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# NASA braced for culture shock as Columbia inquiry reaches verdict

**Tony Reichhardt, Washington**

Six months after the loss of the space shuttle Columbia and its crew, the panel charged with investigating the accident is set to reveal its findings.

The report from the Columbia Accident Investigation Board (CAIB), due to be published on 26 August, is expected to be highly critical of the US space agency — and its implications for the future of manned space flight could be profound.

“There’s no doubt that the report will be important,” says Howard McCurdy, a space-policy expert at the American University in Washington DC. “The question is whether it will be influential, or whether everybody will graciously receive it, forget about it and go back to flight.”

Columbia disintegrated on 1 February as it attempted to re-enter Earth’s atmosphere. Uncovering the cause of the accident has been relatively straightforward, if labour-intensive. CAIB members found their ‘smoking gun’ last month following a lab test in which a chunk of insulating foam, shot from a gun at 800 kilometres per hour, blew a gaping hole in a section of the shuttle’s wing.

The test confirmed a ‘working scenario’ that the 13-member board and NASA investigators had been building for months. Columbia’s break-up was caused by just such an impact, sustained when a piece of insulating foam broke away from a fuel tank during take-off. The resulting hole allowed superheated gases to enter and fatally damage the wing during re-entry.

But other kinds of smoking gun have been harder to come by. Despite the news media’s focus on e-mails sent by low-level NASA engineers apparently warning of impending disaster before Columbia’s return, these turned out to be hypothetical scenarios rather than deeply felt concerns.

What the CAIB investigation has revealed



Columbia commences its ill-fated mission.



Harold Gehman: panel will pull no punches.



Sean O’Keefe: braced for a harsh report.

is more subtle, and perhaps more troubling — a culture at NASA that left staff staring a fatal problem in the face without noticing. Shuttle engineers had become complacent over the years about insulation foam striking the vehicle, in part because they had never analysed the risk in detail. The antiquated software used to assess the effects of the foam impact on Columbia didn’t even consider damage to material on the wing’s leading edge, where the foam actually hit. Based on this faulty assessment, flight managers accepted that there

was no danger to Columbia’s mission.

With this error in mind, the CAIB is likely to advise NASA to routinely collect far more data on the remaining shuttles’ performance and vulnerabilities than it does at present, and to make sure that potential risks come to managers’ attention. As Harold Gehman, the retired navy admiral who chairs the CAIB, said during one of the panel’s hearings: “You’ve got to start looking for trouble.”

Such a research effort could be expensive. Fixing the shuttles’ problems, while designing

and building their replacement, may mean adding several billion dollars to NASA's \$15-billion annual budget, McCurdy estimates. Gehman's board won't consider the cost of its findings, but Congress and the White House will have to, especially if the CAIB recommends that NASA invest more in shuttle safety or stop flying.

Gehman is ideally positioned to issue that kind of challenge. NASA administrator Sean O'Keefe hand-picked him to head the CAIB, because of Gehman's experience in leading the investigation into the October 2000 terrorist attack on the warship *USS Cole* in Yemen, which claimed 17 lives.

Congressional critics, notably Bart Gordon (Democrat, Tennessee), a member of the House science committee, raised early doubts about the CAIB's independence, noting that it had been appointed by NASA's administrator and relied too heavily on agency staff. By contrast, Gordon pointed out, when the space shuttle *Challenger* exploded during take-off in 1986, the investigation commission was set up by the White House. In response, O'Keefe added three more panel members, all from academia, and successfully muted most of the criticism.

### History repeated

The CAIB's report is set to be far more hard-hitting than the *Challenger* inquiry — partly because the institutional failings underlying the first accident seem to have been repeated. As Boston College sociologist Diane Vaughan, author of a book on the *Challenger* accident, told the panel during an April hearing: "The problems that existed at the time of *Challenger* have not been fixed."

Vaughan and other witnesses described a shuttle-engineering culture that habitually, if unintentionally, ignored trouble signs and was slow to question its own assumptions. The CAIB report will probably also take NASA to task for being too insular.

Another issue that the report will address is whether shuttle managers' bad habits are their own fault, or the result of financial and schedule pressures from above. "I think the report is going to point lots of fingers — it's not going to be a one-finger report," says McCurdy. He expects sharp criticism of Congress and of the White House Office of

Management and Budget "for deluding themselves about what's really required to run a programme of this magnitude".

Gehman's panel heard several witnesses describe long lists of safety measures that had been deferred for lack of money. In 1997, NASA estimated that it would need between \$5 billion and \$7 billion for shuttle-safety upgrades. Only a fraction of that amount was actually spent.

Testifying before the CAIB, Henry McDonald, former head of NASA's Ames Research Center in Moffett Field, California, and now an engineering professor at the University of Tennessee in Chattanooga, described the conclusion reached by a panel he chaired in 1999 to look into shuttle safety. His group found that procedures that had evolved over years to improve safety had been eroded because of a reduction in resources and staffing, he said.

Gehman's panel will consider this in identifying the root causes of the accident, and may tackle an even trickier question: how safe should we reasonably expect space flights to be? In 1995, NASA commissioned a comprehensive risk analysis for the entire shuttle system. The study, by engineering consultancy SAIC, based in San Diego, California, estimated the risk of losing a vehicle and crew at between 1 in 76 and 1 in 230. *Columbia's* last flight was the 88th shuttle flight after the *Challenger* disaster.

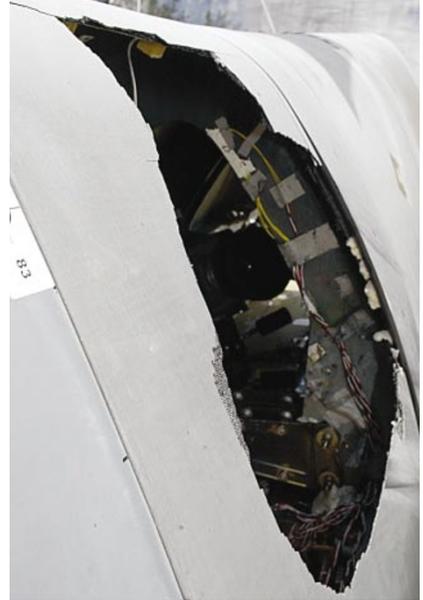
In the months since the accident, NASA managers have occasionally bristled at implications that they had been irresponsible or complacent. Phil Engelauf, a veteran shuttle-flight director and operations manager for the fateful mission, said during an emotional round-table meeting with reporters last month that the shuttle is "the most complicated machine that humans have ever built. Over time, we are going to make some human errors."

### Blame culture

In his public statements, Gehman has criticized the false wisdom of hindsight. "If these flaws are out there lying around and everybody should have seen them ... tell me what the next one is, if you're so smart," he said in May. "If we as a board can't answer that question, we are very slow to sling spears at other people who also failed to answer it."

O'Keefe, meanwhile, has braced his troops for a harsh report, and agency officials have said that they will do whatever they're told. "There will be no attempt whatsoever to argue against a recommendation from the CAIB," said deputy administrator Fred Gregory, who answered reporters' questions earlier this month. Asked whether that would apply to any call to reform NASA's culture, Gregory said: "It would be difficult for me to define to you what the NASA culture is."

Whatever that culture is, attempts have



Smoking gun: a shuttle wing damaged by foam confirms the cause of *Columbia's* demise.

been made to reform it before — after the 1986 *Challenger* accident, most obviously, but also following the 1967 *Apollo 1* fire, which killed three astronauts. An inquiry into that incident led to widespread management and engineering changes at the space agency — yet three years later, the *Apollo 13* astronauts were lucky to make it back from the Moon alive, after an onboard oxygen tank exploded during the flight.

Nor have these incidents been the only motivator for reform. McDonald's safety review was initiated at NASA's own request, after an in-flight problem led the agency to halt launches and inspect wiring throughout the shuttle fleet. The review identified many of the same shortcomings that the Gehman panel will highlight next week: the waiving of safety standards; failure to update safety databases based on fresh problems; and the assumption that hardware will not fail just because it never has before.

NASA "took our report very, very seriously", recalls McDonald. The agency added 100 new inspectors, and got a commitment from President Clinton's budget office for more than \$1 billion in safety upgrades. Only months later, the incoming administration of President George Bush balked at the rising costs of the International Space Station, and told NASA to fix the problem from within its human spaceflight budget. The money for shuttle safety has since been cut drastically. One of the key figures in the budget negotiations was none other than O'Keefe, who worked at the Office of Management and Budget before taking over at NASA in November 2001.

Now, in the wake of the *Columbia* accident and the Gehman report, McCurdy thinks that NASA's paymasters will be forced to accept something they have long been seeking to avoid. "If you want to run the shuttle well," he says, "you've got to belly up to the fact that it costs a lot of money." ■

▶ [www.caib.us](http://www.caib.us)



Piece by piece: compiling evidence on the *Columbia* accident has been a painstaking process.