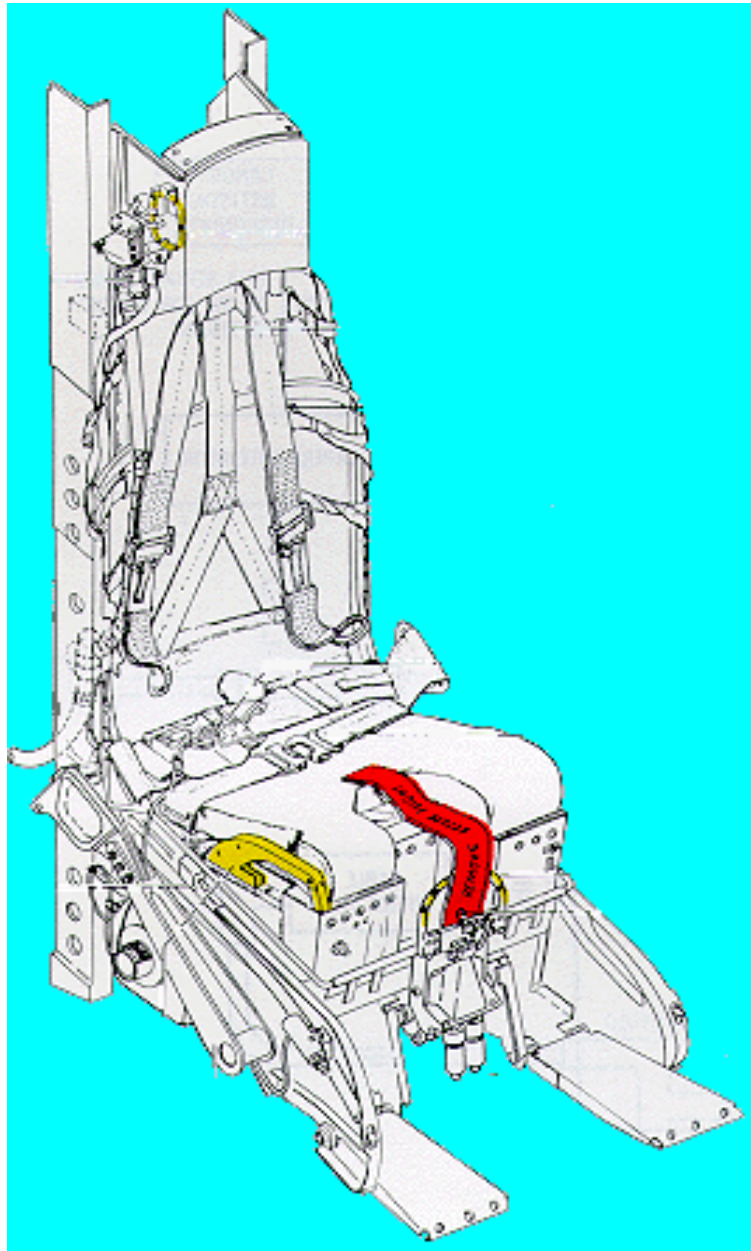
“The past settles its accounts...”

“...the ability to deal with a crisis situation is largely dependent on the structures that have been developed before chaos arrives. The event can in some ways be considered as an abrupt and brutal audit: at a moment's notice, everything that was left unprepared becomes a complex problem, and every weakness comes rushing to the forefront.”

F-104



F-104 Ejection Seat





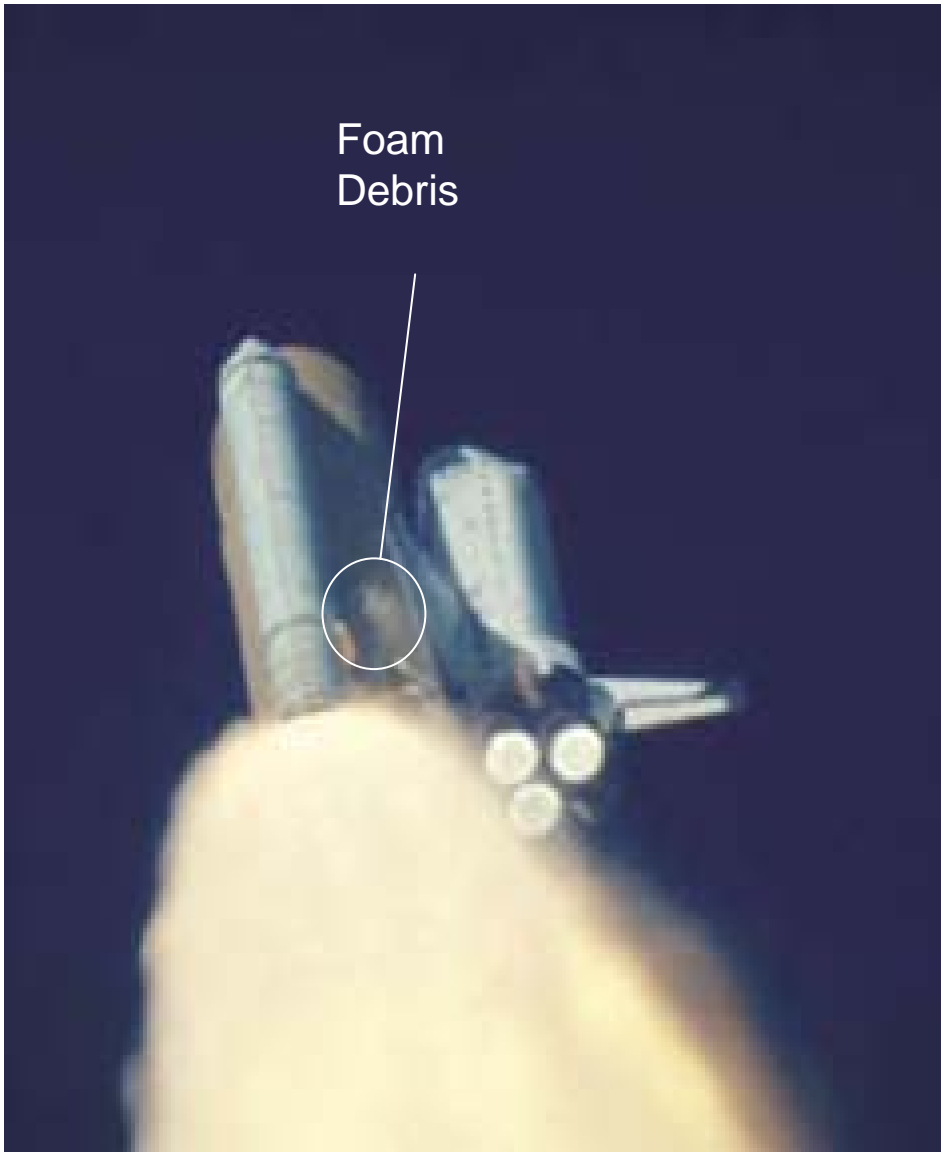


Figure 2.3-2. A shower of foam debris after the impact on Columbia's left wing. The event was not observed in real time.

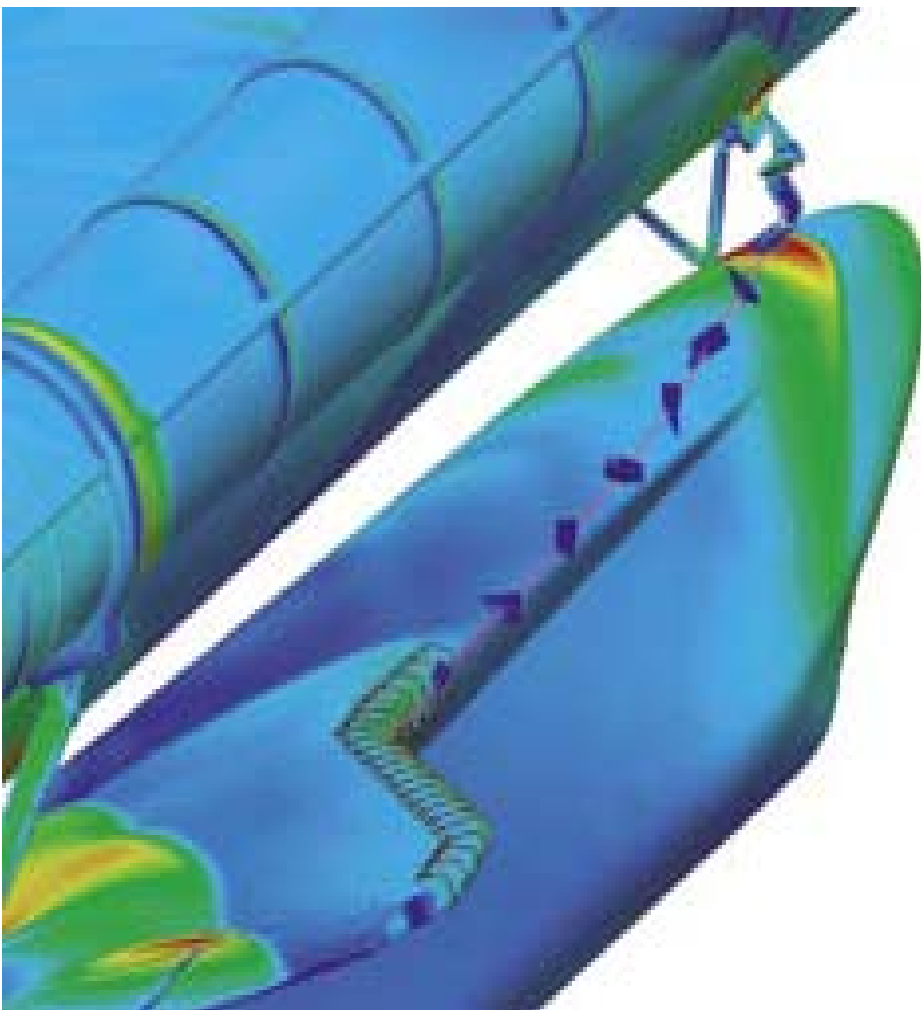


Figure 3.4-6. These are the results of a trajectory analysis that used a computational fluid dynamics approach in a program called CART-3D, a comprehensive (six-degree-of-freedom) computer simulation based on the laws of physics. This analysis used the aerodynamic and mass properties of bipod ramp foam, coupled with the complex flow field during ascent, to determine the likely position and velocity histories of the foam.



This view was taken from Dallas.
(Robert McCullough/© 2003
The Dallas Morning News)

NASA Mission STS-107 as a HRO

Preoccupation with failure.

- NASA definition of 'accepted risk' = known (mis-specified), understood (misunderstanding), tolerable (mis-estimation) threat.
- There is no failure in a 'can do' culture.
- "If not safe, say so" says poster, and yet people are asked to prove shuttle is unsafe.
- There is little room in this business for overconfidence, yet Mission Management team meets infrequently and this is interpreted as overconfidence.
- Rationale for continuing to launch was 'lousy,' yet this was not treated as a sign of a system in poor health.
- NASA did not use Challenger disaster as a case to promote learning, but Navy did use Thrasher and Scorpion disasters to educate.
- If people were afraid of losing their jobs when they disagree, how would you know that? Managers had no answer.

Reluctance to simplify

- When information gets filtered as it moves upward, top management winds up operating on a simpler view than does the bottom.
- Why would you want a photo of something that could be fixed after landing?
- The Crater model that was used to estimate effects is a simplification.
- To call the shuttle 'operational' is simpler than to call it 'experimental.'
- To call a problem "in family" is simpler than to call it "out of family".
- NASA needs to avoid oversimplification says CAIB (pg. 181).
- Multiple perspectives (conceptual slack) help you see more details and more ways to cope.

Sensitivity to operations

- Sources and reasons for imaging requests not sought out.
- People don't know proper channels for imaging request so can't follow them.
- Managers wait for dissent rather than seek it.
- "Mission management" means manage here and now, not 'next mission'.
- Debris assessment team not treated as 'problem resolution team.'
- Frontline not contacted before decision made not to seek external imaging.
- Meaning of "no" to image request is unclear.

Resilience/anticipation:

- Why assess debris if there is nothing we can do? After Apollo 13?
- Used only limited, handy resources to deal with unexpected (e.g. used Crater but not film from astronauts)
- The viewgraph 'nothing has changed' shifts attention from resilience.
- Minimal support for debris assessment team.
- Debris assessment team uses institutional channels not mission channels to get images.

Expertise/rank

- No one knew much about images and imaging (e.g. detour over Hawaii).
- Don't use Crater expertise at Huntington Beach.
- Attribute excess expertise to one supportive tile specialist.
- NASA is not a badgeless culture: who wants the images, not, what are the merits of imaging.
- How does management know if technical staff need images?


Rate Your Preoccupation with Failure


- Regard close calls and near misses as a kind of failure that reveals potential danger rather than as evidence of our success and ability to avoid danger
- We treat near misses and errors as information about the health of our system and try to learn from them

(1 = not at all, 2 = to some extent, 3 = a great deal)

MISSION	DATE	COMMENTS
STS-1	April 12, 1981	Lots of debris damage. 300 tiles replaced.
STS-7	June 18, 1983	First known left bipod ramp foam shedding event.
STS-27R	December 2, 1988	Debris knocks off tile; structural damage and near burn through results.
STS-32R	January 9, 1990	Second known left bipod ramp foam event.
STS-35	December 2, 1990	First time NASA calls foam debris "safety of flight issue," and "re-use or turn-around issue."
STS-42	January 22, 1992	First mission after which the next mission (STS-45) launched without debris In-Flight Anomaly closure/resolution.
STS-45	March 24, 1992	Damage to wing RCC Panel 10-right. Unexplained Anomaly, "most likely orbital debris."
STS-50	June 25, 1992	Third known bipod ramp foam event. Hazard Report 37: an "accepted risk."
STS-52	October 22, 1992	Undetected bipod ramp foam loss (Fourth bipod event).
STS-56	April 8, 1993	Acreage tile damage (large area). Called "within experience base" and considered "in family."
STS-62	October 4, 1994	Undetected bipod ramp foam loss (Fifth bipod event).
STS-87	November 19, 1997	Damage to Orbiter Thermal Protection System spurs NASA to begin 9 flight tests to resolve foam-shedding. Foam fix ineffective. In-Flight Anomaly eventually closed after STS-101 as "accepted risk."
STS-112	October 7, 2002	Sixth known left bipod ramp foam loss. First time major debris event not assigned an In-Flight Anomaly. External Tank Project was assigned an Action. Not closed out until after STS-113 and STS-107.
STS-107	January 16, 2003	<i>Columbia</i> launch. Seventh known left bipod ramp foam loss event.

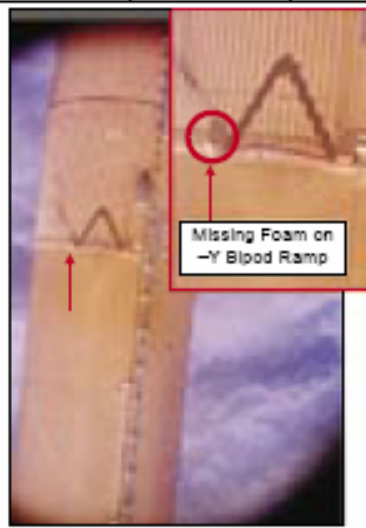
Figure 6.1-7. The Board identified 14 flights that had significant Thermal Protection System damage or major foam loss. Two of the bipod foam loss events had not been detected by NASA prior to the Columbia Accident Investigation Board requesting a review of all launch images.


SPACE SHUTTLE PROGRAM
 Space Shuttle Projects Office (MSFC)
 NASA Marshall Space Flight Center, Huntsville, Alabama





STS-112/ET-115 Bipod Ramp Foam Loss		Presenter: Jerry Swelbar, NASA/MP31
Date: October 31, 2002		Page: 3

- Issue
 - Foam was lost on the STS-112/ET-115 -Y bipod ramp (4" X 5" X 12") exposing the bipod housing SLA closeout
- Background
 - ET TPS Foam loss over the life of the Shuttle Program has never been a "Safety of Flight" Issue
 - More than 100 External Tanks have flown with only 3 documented instances of significant foam loss on a bipod ramp



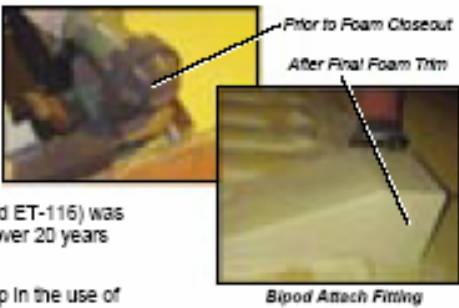
Missing Foam on -Y Bipod Ramp


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STS-112/ET-115 Bipod Ramp Foam Loss		Presenter: Jerry Swelbar, NASA/MP31
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- Rationale for Flight
 - Current bipod ramp closeout has not been changed since STS-54 (ET-51)
 - The Orbiter has not yet experienced "Safety of Flight" damage from loss of foam in 112 flights (including 3 known flights with bipod ramp foam loss)
 - There have been no design / process / equipment changes over the last 60 ETs (flights)
 - All ramp closeout work (including ET-115 and ET-116) was performed by experienced practitioners (all over 20 years experience each)
 - Ramp foam application involves craftsmanship in the use of validated application processes
 - No change in inspection / Process control / Post application handling, etc
 - Probability of loss of ramp TPS is no higher/no lower than previous flights
 - *The ET is safe to fly with no new concerns (and no added risk)*



Prior to Foam Closeout

After Final Foam Trim

Bipod Attach Fitting

Figure 6.1-5. These two briefing slides are from the STS-113 Flight Readiness Review. The first and third bullets on the right-hand slide are incorrect since the design of the bipod ramp had changed several times since the flights listed on the slide.

Rate Your Reluctance to Simplify

- People around here take nothing for granted
- People are encouraged to express different points of view

(1 = not at all, 2 = to some extent, 3 = a great deal)

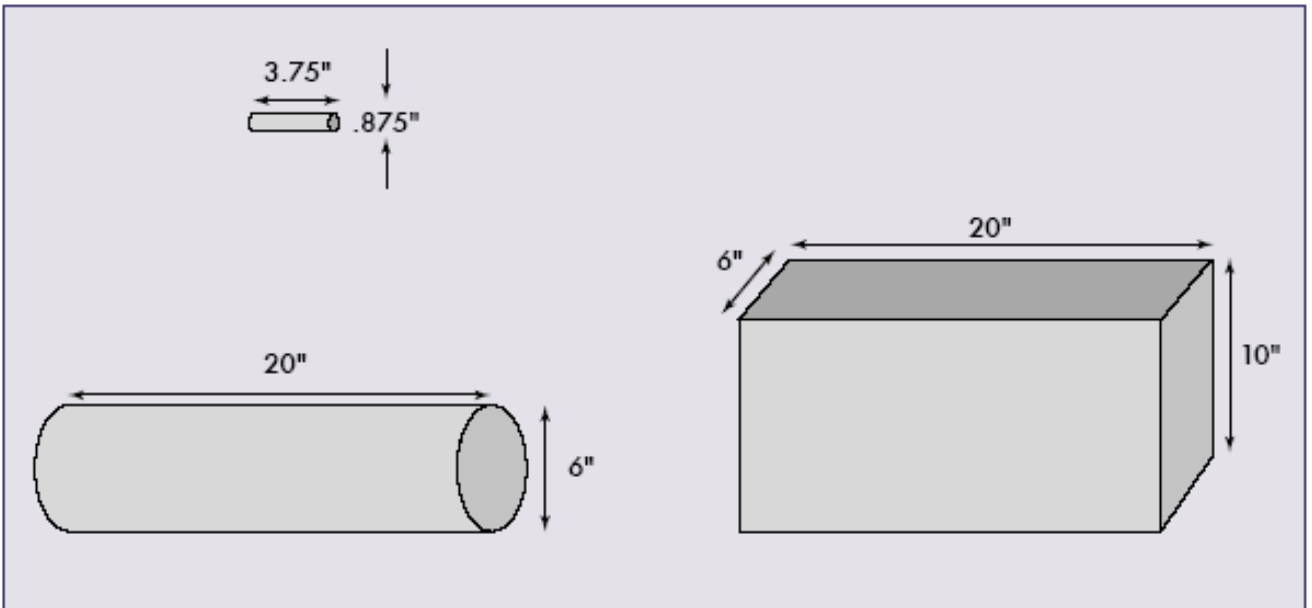


Figure 6.3-1. The small cylinder at top illustrates the size of debris Crater was intended to analyze. The larger cylinder was used for the STS-107 analysis; the block at right is the estimated size of the foam.

Rate Your Sensitivity to Operations

- During an average day, people come into enough contact with each other to build a clear picture of the situation.
- People are familiar with operations beyond one's own job.

(1 = not at all, 2 = to some extent, 3 = a great deal)

MISSED OPPORTUNITIES

1. Flight Day 4. Rodney Rocha inquires if crew has been asked to inspect for damage. No response.
2. Flight Day 6. Mission Control fails to ask crew member David Brown to downlink video he took of External Tank separation, which may have revealed missing bipod foam.
3. Flight Day 6. NASA and National Imagery and Mapping Agency personnel discuss possible request for imagery. No action taken.
4. Flight Day 7. Wayne Hale phones Department of Defense representative, who begins identifying imaging assets, only to be stopped per Linda Ham's orders.
5. Flight Day 7. Mike Card, a NASA Headquarters manager from the Safety and Mission Assurance Office, discusses imagery request with Mark Erminger, Johnson Space Center Safety and Mission Assurance. No action taken.
6. Flight Day 7. Mike Card discusses imagery request with Bryan O'Connor, Associate Administrator for Safety and Mission Assurance. No action taken.
7. Flight Day 8. Barbara Conte, after discussing imagery request with Rodney Rocha, calls LeRoy Cain, the STS-107 ascent/entry Flight Director. Cain checks with Phil Engelauf, and then delivers a "no" answer.
8. Flight Day 14. Michael Card, from NASA's Safety and Mission Assurance Office, discusses the imaging request with William Readdy, Associate Administrator for Space Flight. Readdy directs that imagery should only be gathered on a "not-to-interfere" basis. None was forthcoming.

Rate Your Commitment to Resilience

- There is a concern with building people's competence and response repertoires.
- People have a number of informal contacts that they sometimes use to solve problems.

(1 = not at all, 2 = to some extent, 3 = a great deal)

6.4 POSSIBILITY OF RESCUE OR REPAIR

To put the decisions made during the flight of STS-107 into perspective, the Board asked NASA to determine if there were options for the safe return of the STS-107 crew. In this study, NASA was to assume that the extent of damage to the leading edge of the left wing was determined by national imaging assets or by a spacewalk. NASA was then asked to evaluate the possibility of:

1. Rescuing the STS-107 crew by launching *Atlantis*. *Atlantis* would be hurried to the pad, launched, rendezvous with *Columbia*, and take on *Columbia*'s crew for a return. It was assumed that NASA would be willing to expose *Atlantis* and its crew to the same possibility of External Tank bipod foam loss that damaged *Columbia*.
2. Repairing damage to *Columbia*'s wing on orbit. In the repair scenario, astronauts would use onboard materials to rig a temporary fix. Some of *Columbia*'s cargo might be jettisoned and a different re-entry profile would be flown to lessen heating on the left wing leading edge. The crew would be prepared to bail out if the wing structure was predicted to fail on landing.

In its study of these two options, NASA assumed the following timeline. Following the debris strike discovery on Flight Day Two, Mission Managers requested imagery by Flight Day Three. That imagery was inconclusive, leading to a decision on Flight Day Four to perform a spacewalk on Flight Day Five. That spacewalk revealed potentially catastrophic damage. The crew was directed to begin conserving consumables, such as oxygen and water, and Shuttle managers began around-the-clock processing of *Atlantis* to prepare it for launch. Shuttle managers pursued both the rescue and the repair options from Flight Day Six to Flight Day 26, and on that day (February 10) decided which one to abandon.

The NASA team deemed this timeline realistic for several reasons. First, the team determined that a spacewalk to inspect the left wing could be easily accomplished. The team then assessed how the crew could limit its use of consumables to determine how long *Columbia* could stay in orbit. The limiting consumable was the lithium hydroxide canisters, which scrub from the cabin atmosphere the carbon dioxide the crew exhales. After consulting with flight surgeons, the team concluded that by modifying crew activity and sleep time carbon dioxide could be kept to acceptable levels until Flight Day 30 (the morning of February 15). All other consumables would last longer. Oxygen, the next most critical, would require the crew to return on Flight Day 31.

Repairing Damage On Orbit

The repair option (see Figure 6.4-1), while logistically viable using existing materials onboard *Columbia*, relied on so many uncertainties that NASA rated this option "high risk." To complete a repair, the crew would perform a spacewalk to fill an assumed 6-inch hole in an RCC panel with heavy metal tools, small pieces of titanium, or other metal scavenged from the crew cabin. These heavy metals, which would help protect the wing structure, would be held in place during

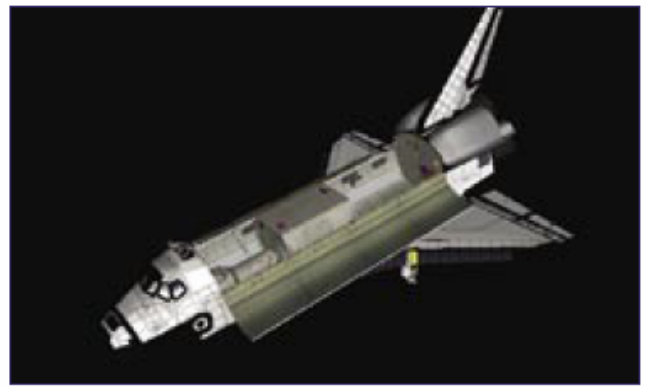
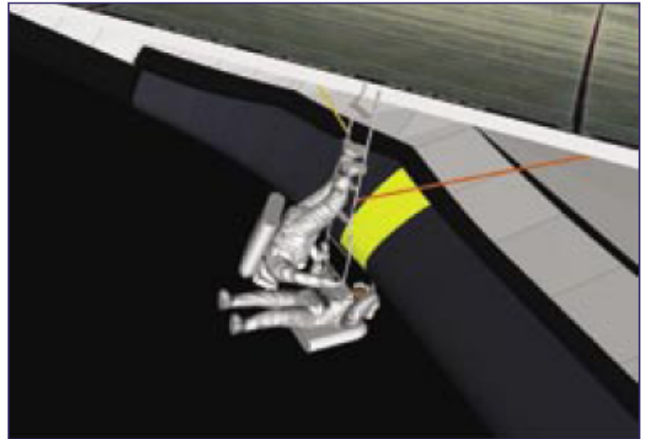


Figure 6.4-1. The speculative repair option would have sent astronauts hanging over the payload bay door to reach the left wing RCC panels using a ladder scavenged from the crew module.



re-entry by a water-filled bag that had turned into ice in the cold of space. The ice and metal would help restore wing leading edge geometry, preventing a turbulent airflow over the wing and therefore keeping heating and burn-through levels low enough for the crew to survive re-entry and bail out before landing. Because the NASA team could not verify that the repairs would survive even a modified re-entry, the rescue option had a considerably higher chance of bringing *Columbia*'s crew back alive.

Rescuing the STS-107 Crew with Atlantis

Accelerating the processing of *Atlantis* for early launch and rendezvous with *Columbia* was by far the most complex task in the rescue scenario. On *Columbia*'s Flight Day Four, *Atlantis* was in the Orbiter Processing Facility at Kennedy Space Center with its main engines installed and only 41 days from its scheduled March 1 launch. The Solid Rocket Boosters were already mated with the External Tank in the Vehicle Assembly Building. By working three around-the-clock shifts seven days a week, *Atlantis* could be readied for launch, with no necessary testing skipped, by February 10. If launch processing and countdown proceeded smoothly, this would provide a five-day window, from February 10 to February 15, in which *Atlantis* could rendezvous with *Columbia* before *Columbia*'s consumables ran out. According to records, the weather on these days allowed a launch. *Atlantis* would be launched with a crew of four: a command-

Flexibility in Trying Times

“In highly uncertain circumstances, when lives were immediately at risk, management failed to defer to its engineers and failed to recognize that different data standards—qualitative, subjective, and intuitive—and different processes—democratic rather than protocol and chain of command—were more appropriate.”

-CAIB report, p. 201

Rate Your Deference to Expertise

- If something out of the ordinary happens, people know who has the expertise to respond
- People in this organization value expertise and experience over hierarchical rank

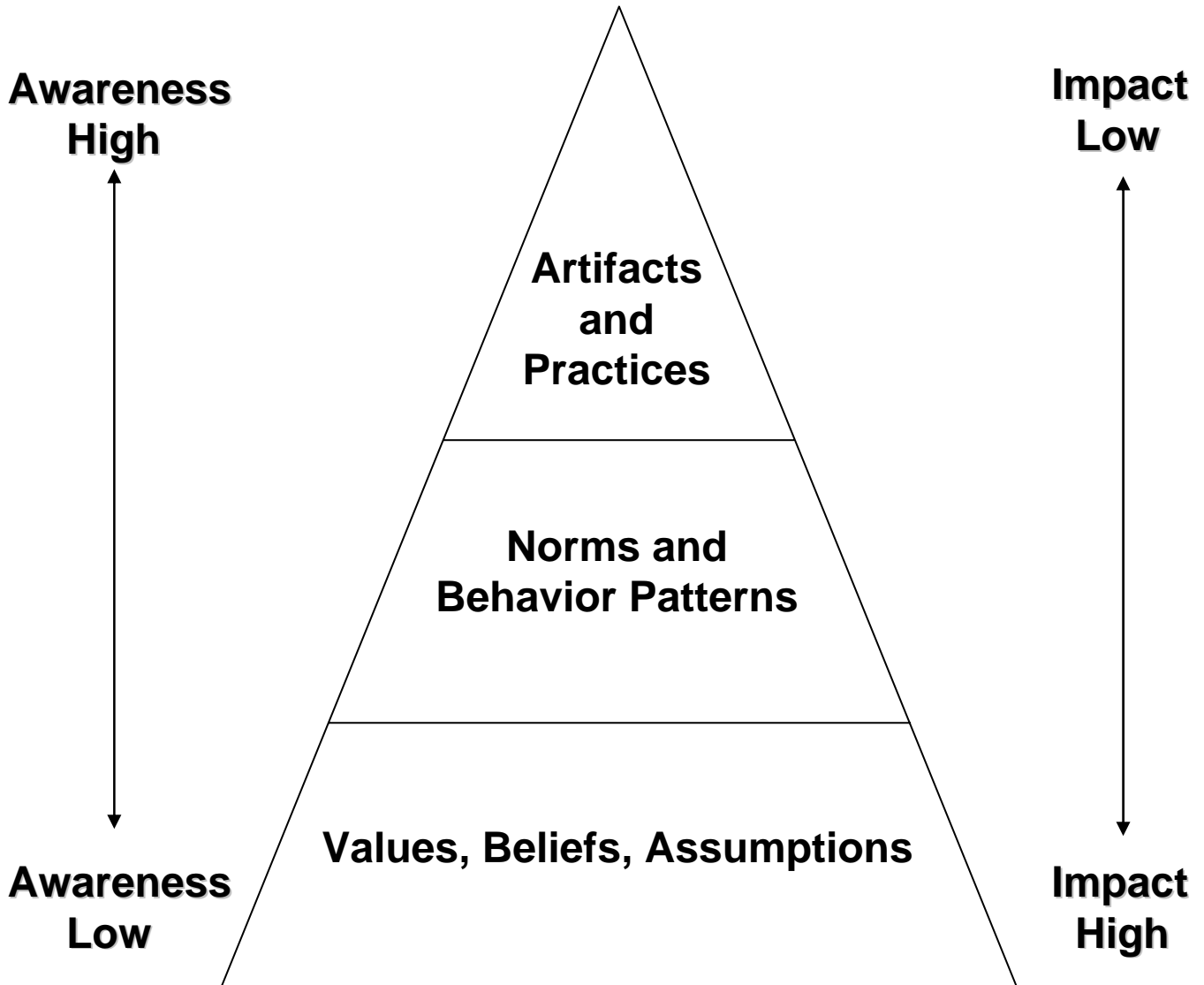
(1 = not at all, 2 = to some extent, 3 = a great deal)

Deference to Expertise in NASA

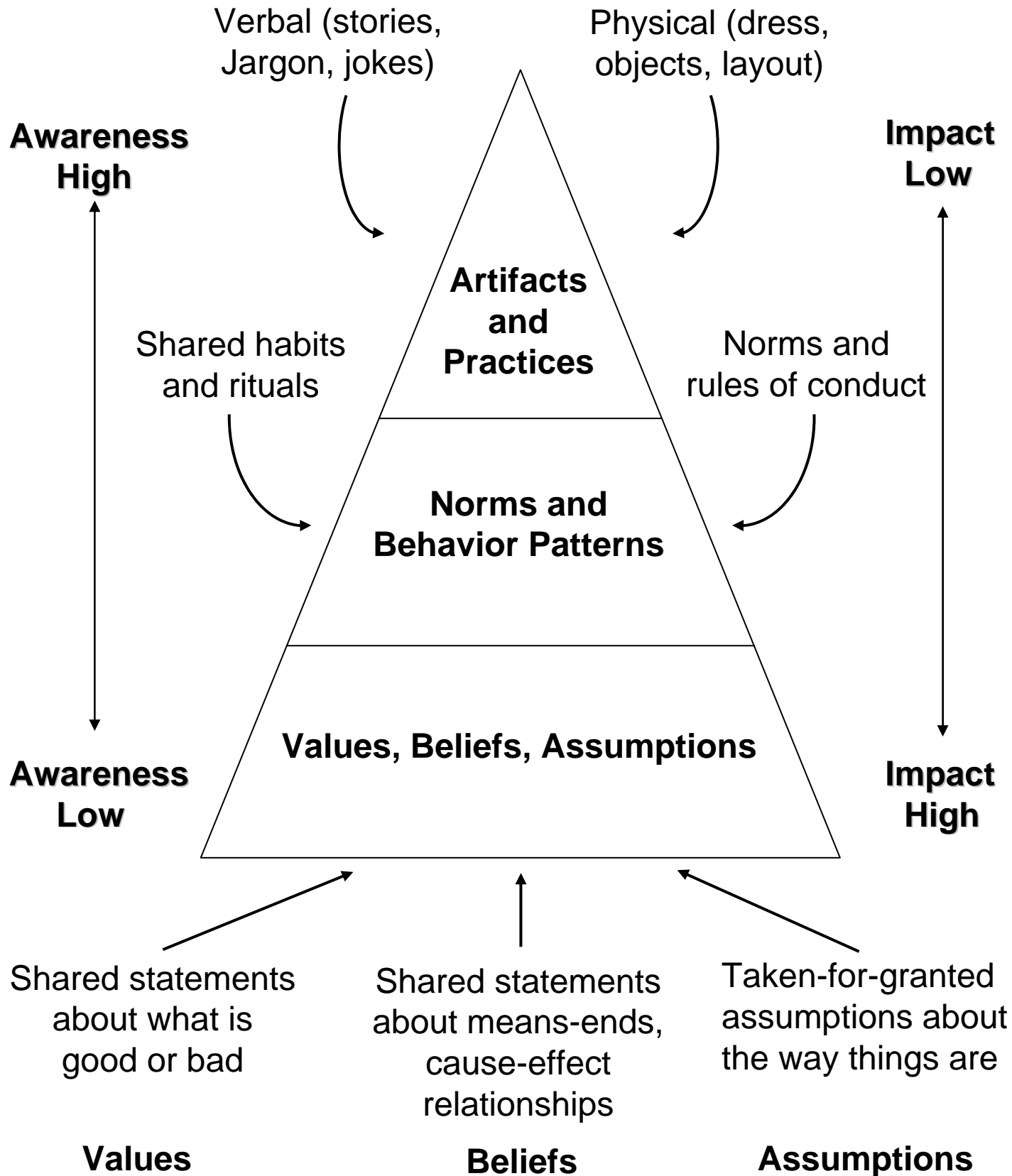
“NASA’s culture of bureaucratic accountability emphasized chain of command, procedure, following the rules, and going by the book....Allegiance to hierarchy and procedure had replaced deference to NASA engineers’ technical expertise”

-CAIB report, p. 200

Understanding Culture



Understanding Culture



Toward a Mindful Culture

- Strive for an “informed culture”— a culture that creates and sustains intelligent wariness.
- Informed cultures result from four co-existing subcultures:
 - ◆ **Reporting culture:** What gets reported when people make errors or experience near misses?
 - ◆ **Just culture:** How do people apportion blame when something goes wrong?
 - ◆ **Flexible culture:** How readily can people adapt to sudden and radical increments in pressure, pacing, and intensity?
 - ◆ **Learning culture:** How adequately can people convert the lessons that they have learned into reconfigurations of assumptions, frameworks, and action?

Being Mindful Means to Pay Attention in a Different Way

- You **STOP** concentrating on those things that confirm your hunches, are pleasant, feel certain, seem factual, are explicit, and that others agree on!
- You **START** concentrating on things that disconfirm, are unpleasant, feel uncertain, seem possible, are implicit, and are contested!

To Be Mindful

Is to “See more Clearly”

Not to Think Harder and Longer

- See where your model didn't work, or see indicators you missed that signaled expectations weren't being filled (failure)
- Strip away labels, stereotypes that conceal differences among details (simplification)
- Focus on what is happening here and now (operations)
- See new uses for old resources through improvisation and making do (resilience)
- Discover people who understand a situation better than you do and defer to them (expertise)

A Mindful Infrastructure for High Reliability

Processes

Preoccupation with Failure

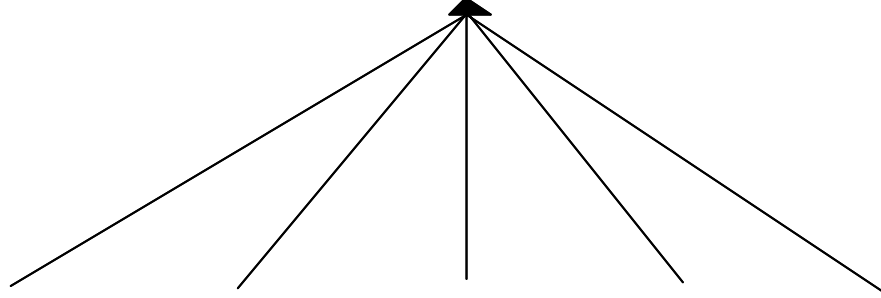
Reluctance to Simplify

Interpretations

Sensitivity to Operations

Commitment to Resilience

Deference to Expertise



Plans and Their Drawbacks

- Plans influence what people see, what they take for granted, what they choose to ignore, and how easy it is for them to spot small problems that are growing.
- Plans focus attention on what we expect and what we can do, which leaves out many potentially crucial details.
- A heavy investment in plans can limit our view of our capabilities to those we now have and expect to use.

TENERIFE ACCIDENT, March 27, 1977

KLM 4805, 747 from Amsterdam to Canary Islands.

PAA 1736, 747 from LAX, JFK to Canary Islands.

Bomb exploded in Canary Islands terminal and there was a warning of a second bomb so airport was closed.

Both planes diverted to Los Rodeos airport at Tenerife.

KLM landed at Tenerife at 13:38, PAA at 14:15.

KLM's passengers did leave the airplane, and all but one, the tour group guide, reboarded.

PAA passengers stayed on their plane the entire time.

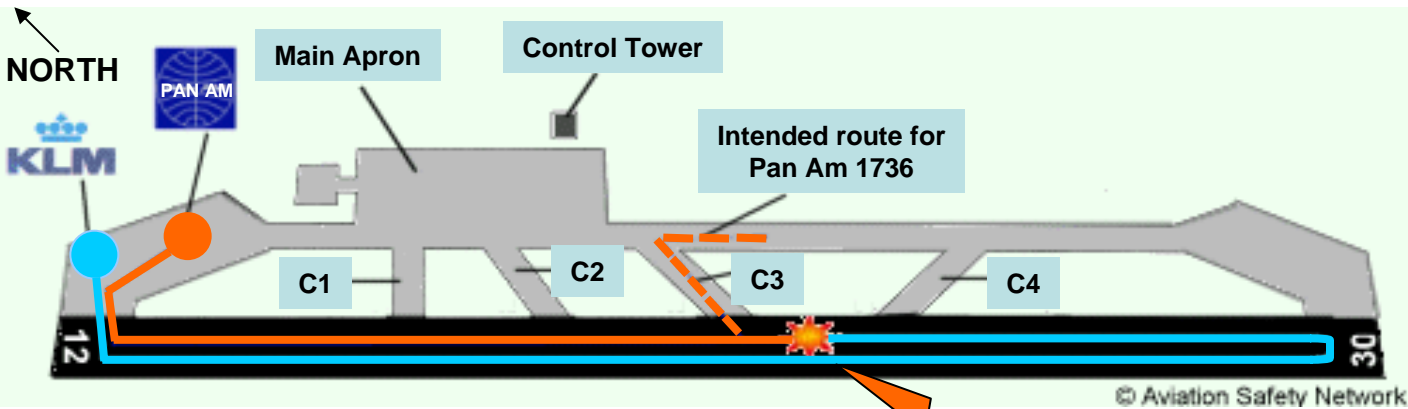
KLM called tower at 16:56 for permission to taxi because the airport was reopened (3-1/2 hour delay).

KLM was first directed to go down runway parallel to takeoff runway and then this was amended to go down the takeoff runway and make a 180 degree turn and await further instruction.

After making the turn they reported "we are at takeoff" and started moving.

Collision at 17:06:50 – KLM 234 passengers, 14 crew; PAA 380 passengers, 16 crew; 70 survived of which 9 later died.

**RUNWAY = 11,154.8 FT. LONG X 147.6 FT. WIDE
(3,400 METERS X 45 METERS)**



SCALE

0	656	1,312	1,969	2,625	3,280	FEET
0	200	400	600	800	1,000	METERS

- PATH OF PAN AM
- - - INTENDED TAXI PATH OF PAN AM
- PATH OF KLM

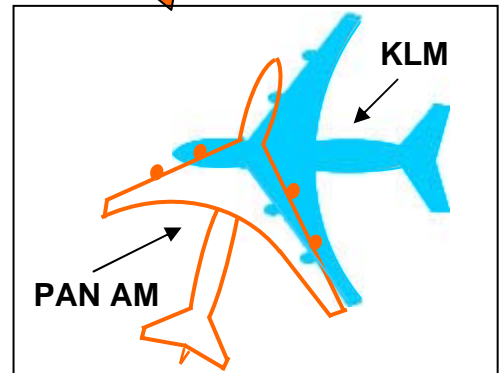


Diagram of the Los Rodeos Airport in Santa Cruz de Tenerife shows where the two Boeing 747s collided. Visibility at the time of the accident was approximately 900 ft. due to heavy fog. The Pan American 747 was backtracking down active Runway 30 with the intention of taking the high-speed turnoff C-4 (since intended turnoff at C-3 was missed) to the parallel taxiway, unusable because of the congestion on the ramp from other aircraft.

Other possible causes:

Route and pilot-instruction experience— Although the captain had flown for many years on European and intercontinental routes, he had been an instructor for more than 10 years, which relatively diminished his familiarity with route flying. Moreover, on simulated flights, which are so customary in flying instruction, the training pilot normally assumes the role of controller—that is, he issues takeoff clearances. In many cases no communications whatsoever are used in simulated flights, and for this reason takeoff takes place without clearance.

Cockpit Management Attitudes

1. Decision making ability **not** as good in emergencies.
2. Encourage First Officers to question decisions.
3. Be aware of personal problems of fellow crewmembers.
4. Captain should **not** take control and fly in emergencies.
5. Disagree that FOs should only take control in the event of Captain incapacitation.
6. Disagree that FOs should only question Captain decisions when they threaten safety of flight.
7. Pilot flying should **verbalize** his plans.
8. Pilots obligated to mention personal stress or physical problems.
9. Disagree that Captains should employ same style of management in all situations with all crewmembers.
10. Agree that conversation in cockpit should be kept to minimum except for operational matters.
11. Disagree that instructions to crewmembers should be general and non-specific.
12. Training one of Captains most important responsibilities.
13. Relaxed attitude essential to cooperative flightdeck.
14. Captain's responsibilities include coordinating cabin crew.
15. Disagree that Captain should give direct orders for procedures in all situations.

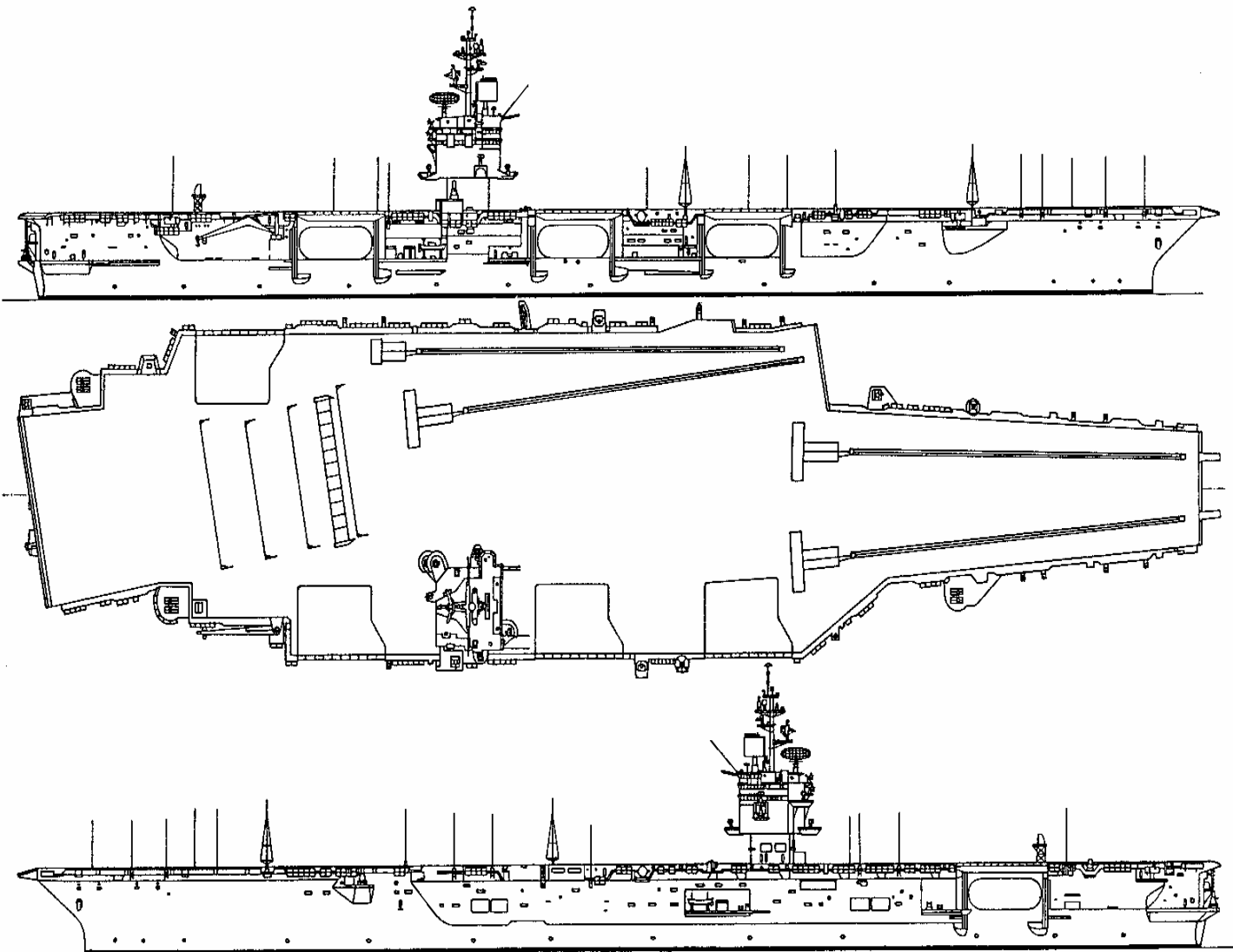
NOTE: For each item, the opinion of the pilots rated as superior is given.

*From Helmreich, Foushee, Benson, & Russini (1985). **Cockpit resource management: Exploring the attitude performance linkage.***

Life on a Carrier

So you want to understand an aircraft carrier? Well, just imagine that it's a busy day, and you shrink San Francisco Airport to only one short runway and one ramp and one gate. Make planes take off and land at the same time, at half the present time interval, rock the runway from side to side, and require that everyone who leaves in the morning returns that same day. Make sure the equipment is so close to the edge of the envelope that it's fragile. Then turn off the radar to avoid detection, impose strict controls on radios, fuel the aircraft in place with their engines running, put an enemy in the air, and scatter live bombs and rockets around. Now wet the whole thing down with sea water and oil, and man it with 20-year-olds, half of whom have never seen an airplane up-close. Oh, and by the way, try not to kill anyone”

The Aircraft Carrier ENTERPRISE



The 'mid-life' conversion of *Enterprise* was undertaken between 1979 and 1982. All three drawings show the post-

conversion appearance of the ship, showing the altered island as well as the updated combat systems.

Flight Operations

As Representative Example of HRO

➤ Preoccupation with Failure

- ◆ Carrier example: Every landing is graded, televised throughout the ship, and small failures are treated as a system problem.
- ◆ Reports errors no matter how inconsequential and worry about liabilities of success.

Preoccupation with Failures

- HROs are preoccupied with all failures, especially small ones.
- Small things that go wrong are often early warning signals of deepening trouble and give insight into the health of the whole system.
- If you catch problems before they grow bigger, you have more possible ways to deal with them.
- But, we have a tendency to ignore or overlook our failures (which suggest we are not competent) and focus on our successes (which suggest we are competent).

Learning from Failure is Hard

- Learning moments are short-lived
 - ◆ We have selective memories: “on the day of the actual battle naked truths may be picked up for the asking...by the following morning they have already begun to get into their uniforms” (p. 58, MTU)
- Learning requires some preconditions:
 - ◆ psychological safety (tolerance for mistakes of commission)
 - ◆ learning orientation (intolerance for mistakes of omission)
 - ◆ efficacy (belief that we can handle what comes up)

Winston Churchill's Debriefing Protocol

- Why didn't I know?
- Why wasn't I told?
- Why didn't I ask?
- Why didn't I tell what I knew?

Flight Operations

As Representative Example of HRO

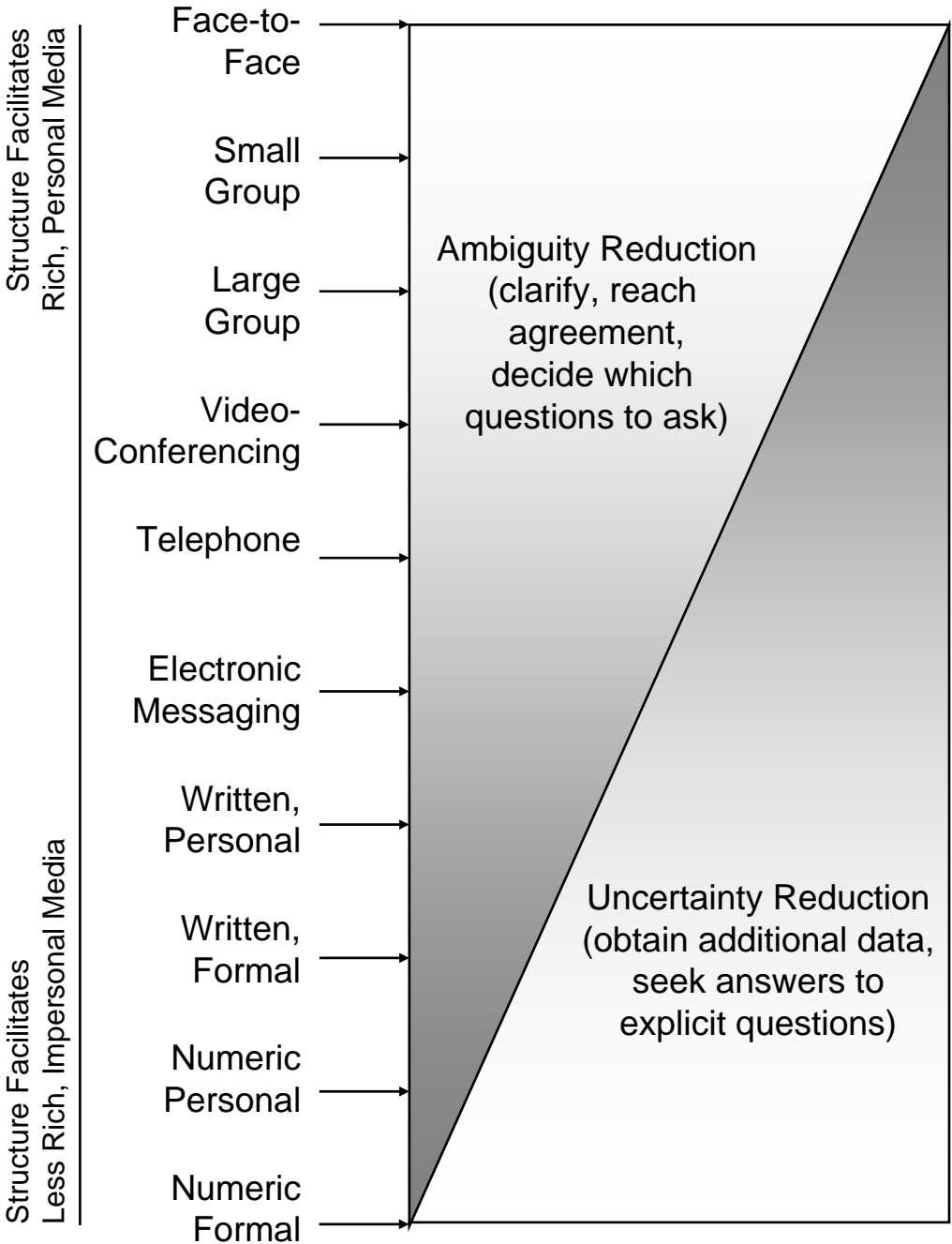
➤ Reluctance to Simplify Interpretations

- ◆ Carrier example: Take nothing for granted. Check takeoff in multiple ways. Pilot won't reduce power until catapult officer stands in front of plane.
- ◆ It takes variety to control variety (e.g. CAG on carrier who has flown all the aircraft he controls; loan officer who has made good and bad loans can sense more; a psychiatrist whose neuroses are under control).

Reluctance to Simplify Interpretations

- Our expectations help us simplify our world and steer us away from disconfirming evidence.
- Basic idea is:
 - ◆ we see what we expect to see
 - ◆ we see what we have labels to see
 - ◆ we see what we have skills to manage
- We need to create more varied and differentiated expectations in order to better understand what we face.
- Our goal is requisite variety.

Reducing Ambiguity or Uncertainty



Flight Operations

As Representative Example of HRO

➤ Sensitivity to Operations

- ◆ Carrier example: Continuous communication and all observe ops.
- ◆ Maintain the big picture of ops.
 - Premium on real-time detailed information.
 - Know how the system works.
 - Talk all the time.

Operations-Sensitive Leadership

1. Speak up (knowledge lies between heads).
2. Encourage others to speak up and ask questions.
3. Check for comprehension; acknowledge what you hear.
4. Be aware of how you react to pressure; tell others.
5. Verbalize your plans.
6. Reduce pressure by changing importance, demands, abilities.
7. Overlearn new routines.

Flight Operations

As Representative Example of HRO

➤ Commitment to Resilience

- ◆ Carrier example: Improvise. Dick Martin drives Vinson backward during storm in 1983 to reduce wind speed over the deck.
- ◆ Don't forget that it's an unknowable, unpredictable, incomprehensible world. You can't foresee everything.

Resilient Groups

1. Skilled at improvisation
 - ◆ deep knowledge of basics
 - ◆ recombine understandings on the spot
 - ◆ improvise on something

2. Adopt attitude of wisdom
 - ◆ more you know, more you don't know
 - ◆ avoid overconfidence, overcaution
 - ◆ near miss = danger in guise of safety
> safety in guise of danger

3. Practice respectful interaction
 - ◆ provide trustworthy reports
 - ◆ trust the reports of partners
 - ◆ resolve differences while maintaining self-respect

Flight Operations

As Representative Example of HRO

◆ Deference to Expertise

- ◆ Carrier example: Squad boss may override higher-ranking people in tower when his pilots get in trouble because he knows their quirks.
- ◆ Important decisions move to those most expert to make them. Migrating decisions. The frontline knows a lot.

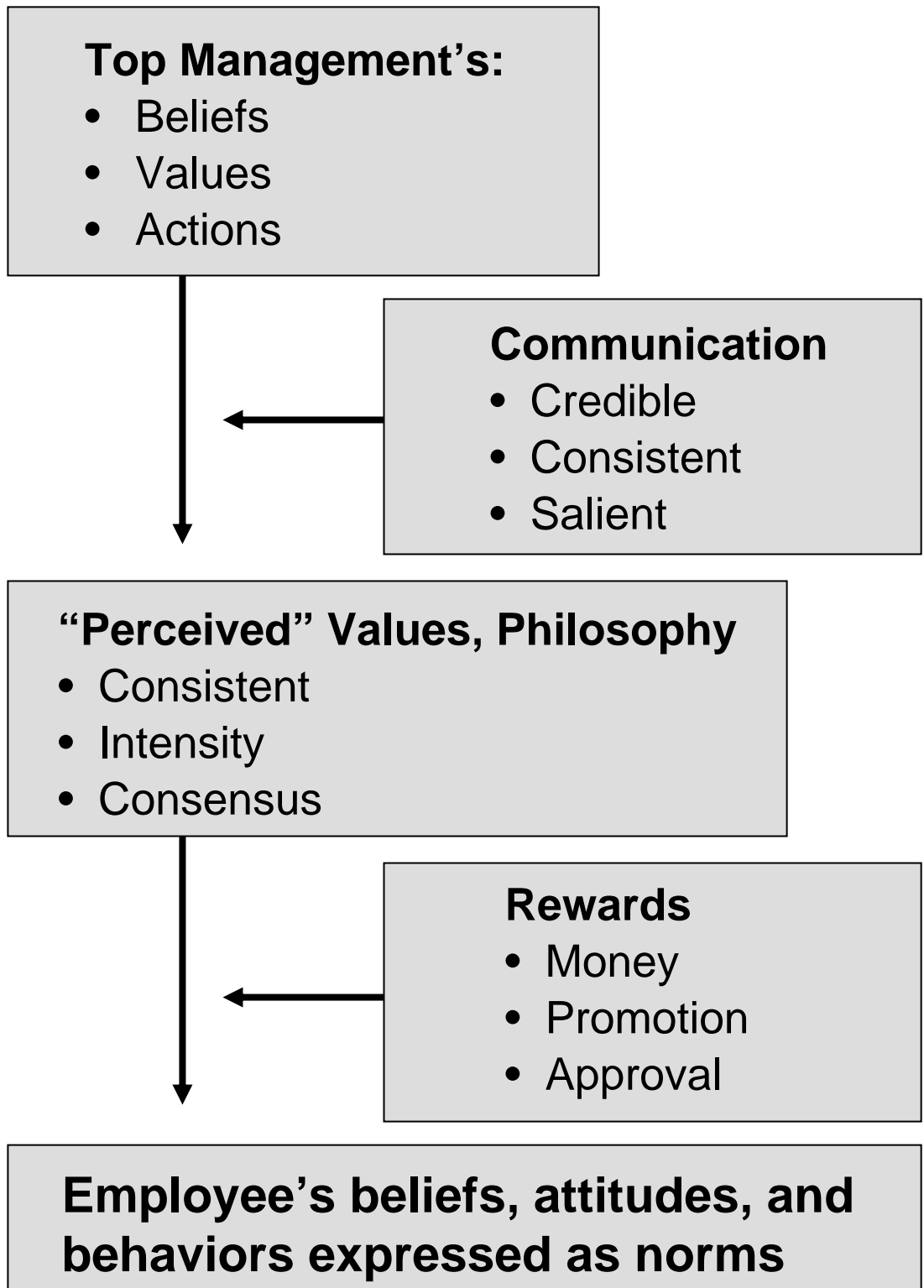
Defer to Expertise

- HROs shift decisions away from formal authority toward expertise and experience.
- HROs have flexible decision making structures; their networks do not have a fixed central player who can mistakenly assume that she/he knows everything.
- Decision making migrates to experts at all levels of the hierarchy during high tempo times.

Fallacy of Centrality

- Because I don't know about this event, it must not be going on.
- Experts overestimate the likelihood that they would surely know about a phenomenon if it actually were taking place.
- Example: Battered Child Syndrome is “discovered” in 1960.

How Leaders Shape Culture



Sensemaking vs Decisionmaking

“If I make a decision it is a possession; I take pride in it; I tend to defend it and not to listen to those who question it.

If I make sense, then this is more dynamic and I listen and I can change it. A decision is something you polish.

Sensemaking is a direction for the next period.”

--Paul Gleason

Why Firefighters Don't Drop Their Tools

LISTENING

People literally or figuratively can't hear the necessity for change.

JUSTIFICATION

No convincing reason for change.

TRUST

Don't trust the person who tells them to change.

CONTROL

Feel more in control if keep the old way.

SKILL AT DROPPING

Lack skills to drop tools.

SKILL AT REPLACEMENT

Lack knowledge of new alternative and don't trust it.

FAILURE

To drop tools is to admit failure.

SOCIAL

No one else is dropping tools.

CONSEQUENCES

Assume change won't make that big a difference.

IDENTITY

I am nothing without my tools, they define me.

“In pursuit of
knowledge, every day
something is acquired;
In pursuit of wisdom,
every day something is
dropped.”

-LaoTzu

Explain Yourself

Situation: Here's what I think we face

Task: Here's what I think we should do

Intent: Here's why

Concern: Here's what we need to watch

Calibrate: Now talk to me

Mismanaging the Unexpected: An Abrupt and Brutal Audit

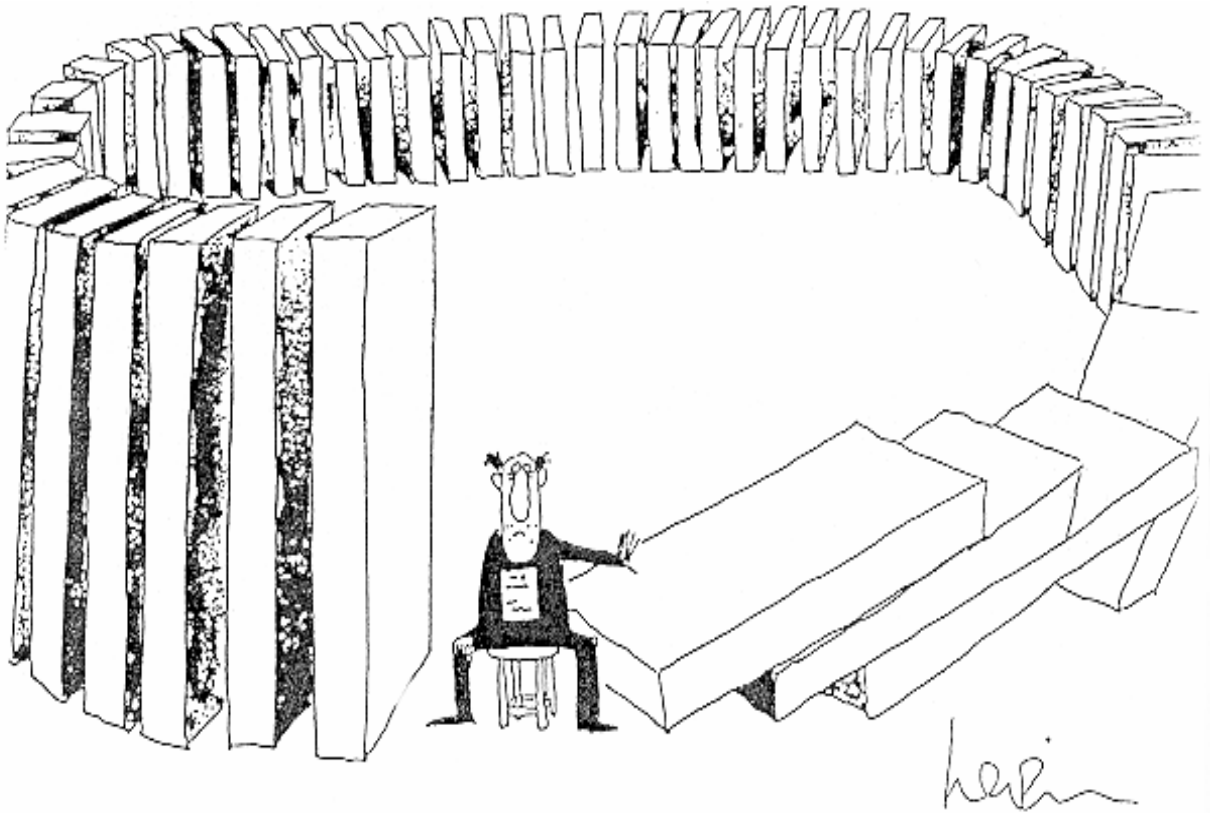


Illustration by Levin; © 1976 The New Yorker Magazine, Inc.

Reframe Strategy As: Errors We Don't Want to Make

Boss says:

Here's my strategy.

Here's what is important to me.

You translate:

Here are errors I don't want to
make!

Here is where I need reliable
performance!

Organizing for Reliable Work

Summary of Key Ideas #1

High reliability systems are attentive to failures, simplifications, operations, resilience, and distributed expertise. The five processes can be thought of as hard-won lessons in the continuing “struggle for alertness” that high reliability organizations face every day.

1. Preoccupation with failure: Systems with higher reliability worry chronically that analytic errors are embedded in ongoing activities and that unexpected failure modes and limitations of foresight may amplify those analytic errors. The people who operate and manage high reliability organizations “assume that each day will be a bad day and accordingly. but this is not an easy state to sustain, particularly when the thing about which one is uneasy has either not happened, or has happened a long time ago, and perhaps to another organization” (Reason, 1997, p. 37). These systems have been characterized as consisting of “collective bonds among suspicious individuals: and as systems that institutionalize disappointment. To institutionalize disappointment means, in the words of the head of Pediatric Critical Care at Loma Linda Childrens’ Hospital, “to constantly entertain the thought that we have missed something.”

2. Reluctance to simplify interpretations: All organizations have to ignore most of what they see in order to get work done. The crucial issue is whether their simplified diagnoses force them to ignore key sources of unexpected difficulties. Mindful of the importance of this tradeoff, systems with higher reliability restrain their temptations to simplify. They do so through such means as diverse checks and balances, adversarial reviews, and cultivation of multiple perspectives. At the Diablo Canyon nuclear power plant people preserve complexity in their interpretations by reminding themselves of two things: (1) we have not yet experienced all potential failure modes that could occur here; (2) we have not yet deduced all potential failure modes that could occur here.

Organizing for Reliable Work

Summary of Key Ideas #2

- 3. Sensitivity to operations:** People in systems with higher reliability tend to pay close attention to operations. Everyone, no matter what his or her level, values organizing to maintain situational awareness. Resources are deployed so that people can see what is happening, can comprehend what it means, and can project into the near future what these understandings predict will happen. In medical care settings sensitivity to operations often means that the system is organized to support the bedside caregiver.
- 4. Cultivation of resilience:** Most systems try to *anticipate* trouble spots, but the higher reliability systems also pay close attention to their capability to improvise and act without knowing in advance what will happen. Reliable systems spend time improving their capacity to do a quick study, to develop swift trust, to engage in just-in-time learning, to simulate mentally, and to work with fragments of potential relevant past experience.
- 5. Willingness to organize around expertise:** Reliable systems let decisions “migrate” to those with the expertise to make them. Adherence to rigid hierarchies is loosened, especially during high tempo periods, so that there is a better matching of experience with problems.

—adapted from Karl E. Weick & Kathleen M. Sutcliffe, “Managing the Unexpected,” Jossey-Bass, 2001

Use The Five Processes As a Framework to Dig Into Your Failures. Did I fail...

1. Because I was too defensive? (I focused only on our successes [failure]).
2. Because I had a simple picture? (I failed to see gray and saw only black and white [simplification]).
3. Because I was too detached? (I failed to experience frontline operations [operations]).
4. Because I was too rigid? (I could not bounce back, improvise, make do, reinvent uses for whatever resources I did have at hand [resilience]).
5. Because I lacked expertise? (I neither admitted it, saw it, or had enough respect for others to spot it and defer to their expertise [expertise]).

Before Something Unexpected Happens Ask Yourself...

1. Can I see weak signals of failure and make sense of them?
(*Failure*, how healthy is the system).
2. How differentiated are the labels I apply to a situation? (e.g., I thought they could fill that order in a week, *Simplification*).
3. Am I aware of the unfolding situation? (*Operations*).
4. Do I have the skills to make do?
(*Resilience*).
5. Who knows how to do what?
(*Expertise*).

Stages in Understanding

- Superficial
Simplicity
- Confused
Complexity
- Profound
Simplicity

How Culture Is Changed

- Never start with the idea of changing culture. Think of your culture as a source of strength (it is the residue of your past successes!).
- **Start** with the problem or issue the organization faces and try to clarify the concrete business issue and ask yourself, how is our culture hindering resolving this issue?
- Wherever possible try to build on existing strengths rather than attempting to change those elements that may be weaknesses.

(from Schein, 1985)

Small Wins Are Opportunistic Steps

1. Planned logical steps work best in a

- stable environment
- where there is agreement on goals
- where there is agreement on means to those goals, and
- where earlier steps don't unravel.

2. Small wins are opportunistic first, and logical second

- a. Easy steps defined by opportunity
- b. “What can I do right now?” NOT “What is the next logical step?”
- c. Small wins often scattered but move in same direction
- d. Often move away from bad conditions
- e. Small wins signal intentions
- f. Small wins uncover goals that CAN be achieved

3. Small wins set several things in motion

- a. Impossible to foresee all outcomes
- b. All outcomes can be claimed as “evidence”

Small Wins

- What questions are frequently asked? What questions are never asked?
- What gets followed up? What is forgotten?
- What is referred to in public statements? What are the themes in speeches?
- Where do I spend time? What gets on the calendar?
- What is important enough to call a meeting for? What isn't?
- What gets on the agenda? What's on the top? What's last?
- What is emphasized in the summary of meetings?
- What gets celebrated? What are the symbols used? What language is used?
- How are social events used? Who gets invited? Where are they held?
- What signals are conveyed by the physical setting?

Guidelines

- You're doing better than you think.
- It's OK to improvise and make it up; reality is as much opportunity driven as it is goal-driven.
- You can't do it alone.
- Subordinates know a lot more than you think.
- Pressure leads you to miss a lot.
- Sensemaking increases the amount of pressure you can handle.
- Variety improves control.
- Meanings are the result of action.
- Quality is a struggle for alertness.
- Knowledge is not something people possess in their heads but something they do together.
- Believing is seeing.

A well-designed organization is not a stable solution to achieve, but a developmental process to keep active.

(Starbuck & Nystrom, 1981, p. 14)