Dogged Engineer's Effort to Assess Shuttle Damage

By JAMES GLANZ and JOHN SCHWARTZ

HOUSTON — Over and over, a projector at one end of a long, pale-blue conference room in Building 13 of the Johnson Space Center showed a piece of whitish foam breaking away from the space shuttle Columbia's fuel tank and bursting like fireworks as it struck the left wing.

In twos and threes, engineers at the other end of the cluttered room drifted away from their meeting and watched the repetitive, almost hypnotic images with deep puzzlement: because of the camera angle, no one could tell exactly where the foam had hit.

It was Tuesday, Jan. 21, five days after the foam had broken loose during liftoff, and some 30 engineers from the National Aeronautics and Space Administration and its aerospace contractors were having the first formal meeting to assess potential damage when it struck the wing.

Virtually every one of the participants — those in the room and some linked by teleconference — agreed that the space agency should immediately get images of the impact area, perhaps by requesting them from American spy satellites or powerful telescopes on the ground.

They elected one of their number, a soft-spoken NASA engineer, Rodney Rocha, to convey the idea to the shuttle mission managers.

Mr. Rocha said he tried at least half a dozen times to get the space agency to make the requests. There were two similar efforts by other engineers. All were turned aside. Mr. Rocha (pronounced ROE-cha) said a manager told him that he
refused to be a "Chicken Little."

The Columbia's flight director, LeRoy Cain, wrote a curt e-mail message that concluded, "I consider it to be a dead issue."

New interviews and newly revealed e-mail sent during the fatal Columbia mission show that the engineers' desire for outside help in getting a look at the shuttle's wing was more intense and widespread than what was described in the Aug. 26 final report of the board investigating the Feb. 1 accident, which killed all seven astronauts aboard.

The new information makes it clear that the failure to follow up on the request for outside imagery, the first step in discovering the damage and perhaps mounting a rescue effort, did not simply fall through bureaucratic cracks but was actively, even hotly resisted by mission managers.

The report did not seek to lay blame on individual managers but focused on physical causes of the accident and the "broken safety culture" within NASA that allowed risks to be underplayed. But Congress has opened several lines of inquiry into the mission, and holding individuals accountable is part of the agenda.

In interviews with numerous engineers, most of whom have not spoken publicly until now, the discord between NASA's engineers and managers stands out in stark relief.

Mr. Rocha, who has emerged as a central figure in the 16 days of the Columbia's flight, was a natural choice of his fellow engineers as a go-between on the initial picture request. He had already sent an e-mail message to the shuttle engineering office asking if the astronauts could visually inspect the impact area through a small window on the side of the craft. And as Mr. Rocha was chief engineer in Johnson Space Center's structural engineering division and a man with a reputation for precision and integrity, his words were likely to carry great weight.

"I said, `Yes, I'll give it a try,' " he recalled in mid-September, in the course of five hours of recent interviews at a hotel near
the space center.

In its report, the independent Columbia Accident Investigation Board spoke of Mr. Rocha, 52, as a kind of NASA Everyman — a typical engineer who suspected that all was not well with the Columbia but could not save it.

"He's an average guy as far as personality, but as far as his engineering skills, he's a very, very detail-oriented guy," said Dan Diggins, who did many of the interviews for the report's chapter on the space agency's decision-making during the flight and wrote that chapter's first draft before it was reworked and approved by the board. Never in hours of interviews did Mr. Diggins find a contradiction between Mr. Rocha's statements and facts established by other means, he said.

Mr. Rocha's experience provides perhaps the clearest and most harrowing view of a NASA safety culture that, the board says, must be fixed if the remaining shuttles are to continue flying.

**Early Love With Shuttle**

Alan Rodney Rocha loved the Columbia long before it was lost. In August 1978, as a young NASA engineer, he took his first business trip for the agency to Palmdale, Calif., where the still unfinished Columbia sat in a hangar among the Joshua trees, awaiting its first mission.

Working from 6 p.m. to 6 a.m. each night, he had the job of climbing into the orbiter's wheel well, through the fuselage and among the labyrinth of tubes, wires, struts and partitions in the right wing, to check that each of 200 strain gauges were just where the plans said they should be. And the Columbia took its place in his heart.

"I felt so privileged to be there," he said.

The Columbia took its maiden flight in 1981; five years later its sister vessel the Challenger was lost with its crew of seven when O-ring seals in one of the solid rocket boosters failed in the launching, severing a strut connecting the booster to the
shuttle's external fuel tank.

For Mr. Rocha, the Columbia disaster began on the eve of its final liftoff. That afternoon, he and other engineers were stunned to learn of new tests at a NASA laboratory showing that a ring attaching the rocket boosters to the external tank had not met minimum strength requirements. As he watched, managers hastily considered the problem at a prelaunching meeting beginning at 12:10 a.m. on Jan. 16.

Instead of halting the launching on the spot, Mr. Rocha said, the shuttle manager, Linda Ham, granted a temporary waiver that reduced the strength requirements, on the basis of data that the investigation board later found to be flawed. Mr. Rocha would draw on an old rocketry term — "launch fever" — to describe what had happened at the meeting.

The launching went ahead that Thursday morning. The ring held, but an unrelated problem turned up when insulating foam tore away from an attachment to the external tank 81.7 seconds after liftoff and struck the orbiter's left wing.

Mr. Rocha said that when he learned of the foam strike in a phone call on Friday afternoon, he gasped. All weekend he watched the video loop showing the strike, and at 11:24 p.m. on Sunday, he sent an e-mail message to the manager of the shuttle engineering office, Paul Shack, suggesting that the astronauts simply take a look at the impact area.

Mr. Shack never responded. But by Tuesday afternoon, Mr. Rocha was showing the loop to the so-called debris assessment team at the meeting in Building 13, where he had his own office. As arresting as the images were, the team agreed, they were too sketchy to draw conclusions without new images.

To engineers familiar with the situation, the request was an easy call. "We all had an intense interest in getting photos," said Steven Rickman, a NASA engineer whose staff members served on the assessment team. "As engineers, they're always going to want more information."

In his second e-mail appeal for satellite imagery, Mr. Rocha
wrote in boldface to Mr. Shack and other managers, "Can we petition (beg) for outside agency assistance?"

But Mr. Rocha did not know that the strange politics of the NASA culture had already been set in motion. Calvin Schomburg, a veteran engineer who was regarded as an expert on the shuttle's thermal protection system — though his expertise was in heat-resisting tiles, not the reinforced carbon-carbon that protected the wings' leading edges — had been reassuring shuttle managers, Mr. Diggins said. Mr. Schomburg either "sought them out or the managers sought him out to ask his opinion," Mr. Diggins said.

Whether because of Mr. Schomburg's influence or because managers simply had no intention of taking the extraordinary step of asking another agency to obtain images, Mr. Rocha's request soon found its way into a bureaucratic dead end.

On Wednesday, an official Mr. Schomburg had spoken to — Ms. Ham, the chairwoman of the mission management team — canceled Mr. Rocha's request and two similar requests from other engineers associated with the mission, according to the investigation board. Late that day, Mr. Shack informed Mr. Rocha of management's decision not to seek images.

Astonished, Mr. Rocha sent an e-mail message asking why. Receiving no answer, he phoned Mr. Shack, who said, "I'm not going to be Chicken Little about this," Mr. Rocha recalled.

"Chicken Little?" Mr. Rocha said he shouted back. "The program is acting like an ostrich with its head in the sand."

Mr. Shack, Mr. Schomburg and Ms. Ham declined to comment for this article or did not respond to detailed requests for interviews relayed through the space agency's public affairs office.

On the day he talked with Mr. Shack, Mr. Rocha wrote an anguished e-mail message that began, "In my humble technical opinion, this is the wrong (and bordering on irresponsible) answer." He said his finger hovered over the "send" key, but he did not push the button. Instead, he showed the draft message to a colleague, Carlisle Campbell,
an engineer.

"I said, `Rodney, that's a significant document,'" Mr. Campbell said in an interview. "I probably got more concerned or angry than he did at the time. We could not believe what was going on."

But Mr. Rocha still decided he should push his concerns through official channels. Engineers were often told not to send messages much higher than their own rung in the ladder, he said.

**Taking the Issue Higher**

The next day, Mr. Rocha spoke with Barbara Conte, a worker in mission operations, about spy telescopes. In a written response to reporters' questions, Ms. Conte said her colleague "was more keyed–up and troubled than I had ever previously encountered him."

That day, she and another NASA employee, Gregory Oliver, took the issue to Mr. Cain, the Columbia's flight director for landing, at an unrelated meeting.

"We informed LeRoy of the concern from Rodney" and offered to help arrange an observation by military satellites, Mr. Oliver wrote on March 6 — a month after the accident — in a previously unreleased e-mail chronology of shuttle events. The message continued, "LeRoy said he would go talk to Linda Ham and get back to us."

About two hours later, at 12:07 p.m. that day, Mr. Cain sent out his own e-mail message saying he had spoken with management officials, who had no interest in obtaining the images. Therefore, Mr. Cain wrote, "I consider it to be a dead issue."

It was not over for Mr. Rocha, though. On Thursday afternoon, Jan. 23, he encountered Mr. Schomburg, the expert on the heat–resisting tiles, on the sixth floor of Building 1, where most of the managers had offices. They sat down in the anteroom of an office and began arguing about the need for imaging, said Mr. Rocha and the investigative
Mr. Schomburg insisted that because smaller pieces of foam had broken off and struck shuttles on previous flights without dire consequences, the latest strike would require nothing more than a refurbishment after the Columbia landed. Mr. Rocha maintained that the damage could be severe enough to allow hot gases to burn through the wing on re-entry and threaten the craft.

As their voices rose, Mr. Rocha recalled, Mr. Schomburg thrust out an index finger and said, "Well, if it's that bad, there's not a damn thing we can do about it."

On Jan. 24, eight days into the mission, engineers and managers held a series of meetings in which the debris strike was discussed. At a 7 a.m. meeting, Boeing engineers presented their analysis, which they said showed that the shuttle probably took the hit without experiencing fatal damage.

Those results were hastily carried into the 8 a.m. meeting of the mission management team, led by Ms. Ham. When a NASA engineer presented the results of the Boeing analysis and then began to discuss the lingering areas of uncertainty, Ms. Ham cut him off and the meeting moved along. The wing discussion does not even appear in the official minutes.

Mr. Diggins, the accident board investigator, said it should not be surprising that such a critical issue received short shrift. A mission management meeting, he said, is simply "an official pro forma meeting to get it on the record." The decision to do nothing more, he said, had long been made.

By then, Mr. Rocha said, he decided to go along. "I lost the steam, the power drive to have a fight, because I just wasn't being supported," he said. "And I had faith in the abilities of our team."

He waited through the weekend until the Boeing engineers closed out the last bit of their analysis, and on Sunday, Jan. 26, he wrote a congratulatory e-mail message to colleagues, saying the full analysis showed no "safety of flight" risk. "This
very serious case could not be ruled out and it was a very good thing we carried it through to a finish," he wrote.

But his anxiety quickly spiked again. He slept poorly. Mr. Diggins said, "I think that what was gnawing away at him was that he didn't have enough engineering data to settle the question he had in his mind." With days to go in the mission, Mr. Rocha continued to discuss the possibility of damage with Mr. Campbell, the expert in landing gear.

"He started coming by my desk every day," Mr. Campbell recalled. "He was trying to be proper and go through his management," he said, but "he was too nice about it, because he's a gentleman; he didn't get nasty about the problem."

Being There for Re-entry On Feb. 1, the last day of the Columbia's flight, Mr. Rocha rose before dawn. He wanted to be in the mission evaluation room, an engineering monitoring center on the first floor of NASA's Building 30, by 6:45 a.m., well before the shuttle fired its rockets to drop out of orbit. Normally, he would just watch the landing on NASA-TV, the space agency's channel, but he said he wanted to see the data from the wing sensors.

The room was jammed with people and computers. There was a pervasively upbeat mood.

Before long, things began to go wrong — and in the ways that Mr. Rocha had feared. The scrolling numbers giving temperature readings for the left and right wings began to diverge. Then, at 7:54 a.m., four temperature sensors on the left wing's wheel well failed.

In fact, the hole that the foam had punched into the wing 16 days before had been allowing the superheated gases of re-entry to torch through the structure for some several minutes, and observers on the ground had already seen bright flashes and pieces shedding from the damaged craft.

As the number of alarming sensor readings quickly mounted, "I started getting the sick feeling," Mr. Rocha said, pointing to his stomach. He looked up from the fog of fear and saw another engineer, Joyce Seriale-Grush, in tears. He
approached her and she said, "We've lost communication with the crew."

Mr. Rocha did the only thing he could think of: He called his wife. "I want you to say some prayers for us right now," he said. "Things aren't good." Finally, they got word that observers on the ground had seen the shuttle break up over Texas.

Emergency plans came out of binders; engineers locked their doors to outsiders and began to store data from the flight for the inevitable investigation. Frank Benz, the Johnson Space Center director of engineering, and his assistant, Laurie Hansen, came in. Mr. Rocha recalled that Ms. Hansen, trying to console him, said, "Oh, Rodney, we lost people, and there's probably nothing we could have done."

For the third time in two weeks, Mr. Rocha raised his voice to a colleague. "I've been hearing that all week," he snapped. "We don't know that."

He was instantly ashamed, he said, and thought, "I'm being rude."

**Troubled Sleep, Late Thanks**

The next days passed in a blur. Mr. Rocha was assigned to the team to investigate the mission. At the same time, he was working with the team that was looking into the attachment ring problem that nearly scuttled the mission the night before liftoff, while handling his other duties.

At one point he got to ask Ralph Roe, a shuttle manager, why the photo request had been denied. He got no direct answer, he recalled. Instead, Mr. Roe replied: "I'd do anything now to get a photo. I'd take a million photos."

Mr. Rocha's sleep was still troubled — now, by nightmares, he said, describing some: he was in the shuttle as it broke up; his relatives were on the shuttle; "Columbia has miraculously been reassembled, and we're looking at the wiring and it's got rats in there."
Since the accident, Mr. Rocha said, engineers and other colleagues have thanked him enthusiastically for speaking up, saying things like, "I can't imagine what it was like to be in your shoes." His immediate supervisor has been supportive as well, he said, But from management, he said: "Silence. No talk. No reference to it. Nothing."

Except, that is, from the highest-up higher-up. One day Mr. Rocha read an interview with the NASA administrator, Sean O'Keefe, who wondered aloud why engineers had not raised the alarm through the agency's safety reporting system. This time, Mr. Rocha broke the rules: he wrote an e-mail message directly to Mr. O'Keefe, saying he would be happy to explain what really happened.

Within a day, he heard from Mr. O'Keefe, who then dispatched the NASA general counsel, Paul G. Pastorek, to interview him and report back. In a recent interview, Mr. O'Keefe said Mr. Rocha's experience underscored the need to seek the dissenting viewpoint and ask, "Are we talking ourselves into this answer?"

NASA, following the board's recommendation, has reached agreements with outside agencies to take images during every flight. And 11 of the 15 top shuttle managers have been reassigned, including Ms. Ham, or have retired.