The Columbia Space Shuttle disaster: science and the profit system

Part 2: Schedule pressures undermined safety considerations

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On February 1, 2003, the Space Shuttle Columbia was destroyed upon reentry into the earth's atmosphere, killing all seven crew members. Shortly after the incident, the Columbia Accident Investigation Board (CAIB) was set up to investigate the causes of the disaster. The board summarized its findings in a report released on August 26. This series of three articles analyzes the report and the accident itself.

Part 1 *discussed the physical cause of the accident—a breach in the orbiter's Thermal Protection System caused by a foam strike during the shuttle's launch. The second part analyzes schedule pressures and the reaction of shuttle engineers and management after the launch. The third and final part looks at the underlying cause of the accident: the subordination of the scientific purposes of the shuttle to a political and economic system dominated by the demands of private profit.*

The report is available at the CAIB website: http://www.caib.us. *All numbers in parentheses refer to page numbers of the report.*

Contributing to the events that led to the *Columbia* accident was the extraordinary pressure that NASA was placed under to meet a strict launch schedule. As mentioned in the first article of this series, this pressure led NASA management to downgrade the significance of previous foam strikes on the orbiter. It also affected the way NASA management reacted to the discovery of the strike on *Columbia*—their main concern was not for the safety of the crew but the impact the incident would have on future launches.

The pressure came directly from the Bush administration, channeled through the Bush-appointed NASA administrator, Sean O'Keefe. The administration presented NASA with an ultimatum: either it had to prove that it could complete the first phase of the International Space Station (ISS) by February 19, 2004—and do this without significant cost overruns—or it risked a sharp cut in budget financing or perhaps an elimination of the manned space program as a whole. The number of launches that NASA needed to complete by February to meet its goal meant that any unforeseen incidents on any of the orbiters would throw the whole schedule off.

A political ultimatum

"NASA's degree of success in gaining control of cost growth on [the] Space Station," warned O'Keefe in congressional testimony on May 1, "will not only dictate the capabilities that the Station will provide, but will send a strong signal about the ability of NASA's Human Space Flight program to effectively manage large development programs. NASA's credibility with the Administration and the Congress for delivering on what is promised and the longer-term implications that such credibility may have on the future of Human Space Flight hang in the balance" (116).

This position was repeated in November 2001, following a report on the status of the space station. O'Keefe stated that the administration "calls for NASA to make the necessary management reforms to successfully build the core complete Station and operate it within the $8.3 billion available through FY 2006 plus other human space flight resources.... If NASA fails to meet the standards, then an end-state beyond core complete is not an option." (117). "Core complete" refers to the completion of the first stage of the station's construction, due to end with the launch of STS-120, scheduled for February 19, 2004.

These statements are quite extraordinary. The budget of NASA had been starved for over a decade, prompting many within the program to warn that safety was deteriorating as a consequence. Now the Bush administration was demanding a strict schedule or the agency would face an elimination of funding for the International Space Station, one of the principal functions of the space shuttle program.

"The White House and Congress," notes the CAIB report, "put the International Space Station Program, the Space Shuttle Program, and indeed NASA on probation. NASA had to prove it could meet schedules with cost, or risk halting Space Station construction at core complete—a configuration far short of what NASA anticipated. The new NASA management viewed the achievement of an on-schedule Node 2 launch [STS-120] as an endorsement of its successful approach to Shuttle and Station Programs. Any suggestions that it would be difficult to meet the launch date were brushed aside..." (117).

In addition to the longstanding attempts to cut NASA funding and make it more "cost efficient," one reason why the February 19, 2004 deadline may have been so important for the Bush administration is that it would come at a critical point in the 2004 presidential campaign, during the initial round of primaries in which Bush's Democratic challenger will be selected. There is a precedent for such crass political considerations influencing a NASA decision. The Reagan administration pushed the *Challenger* launch despite unusually cold weather in part because Reagan wanted to refer to the launch in his 1986 State of the Union address.

The *Columbia* mission that led to the accident did not include servicing the ISS. Indeed, *Columbia*, being the oldest of the orbiters that conducted manned space flight, was not even equipped to dock with the station. Nevertheless, on *Columbia's* on-time launch depended the scheduled launches after it. The rush to send up launches for the ISS was so strained that NASA planned to equip *Columbia* with docking gear so it could perform station missions.

So forced was the schedule that four launches were to take place during the five months leading up to the February 2004 deadline. "To put this in

perspective," states the report, "the launch rate in 1985, for which NASA was criticized by the Rogers Commission [the commission responsible for investigating the cause of the *Challenger* disaster] was nine flights in 12 months—and that was accomplished with four Orbiters and a manifest that was not complicated by Space Station assembly" (136).

The report largely absolves the government of blame. "Certainly those in the Office of Management and Budget and in NASA's congressional authorization and appropriations subcommittees thought they were providing enough resources to operate the Shuttle safely..." (118).

This statement is hardly credible, given the numerous warnings voiced in prior years that shuttle safety was suffering from budget cuts, warnings that the report itself cites. For example, a committee chartered by the White House as early as 1990 found that "NASA is currently over committed in terms of program obligations relative to resources available—in short, it is trying to do too much, and allowing too little margin for the unexpected" (102). Don Nelson, a former mission planner who retired from NASA in 1999, warned the Clinton administration directly that the lives of astronauts were in danger because of safety problems. Former NASA administrator Daniel Goldin, after years of supporting budget cuts to the agency, wrote in a letter to the White House in June 1999 that more funding was needed to improve safety.

These are only a few in a series of such warnings over the course of a decade. The policy pushed by the administration with the complicity of NASA management and Congress was truly criminal in character: it recklessly endangered the life of the crew of *Columbia*.

Reaction after launch

The schedule pressure influenced not only the rush to launch STS-107, but the reaction of NASA management once the foam strike had been discovered. "Most of the Shuttle Program's concerns about *Columbia*'s foam strike were not about the threat it might pose to the vehicle in orbit, but about the threat it might pose to the schedule" (139).

Once the nature of the foam strike became clear—which was at first difficult due to the poor maintenance of cameras tracking the launch—engineers sought to take steps that would give a better indication of the extent of the damage. Shortly after the launch, the group working on the photo analysis sent a request for imagery from military assets of the underside of the Shuttle to better gauge damage. This was the first of three requests for such imagery.

The CAIB report stated that by the second day of the flight there was already a discord between the way shuttle engineers were treating the foam strike and the way it was being handled by NASA and United Space Alliance management. United Space Alliance is the joint venture of Lockheed and Boeing that has the bulk of the NASA space shuttle contract. While engineers sought to obtain more information, managers—including Ralph Roe, head of the Shuttle Program Office of Vehicle Engineering, and Bill Reeves of United Space Alliance—made efforts to downplay the seriousness of the incident.

Without clear evidence of the size of the damage, Boeing engineers sought to estimate what the consequences could be. They used a mathematical model known as Crater, which was not designed for use on large objects such as that which struck the *Columbia*. The consolidation of operations at Boeing seems to have played a role here: because of recent job transfers, the engineer who performed the analysis was inexperienced in the use and accuracy of the model. The Crater model actually predicted severe damage on the orbiter, however the results were discounted because the model was considered to overestimate actual damage and did not take into account certain characteristics of the tiles on *Columbia*.

The model was clearly insufficient to determine the actual extent of the damage. More information was required on the location of the hit to make precise predictions. This is why the engineers—including those involved in the Debris Assessment Team—requested in-flight photos of the Shuttle.

The requests for imagery were eventually cancelled by Linda Ham, the flight manager. The board cites concerns by Ham that the proper chain of command was not followed in the requests. Ham has also stated that in making the cancellation she was unaware that a request had been made by the Debris Assessment Team, which was responsible for analyzing the foam incident.

These excuses do not really stand up. The main concern of Ham and other managers appears to have been that to request photos would require the *Columbia* to delay its other work, causing disruptions in the schedule. Moreover, such a request would acknowledge the seriousness of the strike, potentially causing problems for future flights. Even if Ham was truly as unaware of the activity of the Debris Assessment Team as she states, this would suggest that safety considerations had been pushed aside at NASA to a truly astonishing degree. After all, the Debris Assessment Team was tasked with examining an incident that was potentially catastrophic to the mission and its crew.

In downplaying the significance of the foam strike, Ham cited the rationale for characterizing a foam strike on an earlier flight as a non-serious incident. This was in spite of the fact that she knew the previous rationale was faulty—saying that it "was lousy then and still is" in a January 21, 2003 email sent to Shuttle Program Manager Ron Dittemore (148).

That Ham was aware of the potential damage the foam could have caused is revealed in the personal notes of one person involved in the discussions, who wrote that "Linda Ham said [the photo request] was no longer being pursued since even if we saw something, we couldn't do anything about it. The Program didn't want to spend the resources" (154). In fact, as the CAIB report points out, if action was taken immediately after the discovery of the strike, it would have been possible to send another shuttle up to evacuate the crew of the *Columbia*.

The decision by Ham and other NASA and contractor managers to cancel the imagery request put the engineers in the Debris Assessment Team in an uncomfortable position. They were asked to provide a "need/rationale for Mandatory Viewing of damage site" (156). The demand that the engineers provide a mandatory need for photographs was made by a United Space Alliance manager.

Rodney Rocha, one of the members of the Debris Assessment Team, voiced some of his concerns in an email to his managers: "there are good scenarios...to horrible ones, depending on the extent of the damage incurred by the wing and location....We do not know yet the exact extent or nature of the damage without being provided better images, and without such all the high powered analysis and assessments in work will retain significant uncertainties" (156-57).

In another email Rocha wrote, "In my humble technical opinion, this is the wrong (and bordering on irresponsible) answer from the SSP and Orbiter not to request additional imaging help from any outside source" (157). This email was not sent out to NASA management—apparently Rocha felt intimidated by management into not raising forcefully his safety concerns.

The fact that the foam had struck the orbiter was reported to the Shuttle crew. A transcript of the Mission Management Team quotes Phil Engelauf, chief of the Flight Director's office, as saying, "I will say that crew did send down a note last night asking if anybody is talking about extension days ... but we made it very clear to them no, no concerns" (161). Only a week later, the *Columbia* burned up upon reentry.

To be continued

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