



## 1.8 RISK MANAGEMENT



### CAIB Report Chapter 1, p25:

*As the investigation continued, it revealed a NASA culture that had gradually begun to accept escalating risk, and a NASA safety program that was largely silent and ineffective.*

#### NASA fails to account for program risk.

##### Agency-wide Themes

- NASA must establish a consistent set of risk assessment tools, applied in a uniform way, across all programs.
- NASA management must have a clear understanding of safety requirements and risks associated with key decisions.
- NASA must stop accepting increasing levels of risk without understanding the total program risk.

The public generally understands that space travel is not a risk-free undertaking. NASA's history includes many "firsts," and most of them have involved considerable risk. In the Human Space Flight Program, the risk has been to human life itself. But even when no crewmembers are launched, NASA has the responsibility of ensuring that the public's investment in the space program is a wise investment and that we are successful in achieving our mission. This should not be forgotten when we consider risk management.

NASA's vision and mission can only be achieved by accepting risk. Acceptance means understanding the risks, as well as managing and documenting them. The CAIB Report observed:

Quantitative safety assessments in the Navy submarine program are deterministic rather than probabilistic. NASA does not have a quantitative, program-wide risk and safety database to support future design capabilities and assist risk assessment teams. (CAIB Report, Chapter 7, p. 183)

A fundamental tenet of NASA programs, displayed throughout all field Centers and contractor facilities, is safety and mission assurance. Yet, for all its decades of efforts managing inherently risky spaceflight activities, NASA's organization and risk management processes failed in the losses of *Challenger* and *Columbia*. Ultimately, the CAIB found a Shuttle Program history of increasing risk. Where did the increasing risks come from? According to the CAIB, the answer lies in the traits of the Shuttle Program's organizational culture that "accepted escalating risk"

and a "safety program that was largely silent and ineffective." The CAIB recommendations and findings in the risk management area and the Safety and Mission Success Week responses from the workforce provide a clear picture of the issues and challenges NASA faces in managing future risks.

The incremental and insidious growth of risk in programs is a key theme within the CAIB findings. Another theme in the CAIB Report is the necessity to set uniform standards and assessment methodologies across all programs. Another major theme embodied in the CAIB Report was management's understanding of the risks associated with key decisions. Systematically, resource constraints and schedule pressures clouded management decisions. As for resources, the Board noted that adequate resources and independent assessments are critical to risk management and decision-making. Agency-wide, NASA can look at its programs to determine whether independent organizations are properly resourced and sufficiently independent.

The feedback from Safety and Mission Success Week reinforced the Diaz Team assessment:

- » Missions and programs are being driven by budget and schedule, and a 'faster, better, cheaper' philosophy. Cost and schedule pressures have surpassed technical quality as the drivers for decision making for projects.
- » As in the CAIB Report, Center employees expressed concern over our "can do" attitude, which "goes too far and becomes arrogance, leaving us blind to external information." It tempts us to accept greater risk than may be reasonable or responsible.

Agency-wide, a consistent set of risk assessment tools, applied in a uniform way, will help assure mission success. When applied throughout NASA, all programs would be served by having the best information available by which to make decisions that could impact safety and mission success.

In addition to the actions in the Diaz Team Matrix that address each R-O-F, the Diaz Team has one goal addressing the Risk Management category, as shown in Table 8.

*Table 8. The Diaz Team developed one goal for Risk Management.*

#### Risk Management – Diaz Team Goal

The Agency should identify a set of risk management processes and tools which can be applied across all programs which recognize the diversity with respect to risk tolerance.



## 1.9 SUMMARY

In summary, the CAIB Report includes significant technical and non-technical R-O-Fs, which NASA leaders must adhere to in order to help the Agency move forward to meet the challenges of the future. The Diaz Team realizes that, in some respects, the most challenging changes will be those which pertain to culture, or those which are the non-technical R-O-Fs noted in the CAIB Report.

All of this can be traced back to the culture of the organization. The CAIB Report discussed organizational culture this way:

Organizational culture refers to the basic values, norms, beliefs, and practices that characterize the functioning of a particular institution. At the most basic level, organizational culture defines the assumptions that employees make as they carry out their work; it defines “the way we do things here.” An organization’s culture is a powerful force that persists through reorganizations and the departure of key personnel. (CAIB Report, Chapter 5, p. 101)

The Team knows the organizational changes recommended in the CAIB Report will require sustained planning and implementation over time to achieve the desired future the CAIB and NASA foresee. When making cultural change, large organizations such as NASA need to assure that, throughout the change process, the organization’s core values are both relied on and sustained. The Team believes these core values will help the Agency’s leaders take on the serious challenges ahead, which should yield improved safety, performance excellence, and mission success.

The proposed actions in the Diaz Team Report are based on culture-related issues identified by NASA leadership and the workforce in the areas of: leadership, learning, communication, processes and rules, technical capabilities, organizational structure, and risk management. The Team believes a systematic approach to cultural change at this critical juncture of the Agency’s history will yield a NASA culture that is significantly more responsive and prepared for the promising opportunities of the American space program’s future.

NASA stands at a crossroads. One path is a continuation of the course that allowed the *Challenger* and *Columbia* accidents to occur. The new path of change may be difficult, particularly at the start, and sometimes the goal is not always in sight. But the rewards for walking this path are far greater than those the old path could ever offer us.

For NASA to embark on the new pathway, some fundamental reforms must be instituted. These are encompassed by the 40 Diaz Team actions and seven goals identified in the Report. The essence of these can be captured in three overarching reforms:

- NASA must assure that appropriate checks and balances are in place to develop and operate its missions safely, and must undertake the organizational changes

necessary to make this happen. The organizational structure should help clarify roles and responsibilities of individual employees, work groups and leadership. Every member of the workforce must know his or her position in the organization and all must know their authority, responsibility and accountability for assuring mission success. The entire workforce must also be aware of and understand the rules.

- NASA must enhance communications at all levels with a focus on fostering diversity of viewpoints and eliminating fear of retribution. A communications culture must be established with formal communications procedures to ensure effective communications flow up and down the chain of command and across organizational lines. Communications channels should be sufficiently flexible to support, encourage, and objectively evaluate all viewpoints, ensuring sound decision-making practices.
- NASA must focus on the ways it is managing risk. Safety, mission success and program performance must not be the product of schedule and budget pressures alone. Technological and workforce factors must be considered in program planning and decision-making as well. A critical role of leadership is to ensure there is an appropriate balance between requirements, resources and risk. NASA must assure that the workforce has the appropriate processes, tools and technical capabilities to accomplish this.

## 1.10 NEXT STEPS

It should be noted the NASA Administrator asked the Team in its charter to identify broadly applicable R-O-Fs in the CAIB Report, recommend actions to address those R-O-Fs, and submit a Report documenting its conclusions and recommendations to the NASA Deputy Administrator. The responsibility for preparing implementation plans to accomplish the 40 “specific actions” in the Diaz Team Matrix was given to the appropriate NASA Headquarters organizations. The responsibility for accomplishing the seven “Diaz Team Goals” is not identified in the Report. However, it is anticipated that the NASA Deputy Administrator will provide direction to the development of all implementation plans. It is recommended that all the implementation plans prepared in response to the CAIB Report (i.e. RTF, CTF, Next Generation Vehicle, Diaz Team and Aircraft Operations) be placed under configuration control, and any intent to establish other implementation plans be subject to approval by the Deputy Administrator. It is further anticipated that NASA will implement the appropriate systems to coordinate and track the progress of their implementation.

The Diaz Team suggests that NASA should periodically review and measure the progress of all implementation activities in response to the CAIB Report. It is suggested that this assessment be conducted six months after the release of the Diaz Team Report, and annually thereafter. The Diaz Team, or some subset thereof, could perform this assessment.



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## 2.0 INTRODUCTION

This Report documents the activities of the Diaz Team. The Team was assigned by NASA Administrator Sean O’Keefe with the responsibility of exploring the Agency-wide applicability of the Columbia Accident Investigation Board Report. The Diaz Team Report documents the discussions, conclusions, and goals of the Diaz Team.

### 2.1 BACKGROUND

Over the past eleven months, NASA has initiated a number of activities to investigate and understand the circumstances that led to the loss of the Shuttle *Columbia* and her crew. The NASA Administrator convened the CAIB on the day of the accident. This Board spent the next seven months doing a thorough investigation of the accident, identifying not only the technical reasons for the accident but also the underlying organizational reasons. The Board documented their R-O-Fs in a Report that was distributed in August 2003. The NASA Administrator then directed a number of teams to review the Report and determine what actions the Agency should take to address the R-O-Fs in the Report. The Return To Flight (RTF) Team began immediately to address the technical reasons for the accident and prepared an implementation plan in response to the technical recommendations in the Report. The NASA Administrator also established the Continuing Flight Team (CFT) to review the Report from the standpoint of its implications for the International Space Station (ISS). This team prepared an implementation plan to respond to the technical recommendations in the Report that had direct relationship with the ISS.

Throughout the investigation, the Board focused on the physical causes of the accident but they realized that there were organizational causes as well. While the CAIB Report and subsequent recommendations focused on the former, the latter was also discussed, most specifically in Chapter 7, in the Organizational Cause Statement. The RTF and CFT Teams focused primarily on those actions that were necessary to fly the shuttle again (or continue flying the ISS). However, the NASA Administrator recognized there were underlying messages in the CAIB Report that applied beyond the Human Space Flight Program. Therefore, in September 2003 he established a team to review the CAIB Report and identify those R-O-Fs that might apply broadly across the Agency.

### 2.2 THE TEAM AND ITS CHARTER

The NASA Administrator asked Al Diaz, Director, Goddard Space Flight Center, to lead the team, which has come to be known as “The Diaz Team.” The Diaz Team includes: Dr. Ghassem Asrar, Associate Administrator for Earth Science, NASA Headquarters; Dr. Julian Earls, Director, Glenn Research Center; Mr. Scott Hubbard, Director, Ames Research Center; Mr. Jim Kennedy, Director, Kennedy Space Center; and, Ms. Vicki Novak, Assistant Administrator for Human Resources, NASA Headquarters.

The Diaz Team’s charter was to:

- Identify those R-O-Fs from the CAIB Report that might apply across the Agency.

- Identify a set of actions and suggested leadership for those actions.
- Include the One NASA Team in all activities.
- Summarize results in a Report to the NASA Deputy Administrator.

It was immediately evident to the Diaz Team that while there were very few CAIB recommendations that specifically addressed the organizational causes of the accident, there were none-the-less clear messages in the Report that addressed the underlying organizational culture throughout NASA that allowed the accident to happen. It should be noted that while the Team focused on the organizational causes described in the CAIB Report which were related to NASA’s culture, the Team did not do a broad, in-depth assessment of the cultural changes needed to address the organizational causes. The Team focused specifically on the CAIB Report and those R-O-Fs that had broad Agency-wide application beyond the Human Space Flight Program. Admittedly, some of the actions recommended by the Team are actions one would expect to see an organization take if it were trying to change its culture, but the goals offered by the Team are intended as only a first step in the process.

### 2.3 R-O-F CATEGORIES

Rather than maintain all 85 R-O-Fs as a single large group, the Diaz Team found arranging and presenting them in categories could utilize them most effectively. For this approach to succeed, though, the definition of each category needs to be broadly understood. For example, the definition of Process can have many different meanings. Process can range the gamut of bringing a legal action against somebody or treating light-sensitive film or paper with chemicals. The Team initially developed five categories to organize the R-O-Fs, but after extensive analysis of the NASA workforce inputs from Safety and Mission Success Week, the framework was revised to one made up of seven categories. Each of these is defined in Table 9.

### 2.4 TEAM DISCUSSIONS

The Team met throughout the Fall of 2003 and structured its discussions around the R-O-Fs in the CAIB Report. To facilitate its discussions, it created the CAIB Agency-wide Action Matrix (Diaz Team Matrix, or simply, “The Matrix”), which is included as Appendix A of this Report. The Diaz Team Matrix is a table that lists each R-O-F in the CAIB Report. It includes the:

- CAIB reference number;
- CAIB description of the R-O-F;
- Discussion of why the Team believes the R-O-F was broadly applicable;
- Recommended action to address the R-O-F; and
- NASA Headquarters organization assigned the action.

The matrix also includes a Team-assigned number for each category of R-O-F. (1 – 29 recommendations, 1 – 27 observations and 1 – 137 findings.) Of the 193 R-O-Fs in the CAIB Report, the Team identified 13 of the 29 recommendations, 8 of the 27 observations and 64 of the 137 findings as having broad application



Table 9. Organizing the R-O-Fs – the seven categories and their definitions.

<b>Leadership</b>	Leadership is the action of inspiring, guiding, directing, or influencing people. Leadership is not a position in the hierarchy of management, but rather a series of behaviors and actions, which enables others to achieve goals and shared vision. Leadership occurs throughout all levels of an organization.
<b>Learning</b>	Learning is the acquisition of knowledge or skill. It can be gained through formal education and training, experiences and expertise gained on-the-job, and through life-long experience. Learning outcomes can include the acquisition of knowledge and/or understanding, as well as changes in behavior.
<b>Communication</b>	Communication is the exchange of information between individuals, or groups by means of speaking, writing, or a common system of signs or behavior. One goal of communication is a sense of mutual understanding; both parties must speak the same language.
<b>Processes and Rules</b>	A process is a series of actions directed toward a particular aim, dealing with people or things. A process can also be the means to deal with somebody or something according to established procedures. Rules may be authoritative principles that govern individual or group behavior. Rules can also be used to ensure accountability, to establish authority within an organization, and to convey knowledge.
<b>Technical Capabilities</b>	Technical capability is the set of abilities needed to accomplish specialized tasks, in fields such as industrial applications and applied science. It refers to skilled staff members and the methods, tools and resources they use to perform their work effectively. Technical capability is also the ability to employ a technique according to a strict interpretation of the rules.
<b>Organizational Structure</b>	An organization is a group of people identified by shared purpose. It defines the relationships among separate staff elements that are arranged in a coherent structure. An organizational structure, then, is the framework that enables a system made up of separate but interrelated parts to function as an orderly whole. For example, organizational structure describes the ways in which the constituent components of NASA are able to work together.
<b>Risk Management</b>	Risk is the potential for injury, damage, or loss to individuals or property. Risk is also the statistical chance that such a hazard will occur, especially from the failure of an engineered system. Risk management is the systematic process of analyzing, quantifying, and managing risk as one would do with another resource available in the execution of a project.

across the Agency. The 85 broadly applicable R-O-Fs resulted in 40 specific actions described in the Diaz Team Matrix. (Note that in some cases an action addressed more than one R-O-F. Hence, 85 R-O-Fs and 40 recommended actions.)

## 2.5 SAFETY AND MISSION SUCCESS WEEK

The broad applicability of many of the CAIB Report R-O-Fs was apparent to the Diaz Team very early in its effort. As the Team’s discussions continued, it realized that members of the entire NASA workforce could benefit from reading the CAIB Report and discussing its implications with their peers and supervisors. Initially, the Team discussed the possibility of recommending a “NASA Stand Down Day,” which would be devoted to discussions about the CAIB Report at each NASA Center and facility. However, it was felt that a more effective way to accomplish the intent of the activity was through discussions at the work-unit level in each organization. Therefore, the Team recommended a week-long activity, the Safety and Mission Success Week, during which all civil servant and contractor employees across the Agency would be given the opportunity to discuss the CAIB Report with their colleagues and supervisors. More specifically, it would provide the opportunity to discuss the relevance of the CAIB Report, how it impacts mission success in the work unit, and most importantly, what each employee can do to address those impacts in his and her work unit.

The Diaz Team recognized that this was an opportunity to begin a dialog that each NASA Center and facility could then continue.

The Team also realized that the Safety and Mission Success Week would provide an excellent opportunity to present the Team’s initial findings and goals about the broad applicability of the CAIB Report R-O-Fs to the entire NASA workforce and get their feedback.

Safety and Mission Success Week was conducted across the Agency the week of November 17, 2003. The Diaz Team provided guidance for conducting the discussions that week, and established mechanisms for getting feedback at the NASA Headquarters, Center, and individual levels. The primary intent of the feedback was to provide NASA Management with information it could use to address opportunities for improvement at the NASA Headquarters and Center organizational levels, as identified by their employees. The NASA Headquarters and Center organizations then provided the Diaz Team with a set of summarized comments reflecting the prevailing themes that emerged during the discussions.

Based on the feedback received, the discussions conducted across NASA that week were very productive. In addition, the Safety and Mission Success Week feedback provided to the Diaz Team confirmed its approach and conclusions, and is discussed in general throughout this Report. The feedback also confirmed the Team’s assessment of major issue areas, which were expanded into the seven primary categories that are defined in Table 9 and reflected in this Report.

It is important to note that any discussion of Safety and Mission



Success Week feedback in this Report reflects comments that were received from more than one source. They reflect themes that emerged in the feedback and therefore are not attributable to a specific individual. On the other hand, the statements may have come from a limited number of individuals and therefore should not be construed as attitudes that represent the entire NASA workforce.

## 2.6 REPORT LAYOUT

During the course of its discussions, the Team began to see major themes emerge, which were reinforced by the Safety and Mission Success Week feedback. As a result, it grouped the 85 broadly applicable R-O-Fs and their resulting actions into the following seven categories:

- Leadership
- Learning
- Communication
- Processes and Rules
- Technical Capabilities
- Organizational Structure
- Risk Management

The chapters in this Report are aligned with those categories. Each chapter:

- Cites a key statement from the CAIB Report related to the category.
- Summarizes the issues related to the category that have Agency-wide application.
- Provides a discussion of examples from the CAIB Report that describes the issues related to this category.
- Provides a summary of the Team's discussion and why they feel the R-O-Fs in this category have broad Agency-wide application as supported by Safety and Mission Success Week feedback.
- Provides a goal for the category suggested by the team. (It should be noted that these are in addition to the Diaz Team Matrix actions for the broadly applicable CAIB R-O-Fs.)
- Summarizes the R-O-Fs that are broadly applicable for each of the seven categories.

Each chapter also includes a diagram which highlights key statements from the CAIB Report, how many R-O-Fs in this category were identified as broadly applicable, how many recommended actions resulted from these R-O-Fs, and workforce feedback received during Safety and Mission Success Week that confirmed the issues in this category apply broadly across NASA.



## 3.0 LEADERSHIP



### CAIB Report Chapter 8, p203:

*Leaders create culture. It is their responsibility to change it. Top administrators must take responsibility for risk, failure, and safety by remaining alert to the effects their decisions have on the system. Leaders are responsible for establishing the conditions that lead to their subordinates' successes or failures.*

### Management practices are a cause of the accident.

#### Agency-wide Themes

- Leaders must lead by example, creating conditions and a culture for safety and mission success.
- Leaders must balance schedule and risk.
- Leaders should allow and encourage diversity of views, eliminate retribution towards those with differing opinions, and understand that "No" is an acceptable answer.
- Leaders should be grown throughout all levels of the organization, through succession planning and developmental experiences.

## 3.1 INTRODUCTION

NASA has a strong heritage for developing leaders at all levels of the Agency who have a "can-do" attitude. They have brought our Nation to the Moon and back, launched and managed hundreds of safe and successful human and unmanned missions to space, led us through seemingly hopeless situations like Apollo 13, and begun the complex construction and operation of the International Space Station. However, with the seriousness of the *Columbia* accident and the CAIB Report, NASA leaders need to reflect upon and grow from the lessons learned. The Diaz Team's actions contained in the Diaz Team Matrix require that everyone understand their responsibilities and are given the authority to perform their jobs, with the accountability for their individual and program's successes and failures, including lessons learned. Leadership means being able to make decisions, support those decisions, and be accountable for the outcome. It also means making informed decisions and treating staff and contractor support with respect and courtesy to ensure that everyone understands their inputs are valued and important. It involves empowering and developing the workforce, listening and communicating with them more effectively, and developing future leaders through progressive leadership development and effective organization succession planning and practices. Leadership means creating a climate and conditions for NASA employees and organizations to achieve safety and mission success.

## 3.2 CATEGORY R-O-F SUMMARY

Overall there were no recommendations, three observations, and 14 findings that the Diaz Team determined had broad NASA applicability to Leadership. Table 11 shows these 17 R-O-Fs in brief summary statement form, along with brief discussion points on NASA applicability. Four themes emerge from these discussion points as shown above.

## 3.3 DISCUSSION

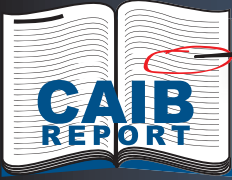
The need for improved leadership practices at NASA permeates the entire CAIB Report and can be found in a broad number of the Report findings and observations. Threaded throughout the Diaz Team Report chapters are discussions and goals for ways to lead and manage more effectively. The Team recognizes that an overarching theme of the CAIB Report is leadership and that to embark upon an aggressive agenda for change, NASA leaders will require a framework of common understanding and approach. When addressing the major changes required by NASA leaders to fulfill the CAIB Report implied mandate, the eight stages of leading change cited by John Kotter in his book *Leading Change* may be applicable to NASA leaders and the challenges they face:

1. Establish a sense of urgency for the change we must undertake as a result of the accident and CAIB Report;
2. Create a team-based coalition to lead the change;
3. Develop a shared vision and strategy for the change effort;
4. Communicate the change and the associated changed behaviors and practices;
5. Empower the workforce to undertake the envisioned changes, ridding ourselves of obstacles, changing systems and structures that undermine the changes, and encouraging risk taking within agreed-upon thresholds;
6. Recognize the workforce for visible improvements;
7. Align systems, structures, policies, people, and projects with the new vision; and,
8. Anchor the new approaches in the changing culture through connections between new behaviors and organizational success and leadership development and succession.

Based on the CAIB Report R-O-Fs and best leadership practices, the Team has identified several means to assure NASA's leadership. The Team believes NASA's leadership for the future is quite promising based on the talent we have, we will recruit, and we will develop. The insights NASA leaders have gained from the accident and the CAIB Report and the knowledge gained from studying and applying best leadership practices will help them to build a leadership philosophy and culture that supports safety and mission success for the Nation's future space program.

The criteria used to delineate those R-O-Fs that were applied to leadership included the themes above and a leader's ability to make and support decisions. These criteria also pointed to the required behaviors of desirable leaders, their ability to model good leadership traits, and their ability to mentor subordinates in support of effective leadership succession transitions. These criteria address:

# LEADERSHIP



Management practices  
are a cause  
of the accident

## CAIB Statements

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. Synopsis, p11

Post-*Challenger* policy decisions... leadership resulted in... reproducing many of the failings identified by the Rogers Commission. Policy constraints affected the Shuttle Program's organization culture, its structure, and the structure of the safety system. C8, p197

At the same time that NASA leaders were emphasizing the importance of safety, their personnel cutbacks sent other signals. Streamlining and downsizing, which scarcely go unnoticed by employees, convey a message that efficiency is an important goal. C8, p199

Leaders create culture. It is their responsibility to change it. Top administrators must take responsibility for risk, failure, and safety by remaining alert to the effects their decisions have on the system. Leaders are responsible for establishing the conditions that lead to their subordinates' successes or failures. C8, p203

## Response

Learning	Recommendations	Observations	Findings
Broadly Applicable	0	3	14
Actions	0	3	4

## Reinforcement/Feedback

*Safety & Mission Success Week Statements from NASA Workforce*

Our employees believe that the leadership issues and concerns significantly hinder our ability to do our jobs effectively, hamper communications through the chain of command, and compromise product quality or science.

There is lack of a clear vision and mission that all employees can relate to and understand. Our current vision lacks sufficient clarity to enable program/project and subproject decisions that are consistent with the Agency objectives.

...management must create an open environment: explicitly and actively seek out minority opinions, encourage discussion and closure, promote asking "why?"

# DIAZ TEAM FINAL REPORT

# IMPLEMENTATION PLAN





- Empowerment by understanding and communicating responsibility, accountability, and authority.
- Serving as an example and role model to employees by understanding and following the rules (but not “blindly”), and having a willingness to challenge the rules when safety and mission success are at stake.
- A willingness and ability to challenge schedules when appropriate and necessary based upon well thought-out and presented analyses of risks.
- Respect of others and fostering fair consideration of all points of view.

The feedback from Safety and Mission Success Week reinforced the Diaz Team assessment:

- » We need to make sure every voice is heard without fear of retaliation or suppression.
- » NASA leadership has become preoccupied by actions to address symptoms; we need the resources and leadership commitment to fix underlying causes.
- » We need to stress among NASA leadership the importance of responding to even the lowest-level question. This was exactly why NASA did not exercise additional techniques with *Columbia* to research the problem.

*Table 10. The Diaz Team developed one goal for Leadership.*

**Leadership – Diaz Team Goal**

The Agency should assess whether program management and budget formulation processes are adequate to assure there is an appropriate balance of requirements, resources, and risk to ensure safety and mission success.

Throughout its Report, particularly in the “Organizational Cause Statement,” the CAIB emphasizes that many of NASA’s challenges for today and the future relate to its culture, which will require the Agency’s reliance on: sound engineering practices; effective communication; employee empowerment; integrated management across programmatic and organizational elements; and adherence to well-defined rules and standards of operations.

In addition, in direct response to concerns expressed by the CAIB and individuals in the workforce during Safety and Mission Success Week, the Diaz Team believes that it would be worthwhile for the leadership of the Agency to confirm that the processes in place or anticipated are adequate to assure that programs contain the appropriate balance between requirements and resources. As a consequence, the Team developed an additional goal which it believes, when taken with others contained in this Report, will enhance the probability of mission success. This one goal is included in Table 10.



Table 11. The Diaz Team determined that three Observations, and 14 Findings could be included in the Leadership Category resulting in seven actions.

<i>Diaz Team #</i>	<i>CAIB #</i>	<i>CAIB Report Recommendations and Pertinent Factors</i>	<i>Diaz Summary Discussion</i>	<i>Diaz Action #</i>	<i>Responsible</i>
O13	O10.6-2	NASA and USA must understand workforce and infrastructure requirements	NASA managers must match workforce and facility requirements against capabilities	14	J
O14	O10.6-3	Work with Air Force on management of aging systems	Organizations outside NASA can provide risk management lessons	15	AE
O27	O10.12-1	Implement strategy for leadership and management training	Agency-wide succession planning and leader development	17	F
F59	F6.1-4	Lack of effective project feedback processes for anomalies	Feedback mechanisms important for all programs	28	AE
F67	F6.2-1	NASA HQ focus was on ISS Node 2 launch date of Feb. 2004	Management decisions without understanding implications	30	AE
F69	F6.2-3	Capabilities stretched to limit to support schedule	Audit staffing practices and workforce management	32	AE
F71	F6.2-5	No schedule margin to accommodate for unforeseen problems	All programs need adequate schedule margin	33	AE
F72	F6.2-6	Node 2 schedule may have influenced manager's decisions	Minority views and intuition are important information sources	28	AE
F75	F6.3-2	Outside imagery help requested on Flight Day 2	Streamlined communication needed for time-critical issues	28	AE
F79	F6.3-6	No MMT manager owned the Team's actions	Best practices define accountability and responsibility	28	AE
F81	F6.3-8	Team routed imagery request through JSC MER	Clear lines of authority across organizations needed	28	AE
F82	F6.3-9	Team members never realized imagery decision was not final	Rationale for decisions and feedback systems needed	28	AE
F85	F6.3-12	Damage assessments uncertain due to multiple failures	Similar potential problems across Agency	28	AE
F88	F6.3-15	Lapses in leadership and communication for raising concerns	Experts need to be heard and understood	28	AE
F91	F6.3-18	Foam not a problem confirmed by expert, and no one questioned	Logical rationale to support conclusions needed	28	AE
F92	F6.3-19	"Who requested photos?" rather than merits of request asked	Merits of problems communicated to managers need response	28	AE
F95	F6.3-22	Engineers had to prove the system was unsafe rather than safe	Leaders need to develop process to address merit of problems	28	AE



## 4.0 LEARNING



### CAIB Report Chapter 7, p192:

*The Board concludes that NASA's current organization does not provide effective checks-and-balances, does not have an independent safety program, and has not demonstrated the characteristics of a learning organization.*

### NASA has not demonstrated the characteristics of a learning organization.

#### Agency-wide Themes

- NASA should provide robust simulation and emergency response training.
- Tools, databases, and models should be developed and used appropriately.

### 4.1 INTRODUCTION

Much was said in the CAIB Report about the NASA culture and how its attributes contributed to the *Columbia* accident. The Report specifically stated that NASA “has not demonstrated the characteristics of a learning organization.” While there may be a variety of views on what these characteristics would be, if we refer to Peter Senge, a noted authority on this matter, they would be:

1. Systems thinking
2. Personal mastery
3. Mental models
4. Shared vision
5. Team learning

According to Senge, these characteristics of a learning organization, taken together, increase the capacity for adaptation and change. The Diaz Team recognizes that none of this Report’s discussion or recommendations address Learning in terms of “changes in behavior” (per the definition of Learning) or the ability to adapt and change, per Senge’s Learning Organization. However, learning by its very nature is not tied to one NASA program. Therefore, learning can have the widest applicability across NASA. Aside from the obvious lesson to not repeat history by failing to learn from it, the CAIB provided NASA with a number of recommendations and findings that could help it achieve the beneficial traits of a learning organization.

### 4.2 CATEGORY R-O-F SUMMARY

Overall there was one recommendation, no observations, and four findings that the Diaz Team determined had broad NASA applicability to the Learning category. Table 13 shows these five R-O-Fs in brief summary statement form, along with brief discussion points on NASA applicability. Two themes emerge from these discussion points as listed above.

### 4.3 DISCUSSION

While there was only one CAIB recommendation that could broadly apply to learning within NASA, inputs from individuals in the NASA workforce during Safety and Mission Success

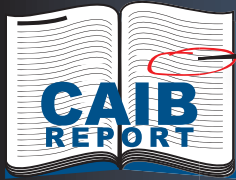
Week, as well as lessons from NASA mission successes and failures, provide potential strategies to improve the NASA learning culture. The Diaz Team’s NASA-wide actions resulting from these R-O-Fs require that NASA address training and learning technology on a comprehensive basis.

It is recognized there are efforts underway in NASA to address knowledge capture, management, and dissemination. These actions are in response to the concern for the impending retirement of a large segment of the NASA workforce. The best recent example has been the Corporate hiring strategy which has promoted the use of existing Agency authority to hire freshouts. This action will help in assuring that critical skills are replaced early enough to assure overlap in some areas where retirements are anticipated. But more needs to be done to understand what the knowledge architecture in NASA is so that steps can be taken to preserve it.

In addition, comprehensive and systematic emergency response training simulating the work environment, as well as hands-on experience, are critical to creating a learning organization. NASA personnel need to achieve a high level of technical and managerial competency along with a high state of readiness to deal with the research, developmental, and operational challenges inherent in the aerospace systems they manage and operate. In concert, the technical tools, information systems, and knowledge repositories of the Agency must be up to date and readily available to be used by personnel across the Agency. Supervisors must also take an active leadership role in fostering professional development of their subordinates and ensure that necessary technical and leadership skills are developed in the workforce.

For Shuttle mission operations, the CAIB had noted that NASA did not always “train like you operate” and “operate like you train.” This same maxim can be applied to training for NASA personnel across all operational programs. Training should embody how the organization will operate its missions, and operate their missions the way they trained. Safety and Mission Success Week responses validated this need with input that the Agency must devote greater resources, particularly training resources to facilitate learning. NASA must first examine best practices for contingency, emergency, and operational procedures and training, and then make the appropriate comprehensive changes for safety and mission success.

The first common aspect is the appropriate use of tools, databases, and simulation and modeling programs by operating personnel. Of particular importance is training on their relevance and the environments in which they apply. The improper use of the CRATER program in assessing debris damage to *Columbia* is a prime example of the need to fully understand how to use modeling tools correctly. In addition, training on the history and the underlying development of these tools is critical. The CAIB



# LEARNING

NASA has not demonstrated the characteristics of a learning organization.

## CAIB Statements

Senior Safety, Reliability & Quality Assurance managers do not use the Lessons Learned Information System. NASA... does not have... program to use past lessons to educate engineers, managers, astronauts, or safety personnel. Finding F7.4-10

An inexperienced team, using a mathematical tool that was not designed to assess an impact of this estimated size, performed the analysis of the potential effect of the debris impact. C6, p168

...management declined to have the crew inspect the Orbiter for damage, declined to request on-orbit imaging, and ultimately discounted the possibility of a burn-through... The Board views the failure to do so as an illustration of the lack of institutional memory... NASA is not functioning as a learning organization. C6, p127

Numerous reports, including most recently a General Accounting Office 2001 report, highlighted fundamental weaknesses in the collection and sharing of lessons learned by program and project managers. C7, p189



## Response

Learning	Recommendations	Observations	Findings
<b>Broadly Applicable</b>	1	0	4
<b>Actions</b>	1	0	2



## Reinforcement/Feedback

*Safety & Mission Success Week Statements from NASA Workforce*

...NASA does not effectively transfer knowledge... NASA can significantly improve our knowledge management culture with lessons learned processes, trend analyses, transferring expert knowledge from people to systems, and portals that share information.

the Agency can and should devote greater resources... particularly training resources to facilitate learning.

As time passes... many of the valuable lessons learned from the CAIB report may be lost.



# DIAZ TEAM FINAL REPORT



# IMPLEMENTATION PLAN



Report noted that an “inexperienced team, using a mathematical tool that was not designed to assess an impact of this estimated size, performed the analysis of the potential effect of the debris impact.”

The feedback from Safety and Mission Success Week reinforced the Diaz Team assessment:

- » Mandate that current and new employees moving into management positions attend a lecture (sponsored by NASA) outlining historical lessons learned by NASA and comparable agencies. This lecture should be at least one day long and should cover lessons learned in several disasters (*Challenger, Columbia, Apollo 1, USS Thresher*) and close calls (i.e. STS-93 and *Apollo 13*).
- » NASA should routinely run mock mishap investigations to root out its process, product, and programmatic weaknesses before a mishap actually happens.
- » NASA does not effectively transfer knowledge. NASA can significantly improve our knowledge management culture with lessons learned processes, trend analyses, transferring expert knowledge from people to systems, and portals that share information.
- » NASA should employ a more rigorous/disciplined acceptance testing & checkout procedure prior to placing any system (hardware or software) in operation. The requirements and results should be kept in a database with an independent group auditing input.

Knowledge management is a key element in creating a learning environment so the CAIB Report lessons are indeed not lost. The CAIB Report noted “ideally, the Lessons Learned Information System should support overall program management and engineering functions and provide an historical experience base.” When Shuttle Program Management declined to have the crew inspect the *Columbia* for damage while on orbit, when it did so for a previous debris impact mission, this illustrated to the Board a lack of “institutional memory” that supported the Board’s claim NASA is not managing its knowledge resources.

The Safety and Mission Success Week provided valuable insight in singling out knowledge management weakness along with a suggested cure. Responses suggested NASA does not effectively transfer knowledge, and can significantly improve the knowledge management culture with lessons learned processes, trend analyses, transferring expert knowledge from people to systems, and portals that share information. This Safety and Mission Suc-

cess feedback provides a focal point for the training and methods necessary for an effective learning environment.

Another fundamental aspect of learning in NASA is training in contingency and emergency procedures, which NASA should conduct on all programs. Included in this aspect of an effective and rigorous training program are:

1. Situational awareness;
2. Experiencing problems without known outcomes; and
3. Simulating a stressful environment for decision-making.

NASA can explore personnel training and learning through a variety of methods. More on-the-job training through apprenticeship programs and hands-on work can be emphasized for critical skills being lost at the Centers. NASA-wide information systems utilizing the Web can be a powerful method for dissemination of knowledge throughout the Agency. The CAIB noted the existence of multiple databases without any convenient way to integrate them. The consolidation and linkage of information systems to provide effective collaboration and information sharing is important to NASA becoming a learning organization.

As part of career development and embracing life-long learning as a method of creating a true learning organization, personnel should be encouraged to improve their certification levels and attend specialized training and development programs. These are key to the Agency being technologically current on the latest technical and management methods. Role-playing, simulations, and case study development and utilization on a comprehensive basis can also contribute to creating a learning environment. Leaders and supervisors are responsible for ensuring that employees learn needed skills and develop capabilities to perform future missions, as well as mentoring them.

Many of these methods and activities are already in place across the Agency. The next step is to comprehensively assess what needs to be improved. NASA leadership must make learning a priority to facilitate the workforce acquiring and retaining needed skills and competencies, thereby contributing to successful mission accomplishment.

In addition to the actions in the Diaz Team Matrix that address each R-O-F, the Diaz Team has one goal addressing the Learning category, as shown in Table 12.

*Table 12. The Diaz Team developed one goal for Learning.*

**Learning – Diaz Team Goal**

The Agency should identify an appropriate approach for the future development of a knowledge management system and infrastructure to assure knowledge retention and lessons learned.



Table 13. The Diaz Team determined that one Recommendation and four Findings could be included in the Learning Category resulting in three actions.

<i>Diaz Team #</i>	<i>CAIB #</i>	<i>CAIB Report Recommendations and Pertinent Factors</i>	<i>Diaz Summary Discussion</i>	<i>Diaz Action #</i>	<i>Responsible</i>
R20	R6.3-1	Expanded training program for Mission Management Team	All programs need robust training and simulation	7	AE
F96	F6.3-23	Little discussion of analysis, assumptions, issues	Managers need to base decisions on facts	7	AE
F114	F7.4-9	Information databases marginally effective decision tools	Need for assessing program management support tools	38	AE
F115	F7.4-10	SR&QA do not use the Lessons Learned Info System	Case studies and training for lessons learned needed	38	AE
F116	F7.4-11	Multiple databases without a convenient way to integrate	Database commonality and real-time access necessary	39	AE