# The Cost of Complacency: Moral Responsibility in the Space Shuttle Columbia Disaster

STS Research Paper
Presented to the Faculty of the
School of Engineering and Applied Science
University of Virginia

By

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May 9, 2025

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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“This cause of exploration and discovery is not an option we choose; it is a desire written in the human heart … We find the best among us, send them forth into unmapped darkness, and pray they will return. They go in peace for all mankind, and all mankind is in their debt.”
– President George W. Bush, February 4, 2003

## Introduction

Humanity has long been enamored with outer space. The desire to reach for the stars has shaped the modern era, advancing society and straining global politics. This tension rose to its peak on several occasions, the most recent of which transpired when the Space Shuttle *Columbia* disintegrated during its final descent back to Earth in 2003. The *Columbia* tragedy left the United States in shock, wondering how such an accident could occur at a time in which space travel had become almost routine.

Most scholarly analyses of the *Columbia* disaster distribute the blame across NASA as a whole rather than pinpoint individuals. These papers cite the organizational culture of NASA as the primary element that led to the disaster occurring in the first place (Columbia Accident Investigation Board, 2003; Mason, 2004; Turner, 2006). However, such examinations ignore the role that certain individuals within NASA played in *Columbia's* destruction. As a result, their conclusions minimize the accountability across the entire agency while simultaneously obscuring the specific decisions and actions that could have prevented the tragedy. By focusing solely on systemic issues, these perspectives fail to address the moral responsibility of key decision-makers whose choices directly contributed to the shuttle's demise.

In what follows, I show how certain key NASA managers are morally responsible for the Space Shuttle *Columbia* tragedy because they satisfy the four conditions in the criteria of responsibility, particularly the foreseeability and freedom of action criteria. My analysis draws on the Science, Technology, and Society framework of Actor-Network Theory to identify each major contributor to the *Columbia* disaster as well as the ethical Responsibility framework to determine who bears moral responsibility. To support my conclusions, I examine several artifacts

from the time, including government reports, interviews with NASA engineers and managers, and books detailing the events.

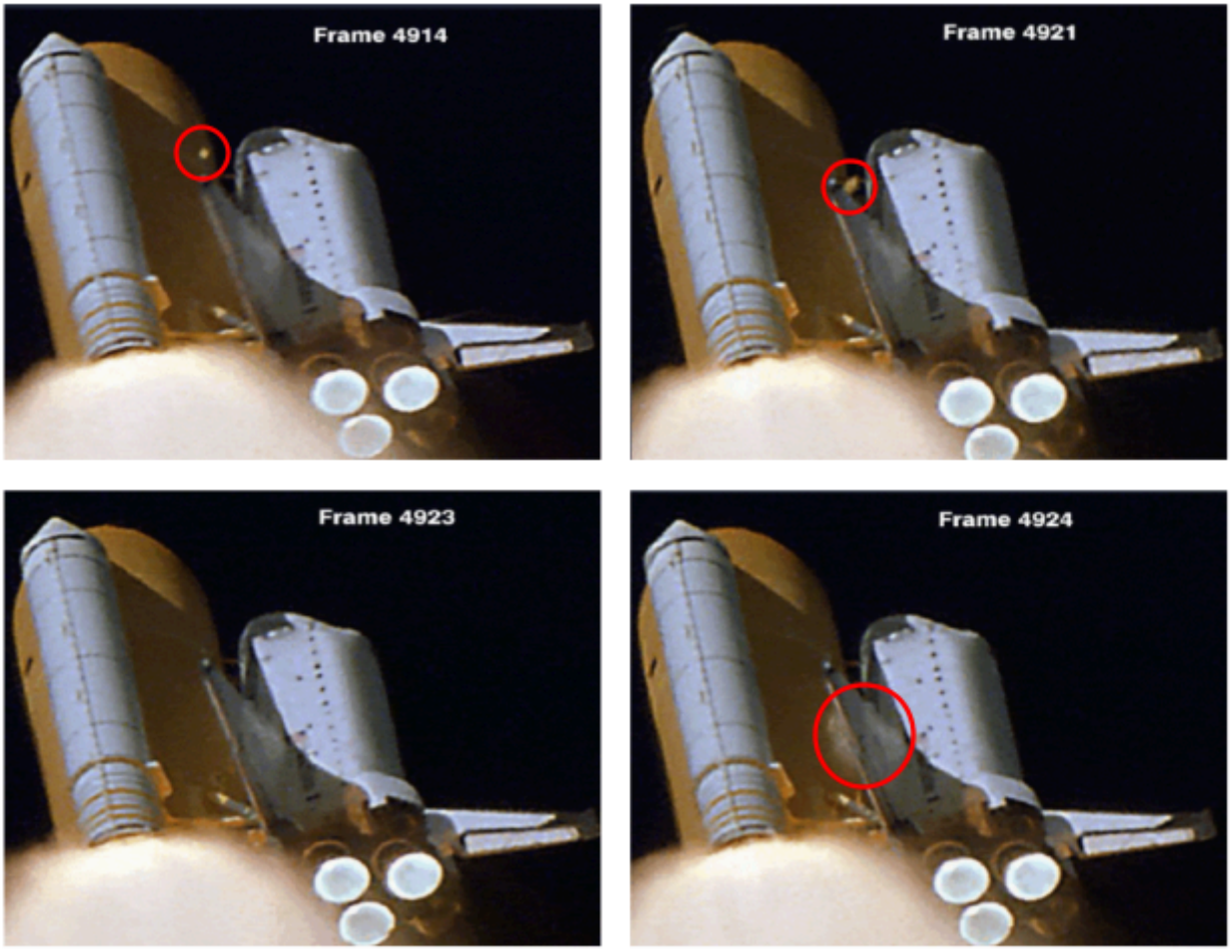
**Background**

On February 1, 2003, the Space Shuttle *Columbia* disintegrated over Texas as it re-entered the atmosphere following a 16-day scientific mission in Earth's orbit, killing all seven astronauts on board. STS-107, the first shuttle mission of 2003, marked the 113th flight in NASA's Space Shuttle program and the 28th flight of the Space Shuttle Orbiter *Columbia*. The disaster served as a strong reminder of the *Challenger* explosion 17 years earlier and once again placed NASA under intense scrutiny.

Within a day, the Columbia Accident Investigation Board (CAIB) was formed to determine the causes of the tragedy and recommend measures to prevent future accidents. After a thorough examination, the CAIB concluded that the technical failure was caused when a briefcase-sized chunk of insulating foam detached from the left bipod ramp and struck *Columbia's* left wing 81 seconds after launch (Smith, 2003). This collision created a hole in a leading-edge reinforced carbon-carbon (RCC) panel, allowing superheated air to penetrate the shuttle's Thermal Protection System upon re-entry. The extreme heat melted the wing's aluminum structure, increasing the aerodynamic forces and resulting in the eventual disintegration of the Orbiter (see Figure 1 for a frame-by-frame analysis).

**Figure 1**

*Space Shuttle Columbia Foam Strike*




*Note.* Insulation foam detaches from the external tank (upper-left, upper-right), disappears behind the left wing (lower-left), and the resulting debris (lower-right). From National Aeronautics and Space Administration, 2003

Although the CAIB successfully identified the physical cause of the failure, they did not stop there. Tasked with preventing future disasters, the Board dissected the root organizational causes that enabled the accident. Their final report concluded that the tragedy stemmed from NASA's flawed decision-making process and its "broken safety culture." This finding sent shockwaves through both NASA and the nation. Historically, NASA had a reputation of accomplishing the impossible. Despite previous tragedies, such as the Apollo 1 fire and the

*Challenger* disaster, nearly two decades had passed without a major failure, during which space travel had become commonplace. However, unlike Challenger, *Columbia's* destruction left the United States one failure away from the potential abandonment of human space exploration altogether.

**Literature Review**

There is no shortage of scholarly research attempting to identify the actors responsible for the *Columbia* disaster. While many scholars agree that NASA as a whole is at fault, no clear consensus has emerged regarding which individual actors within NASA contributed most to the shift in culture leading up to the accident. Several scholars agree with the CAIB's conclusions regarding NASA's systemic failures. Ethicist Richard O. Mason, for instance, examines whether culture itself can be lethal, arguing that organizational culture is learned and resistant to change once formed. NASA's initial culture of excellence, instilled by legendary aerospace engineer Wernher von Braun, prioritized precision, risk awareness, and open communication across all levels of the organization, all of which had faded by the time *Columbia* launched for its last time. Mason points to President Nixon's 1972 speech approving the Space Shuttle program as the beginning of this shift, in which Nixon declared that the shuttle would " revolutionize transportation into near space, by routinizing it." This marked the transition to a "culture of production," where efficiency and cost-cutting took precedence over safety. Mason argues that as efficiency became NASA's dominant value, engineers struggled to raise safety concerns. As a result, engineers "found themselves having to prove that a major calamity would very likely occur in order to get an audience with upper management," whereas in the past, "executives would have been eager to listen." This shift in priorities led NASA to justify increasing risks

based on past successes (Mason, 2004). While compelling, Mason risks oversimplifying NASA's decision-making, portraying the agency as indifferent to safety, rather than acknowledging the complexities of balancing risk and progress.

On the other hand, Arjen Boin and Denis Fishbacher-Smith adopt a more pessimistic stance, contending that the accident was bound to happen eventually. Taking a Normal Accident Theory (NAT) approach, they believe that failures in a system the size and complexity of NASA are inevitable. Boin and Fishbacher-Smith explain that society expects NASA to take responsible risks, and that the balance between safety and performance is their ever-present dilemma. They argue that institutional discipline and adherence to proven safety systems, not a decline in safety culture, enabled the shuttles to launch in the first place. Consequently, they conclude that NASA's culture had not fundamentally changed since the Apollo missions (Boin & Fischbacher-Smith, 2011). Yet this is also a shortcoming of their analysis; for by implying that the *Columbia* disaster was an unavoidable consequence of operating within an inherently high-risk system, Boin and Fishbacher-Smith ultimately fail to account for NASA's past success under von Braun without compromising safety. By downplaying the possibility of internal cultural deterioration, their analysis risks excusing systemic failures rather than critically examining them.

While these perspectives either diffused the moral responsibility across the organization of NASA as a whole or deflected it entirely, a gap exists in which individual actors played a key role in the underlying issues leading up to the Columbi*a* disaster. In my analysis, I will advance current understanding in the scholarly discourse by identifying the discrete actors whose decisions and actions were pivotal in shaping the conditions that led to the *Columbia* tragedy and ultimately determine who was morally responsible.

**Conceptual Framework**

My analysis of the *Columbia* accident draws upon Actor-Network Theory (ANT) and the Responsibility framework, which allows me to examine the *Columbia* tragedy to determine who is morally responsible. Developed by STS scholars Michel Callon, Bruno Latour, and John Law, ANT claims that everything can be viewed as a diverse technological network composed of both human and non-human actors. These actors are often associated together by a network builder to accomplish a goal. Furthermore, no single actor is more powerful, important, or influential than others because they each depend on one another. In this sense, a network's power is determined by the strength of the bonds that unite actors together to work towards the network's objective. Law and Callon expand on this by stating that the goal of ANT is to determine how actors "define and distribute roles, and mobilize or invent others to play these roles" (Cressman, 2009). By mapping out these relationships, ANT helps scholars uncover how complex interactions contribute to major events.

The Responsibility framework attempts to identify and determine the distribution of responsibility in engineering systems. In their book, *Ethics, Technology, and Engineering*, Ibo van de Poel and Lambér Royakkers explain how it is often difficult to pinpoint where the responsibility for a particular outcome lies in complex engineering projects. This concept, known as the problem of many hands, often leads to the conclusion that no individual can be held responsible, but a collective can. To address this, van de Poel and Royakkers propose four conditions which, if satisfied, are used to hold moral actors responsible: wrong-doing, causal contribution, foreseeability, and freedom of action (Van de Poel & Royakkers, 2011).

Wrong-doing occurs when an actor violates a norm or does something wrong. Causal contribution means that the actor who is held accountable either acted or failed to act in a manner

that directly contributed to the undesirable outcome. Van de Poel and Royakkers define foreseeability as the ability to "know the consequences of his or her actions" before the incident transpired. Finally, the freedom of action condition states that the actor who is held responsible must have not acted under compulsion. Therefore, the actors considered can only be held morally responsible under the Responsibility framework if all four conditions are satisfied (Van de Poel & Royakkers, 2011).

Drawing on ANT and the Responsibility framework, in the analysis that follows I begin by identifying and mapping the major actors contributing to the Space Shuttle *Columbia* disaster. Subsequently, I delve into the extent to which each human actor meets the conditions for moral responsibility. Finally, I pinpoint who (if anyone) is morally worthy of blame for the tragedy through the Responsibility framework.

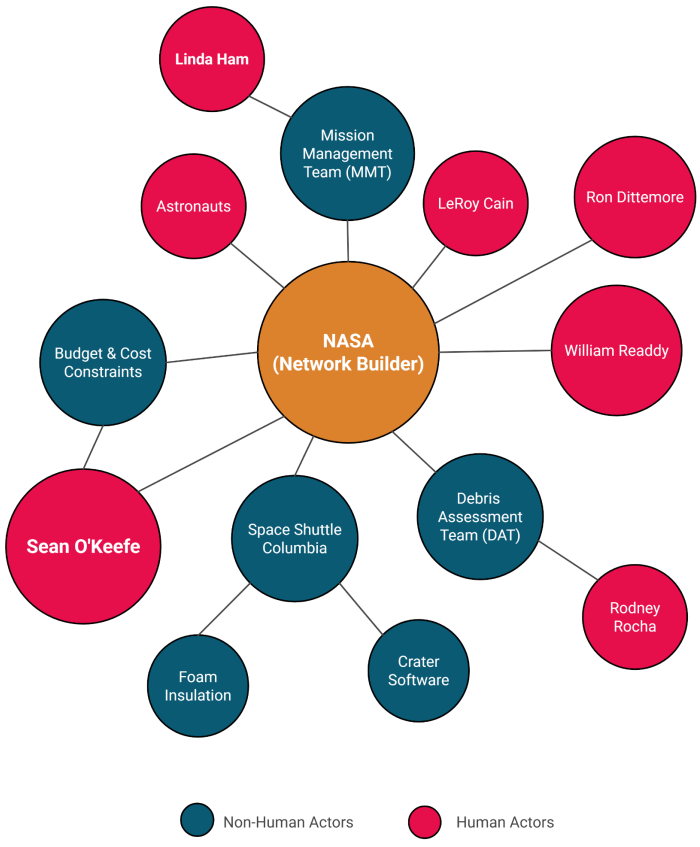
**Analysis I: The Major Actors**

The *Columbia* disaster was a result of interactions between various human and non-human actors, combining to form a network that shaped the decision-making leading to the tragedy. In order to determine who holds moral accountability, I must first identify the major actors that contributed to the accident through the use of the Actor-Network Theory framework (see Figure 2). NASA, and more specifically the Space Shuttle program, commanded the role of the network builder, bringing each actor together to construct the system. Key human actors formed these operations, including several critical executives within the agency. Sean O'Keefe, the NASA Administrator from 2001 to 2004, was the highest-ranking official within the organization and served as NASA's chief decision maker. While not an engineer, O'Keefe's expertise lay in managing large government programs, reflecting the Bush administration's focus

on reducing NASA's scheduling delays and cost overruns (Columbia Accident Investigation Board, 2003, p. 115). Another important figure is William Readdy, the Associate Administrator for Space Flight, who was the agency's top manager for manned missions and "the man ultimately responsible for shuttle operations" (Cabbage & Harwood, 2004, p. 23).

**Figure 2**

*Actor-Network Map of Space Shuttle Columbia Disaster*




*Note.* Non-human actors are depicted in blue while human actors are shown in crimson

Ron Dittemore, the Shuttle Program manager when *Columbia* exploded, was responsible for overseeing shuttle operations, including pre-launch and flight operations. During a technical briefing on February 3, 2003, Dittemore stated that he was "the accountable individual" for the

disaster (C-SPAN, 2003a, 1:03:00). LeRoy Cain, the entry flight director for STS-107, also was instrumental in overseeing *Columbia's* climb to orbit and return to Earth, which is considered the most dangerous part of space travel. The Mission Management Team (MMT), chaired by Linda Ham, was tasked with reviewing mission status and making risk assessments for issues that arose throughout the mission. As chairwoman of the MMT, Ham approved the analysis concluding that the foam strike was not a safety concern (Cabbage & Harwood, 2004, p. 20). Another key actor was Rodney Rocha, a NASA veteran and chief engineer for the Thermal Protection System. Rocha raised concerns immediately after he became aware of the foam striking the Orbiter's wing. He was also a member of the Debris Assessment Team (DAT) that formed to analyze the incident, who unanimously agreed to request higher-resolution imagery of *Columbia* on-orbit from the Department of Defense (DoD) to better understand the severity of the damage.

Non-human actors also played a significant role in this network. *Columbia* itself was central, as was the piece of foam insulation that detached from the external tank and struck the left wing. Astronaut Sally Ride, the first American woman in space and CAIB member, noted that foam shedding had occurred on previous shuttle flights:

> "With *Columbia*, there was a history of foam coming off the external tank during launch. Each time, it was identified as a problem. But there was never a real significant engineering effort to understand why this was happening, what the potential implications were and what needed to be done to stop it. There was no catastrophic damage the first time, the second time or even the third time. It got to be accepted as almost, 'in the family.'" (Dreifus, 2003)

Ride's statement illustrates how repeated instances of foam shedding without causing severe damage were normalized, leading NASA to dismiss the problem. As a result, NASA

management became detached from potential catastrophic outcomes by not relying on extensive engineering analysis to support their conclusions. Another crucial non-human actor was the Boeing software known as Crater, which NASA used to assess the risk of foam strikes. However, the program was designed to evaluate small impacts and lacked the capability to assess a strike of *Columbia*'s magnitude. Despite this limitation, NASA engineers extrapolated from previous data and concluded that the foam impact posed no serious risk (Schwartz, 2003).

While non-human actors like *Columbia*, the foam, and Crater played integral roles, they lack agency and cannot be held morally responsible for the systemic failures that led to the catastrophe. Instead, accountability must be assigned to the human actors who designed, utilized, or interpreted these technologies. Having mapped the key actors and relationships, I now apply the Responsibility framework to determine who bears moral responsibility for the accident.

**Analysis II: Determining Moral Responsibility**

Certain human actors within NASA leadership meet the four conditions for moral responsibility: wrong-doing, causal contribution, foreseeability, and freedom of action. Their decisions, or lack thereof, directly influenced the failure to address the foam strike which ultimately led to the *Columbia* disaster. In a statement to the Senate on February 12, 2003, Sean O'Keefe emphasized that the agency had "no indications that would suggest a compromise to flight safety" during the entirety of the STS-107 mission (O'Keefe, 2003). However, this ignorance was a direct result of the flawed communication structure in place at NASA, which prevented critical safety concerns from being properly escalated. Although O'Keefe was the highest-ranking official at NASA during the disaster, he does not meet all four conditions of moral responsibility because he was not responsible for approving or denying imaging requests,

nor was he embedded in the daily operations of mission management. Additionally, O'Keefe's background was not in engineering, so he lacked the technical foresight necessary to fully understand the consequences of the foam strike. As another key leader within the space flight program, some might point to William Readdy as the one to blame for the disaster. Indeed, Readdy himself stated that he was "the one responsible for shuttle and station within NASA" (C-SPAN, 2003b, 12:30). However, like O'Keefe, Readdy was not actively involved in the MMT's daily operations and did not understand the severity of the foam strike. Furthermore, Readdy was willing to receive additional imagery help, but because the MMT did not classify the strike as a safety-of-flight issue, the priority was low for the DoD (Columbia Accident Investigation Board, 2003). Likewise, Ron Dittemore and LeRoy Cain failed to satisfy the foreseeability condition as they did not have all the information available to them to fully understand the risks.

In contrast, Rodney Rocha was among the first to recognize the potential severity of the foam strike. Although Rocha and the DAT requested additional imagery help from the DoD, they did not follow the proper protocol. Rather than sending the request through the usual mission chain of command to the MMT, Rocha pursued the appeal through his division manager, Paul Shack, because the MMT had shown little engagement with the foam investigation. This deviation from the standard protocol contributed to the shuttle program managers dismissing the request as unnecessary. In an email to Shack, Rocha conveyed his concerns, stating:

> "Without better images it will be very difficult to even bound the problem and initialize thermal, trajectory, and structural analyses. Their answers may have a wide spread ranging from acceptable to not-acceptable to horrible, and no way to reduce

> uncertainty…Can we petition (beg) for outside agency assistance?" (Rocha, personal communication, January 21, 2003).

Rocha emphasizes the uncertainty of the analysis and stresses the potentially disastrous consequences. He explicitly states that the DAT does not have enough information to arrive at a sound engineering conclusion, without which may result in "horrible" outcomes. Additionally, he "begs" leadership to approve the request for additional imagery, highlighting his desperation and the necessity of obtaining the high-resolution images. However, these warnings failed to reach those with the authority to act. Linda Ham, the chair of the MMT, insisted that she was never made aware of any official requests for imagery. Ham later reflected on these appeals, stating:

> "It never came up to me personally… When I did hear about the possible request, I began to research who was asking … I couldn't find any request, so we did not pursue that" (Pianin & Smith, 2003).

Ham's response indicates that she was at least partially aware of informal requests for imagery but chose not to investigate them further. Analyses from foam strikes on previous missions justified this decision, despite them being magnitudes smaller in size. Rather than treating the concerns seriously, she dismissed them as distractions from the already demanding task of managing an active mission. As a result, the DoD canceled the imaging request. After Shack informed Rocha that the MMT was not fulfilling the request, Rocha continued to push for reconsideration. He even drafted an email he ultimately chose not to send, later explaining that he did not want to violate the chain of command:

> "In my humble technical opinion, this is the wrong (and bordering on irresponsible) answer from the [Space Shuttle Program] and Orbiter not to request additional imaging help from any outside source. I must emphasize (again) that severe enough

> damage…could present potentially grave hazards…Yes, it's that serious." (Rocha, personal communication, January 22, 2003)

While Rocha clearly understood the potential danger and made efforts to prevent it, he does not meet the conditions for moral responsibility. Although he foresaw the risk and made a causal contribution by failing to escalate the issue further, he lacked the freedom of action necessary to change the outcome. Rocha operated within NASA's rigid hierarchy, where challenging authority was discouraged and "the humiliation factor always runs high" (Wald & Schwartz, 2003). As a result, he never sent the email that may have finally reached the audience necessary to take action. His decision not to go outside the command structure was shaped by a culture of deference to leadership and his hesitation, while tragic, was not a willful act of negligence.

On the other hand, Linda Ham meets all four conditions of moral responsibility. She violated the wrong-doing principle by shifting the burden of proof to show that the shuttle was unsafe. Additionally, Ham made a causal contribution by denying the request for additional imagery of *Columbia*'s damage. The risk was foreseeable, as multiple engineers shared concerns, and Rocha's emails explicitly outlined the potential consequences of inaction. Ham's dismissal of these warnings played a direct role in stopping the foam damage from being properly assessed. Finally, she had the freedom to act differently by approving the request for higher-resolution images. Unlike Rocha, Ham was in a position of authority and made a deliberate decision not to pursue critical safety measures. Although she had no ill intentions toward the crew or the mission, she bears a greater degree of moral responsibility for the *Columbia* disaster.

So far, I have argued that NASA leadership, and specifically Linda Ham, meets all four conditions of the Responsibility framework. Some, such as the CAIB and Richard O. Mason,

insist that responsibility was too widespread, claiming that "the overwhelming force of the organization's culture and decision-making structure at the time effectively overrode their instinctive moral concerns" (Mason, 2004). Therefore, they contend that no single individual or group can be blamed for the tragedy because NASA's failure was the result of an ingrained organizational culture rather than the negligence of any one person. However, while NASA's broader culture contributed to the disaster, key leaders actively ignored risks and dismissed safety concerns.

When Ham learned of the imaging requests, she questioned NASA's managers to determine where they came from and whether they deemed it a "requirement." The CAIB explains the following:

> "These individuals all stated that they had not requested imagery, were not aware of any 'official' requests for imagery, and could not identify a 'requirement' for imagery. Linda Ham later told several individuals that nobody had a requirement for imagery" (Columbia Accident Investigation Board, 2003, p. 153)

Ham's response shows her deflection and inaction as she did not ask the necessary questions to determine if the shuttle was truly at risk when the appeal for external imaging was brought to her attention. Instead, Ham concentrated on whether the request had been officially classified as a "requirement." By strictly following the formal definitions of NASA's policies, she effectively dismissed the request which led to the DoD canceling the imaging order. Despite the acknowledgment of the informal requests, Ham treated the concerns as invalid and relied on the absence of a "requirement" as an excuse to not inquire further.

This course of action highlights how NASA's culture at the time prioritized following procedures and precedence over proactively verifying safety. Ham had the authority to escalate

the engineers' concerns to receive the additional images necessary to make a full analysis of the shuttle damage. Yet, instead of viewing the request as a possible warning sign, she treated it as an administrative issue and moved forward to keep the schedule and budget on track. Ham's response to the appeals illustrates NASA's approach to risk management at the time. If a concern did not conform to the existing procedural categories, it was discarded. Therefore, Ham ensured that *Columbia* remained on course for disaster by choosing to follow the established protocol rather than proceeding with caution. Thus, while NASA's failures were systemic in nature, certain individuals bore more moral responsibility than others. Leaders like Linda Ham actively dismissed risks, whereas Sean O'Keefe, William Readdy, Ron Dittemore, and LeRoy Cain failed to grasp the severity of the situation but did not deliberately obstruct safety measures.

**Conclusion**

The Space Shuttle *Columbia* disaster may have originated from the organizational complexity of a system like NASA, but it resulted directly from managerial failures that satisfy the four conditions for moral responsibility. The blameworthiness across NASA leadership was not equal, with some such as O'Keefe, Readdy, Dittemore, and Cain playing crucial roles in the flawed decision-making process. However, they lacked the involvement in day-to-day operations to meet all four criteria. In contrast, Linda Ham satisfies these conditions because she knew of the risks, possessed the freedom to act, and dismissed critical warnings that could have prevented the disaster. When viewed from this perspective, the *Columbia* tragedy illustrates not only organizational failure but also how leadership decisions, made within the context of a wider culture, can normalize risk and lead to catastrophic consequences. That is not to say that the broader systemic risks within NASA played no role in the disaster; they are critical to

understanding how such failures emerged in the first place. However, they alone do not fully explain why preventable warnings were ignored. To do that, one must examine how individual decision-makers, particularly Ham, reinforced a culture of complacency that ultimately doomed *Columbia* and its crew.

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