The Greatest Day

Eric Choi

"Why is Gene Kranz a hero? Well, Apollo 13. I mean, they had the greatest catastrophe that ever happened in space, and it was the greatest day ever for Mission Control because they saved the crew and snatched victory from the jaws of defeat . . . I can't say that. We never even gave ourselves the opportunity."

—Wayne Hale,

Former NASA Flight Director

* * *

Kennedy Space Center
Central Instrumentation Facility
January 17, 2003

The engineers stared at the screen on the far wall of the conference room, mesmerized by the grainy footage of the previous day's liftoff of the Space Shuttle *Columbia* that was playing on a repeating loop. Over and over, the film showed an object breaking away from *Columbia's* external tank and smashing into its left wing, bursting into a shower of particles.

"What do we have here?" asked Wayne Hale.

"Something, probably a piece of insulating foam, came off the external tank about 82 seconds after launch and hit the left wing of the vehicle," said Bob Page, the chair of the Intercenter Photo Working Group.

"Is there a danger?" Hale asked immediately.

"We don't know," Page said. "It depends on the size of the foam, the speed and angle of impact, and where it hit. Based on this footage, our preliminary estimate for the foam size is between 21 to 27 inches in length and 12 to 18 inches in width, with an estimated impact speed somewhere between 625 and 840 feet per second relative to the vehicle."

"And the impact location?"

An engineer named Armando Oliu picked up a model of the Shuttle and tapped his finger on the leading edge of the left wing. "Somewhere here, probably on the reinforced carbon-carbon panels, or maybe on the thermal protection tiles just below."

"That's a lot of uncertainty," said Hale.

"The uncertainties are due to the low frame rate and poor resolution of the camera," Page explained. "These views were taken by a film camera 17 miles away."

"What does your team need to resolve the uncertainties?" Hale asked.

"Better images," Oliu said, without hesitation.

"Can the astronauts see that area, by looking out the windows?"

"No. The payload bay door blocks the view."

"You know," Page said, "back in the early days of the program, they sometimes got spy satellite images of the shuttle in orbit to check the thermal protection tiles. Could we petition for outside agency assistance?"

The question was met with silence. Talk about classified capabilities was off-limits. Page rephrased his request. "We can't tell whether there's damage to *Columbia*, and we need pictures of the vehicle in orbit."

"Okay, I'll bring this up with the MMT," Hale said, referring to the Mission Management Team at the Johnson Space Center in Houston. After twenty-five years at JSC, including serving as a Mission Control flight director for forty-one shuttle missions, Hale had recently relocated to Florida to start a new stint as Kennedy's launch integration manager. Post-launch flight operations were no longer his responsibility, but if Page and Oliu thought it was important he would raise the issue with his former colleagues in Houston.

* * *

Kennedy Space Center
Headquarters Building
January 20, 2003

The meeting of the Mission Management Team commenced in Houston at precisely 8:00 A.M. Central. Wayne Hale, Bob Page, and a number of managers and engineers participated by teleconference.

"Good morning," MMT chair Maria Garabedian said through the speakerphone. *"Flight ops don't respect stat holidays, so I appreciate everyone being here."*

Hale listened in amazement as Garabedian prosecuted the meeting with brutal efficiency. She seemed to revel in briskness, speaking in a stilted syntax of shorthands and acronyms like some NASA auctioneer. A/C problem in the SPACEHAB? Check. Leak in the WLCS? Check. Ku-band antenna glitch? Check.

Discussion of the foam strike was left to the end.

"We've received data from Bob Page's team on the potential range of sizes and impact angles and where it might have hit, and my team has done an analysis," said Don McCormack, the manager of the Mission Evaluation Room. *"While there is potential for tile damage, our thermal analysis does not indicate burn-through, only localized heating."*

"No damage and localized heating means tile replacement," Garabedian summarized.

"Now, the foam might have hit the RCC," McCormack continued, referring to the reinforced carbon-carbon panels on the leading edges of the Shuttle's wings. *"But there shouldn't be anything more than coating damage."*

"So, there's no burn-through and no safety-of-flight issues." Garabedian paused, and Hale could hear the sound of typing. *"All right, it's 8:30. Thanks, everyone."*

Page turned to Hale in disbelief. "This is ridiculous. Is that all they're going to say about it? And what about the imagery request?"

Hale phoned Garabedian when he got back to his office.

"Maria, it's Wayne," Hale said. "Do you have a minute?

"What do you want?"

Hale summarized the discussion from the January 17th meeting of the Intercenter Photo Working Group and reiterated the concerns of Bob Page and Armando Oliu that the launch pictures weren't clear enough to assess the damage to *Columbia* from the foam strike. "So, I emailed you two days ago about on-orbit imagery, but I never heard back. Why wasn't it discussed at the MMT this morning?"

"Is there a mandatory requirement for imagery?" Garabedian asked.

"Mandatory?" Hale blinked. "I'm not sure what you mean."

"Is there a mandatory requirement for imagery? Because I haven't seen anything yet that would indicate a mandatory need."

Hale thought he understood. "Maria, you're putting the team in an impossible situation. They need images to be able to assess potential damage, but you're saying they need to prove the damage is bad enough to justify taking images."

"I can't do anything until someone shows me a mandatory requirement," Garabedian said before abruptly hanging up.

Hale put down the handset, his mind churning. None of this was really his business anymore, but if there was potential safety-of-flight issue, he felt obligated to do something. He picked up the phone again, and placed a call to the NASA liaison at Patrick Air Force Base.

* * *

Kennedy Space Center
Headquarters Building
January 21, 2003

Wayne Hale's phone rang. The call display showed Maria Garabedian's number.

"Why did you call the 45th about on-orbit imagery?" she demanded, referring to the 45th Space Wing at Patrick Air Force Base. *"You are not mission ops anymore. In any case, those requests are supposed to go through proper channels. Through me."*

"I did go through you," Hale said quietly. "There was no response."

"We don't have anybody who has a mandatory requirement for imagery. You know this is a busy flight. We've got all these science payloads, and the flight plan is carefully integrated, and we've got to fly this direction for this payload and that direction for another. Every time we've taken these images before they've never been useful to us."

Hale stayed silent, so Garabedian continued. *"You know, Wayne, even if there was damage, there's nothing we can do about it."*

"Maybe you're right," Hale said at last.

"So, let's just turn this off, okay? Tell them the vehicle's in excellent shape, and that in the future we'll better coordinate so that when a request is made it's done through proper channels."

Hale hung up. For some reason, he found himself shaking. He took a few deep breaths, then got up and walked down the hall. Bob Page was standing near a water cooler. When Hale broke the news, Page was devastated.

"The program doesn't want to spend the resources because MMT thinks that even if we saw something we couldn't do anything?" Page shook his head angrily. "That's bullshit!"

"I know," Hale said.

Page drained the paper cup and threw it into the recycling bin. He stared at the floor for a moment, then turned to Hale.

"Wayne," Page said slowly, "you're a real busy guy, right? You might not have time to get to this until later today, maybe even tomorrow."

Hale looked at his colleague and allowed himself a faint smile.

* * *

Kennedy Space Center
Headquarters Building
10:22 A.M. EST, January 22, 2003

Wayne Hale had just gotten up from his desk when the phone rang. He was about to let it go to voicemail when he noticed the local area code on the call display.

"This is Dave Phillips with the 45th Space Wing at Patrick Air Force Base. I'm calling in regard to your email cancelling the imaging request."

"Yes," Hale said.

"Well, I'm afraid this is a bit awkward, but—the images have already been obtained."

Hale gripped the handset tighter.

"What would you like us to do with them? Do you still want them?"

"Yes," Hale said immediately. "Absolutely, please."

"Understood. I need to remind you the images are classified, so they can only be transferred to and viewed by members of your team with Top Secret clearance."

"That would be me and the flight dynamics officer in Houston, Richard Jones."

"Fine. I'll set up the secure file transfer within the hour."

* * *

Kennedy Space Center
Central Instrumentation Facility
8:36 A.M. EST, January 23, 2003

There was a ghostly beauty to the greyscale images of *Columba* in orbit. The white and grey delta-shaped shuttle stood out starkly against the black of space. *Columbia* looked almost serene and, in the words of Maria Garabedian, appeared to be in excellent shape.

Except for the hole in its left wing.

"Of the dozen or so images obtained, these three provided the best views," explained Bob Page. "The portside payload bay door obscured the other views." He used a laser pointer to indicate the dark square on the leading edge of *Columbia's* left wing. "This is *not* a shadow or an artifact or a glitch. It appears in both of the visible light images as well as the near infrared image, in different lighting conditions and different viewing angles."

Wayne Hale approached the screen and touched the black spot with his finger, as if it were a smudge he could wipe away. "How big is this?"

"Approximately six inches square," said Page.

"I don't see how such a conclusion can be made from these images," said Maria Garabedian on the speakerphone from Houston.

"These pictures have been downsampled and blurred to protect the true capabilities of the imaging assets," Hale explained. "The Air Force assessment was based on the classified full-resolution images, which Richard Jones and I have seen." He leaned closer to the speakerphone. "Joyce, what are the implications for reentry?"

"The implication for reentry is that it's not happening," said Joyce Seriale-Grush, an engineering manager in Houston. *"Based on a number of thermal analyses with different assumptions, the best-case estimate is that plasma will burn-through the wing leading edge spar between EI-plus 450 seconds and EI-plus 970 seconds, resulting in catastrophic structural failure of the left wing, associated loss of flight control . . . and loss of vehicle and crew."*

EI was "entry interface," the point about eighty miles altitude when the shuttle started encountering the effects of the atmosphere. The implication was obvious. *Columbia* would be destroyed long before it got anywhere near the safety of a runway.

"All right," said Hale, "we need to conserve every resource, every consumable, to buy ourselves time to figure out what to do. Let's start with power."

"My team is working on a power-down procedure," said Max Leistung, the lead power engineer in Houston. *"Our goal is to bring peak power down to 9.5 kilowatts, maybe less."*

"What about food and water?"

"I have good news, Wayne," said Katie Rogers, the operations lead for environmental controls and consumables. *"As long as the crew restricts their physical activities, they've got enough food to last more than a month. Assuming the minimal power level, we should still get about three gallons of potable water per crewmember per day as a by-product of the fuel cells."*

"That's definitely good news, Katie. What about oxygen?"

"We're good for oxygen for thirty-one days," Rogers said. *"Actually, the most serious limitation is not too little of something, but too much."*

"You mean carbon dioxide."

"Yes. There are sixty-nine cans of LiOH aboard Columbia." Rogers pronounced it "lye-oh," referring to the lithium hydroxide canisters used to scrub carbon dioxide from the air. *"We'll have to put the crew on a twelve-hour wake and twelve-hour sleep cycle, minimize physical*

activities, and allow the partial pressure of CO_2 to go up to fifteen millimeters of mercury. It won't be a pleasant experience for the crew. They'll suffer shortness of breath, fatigue, headaches. But we'll have enough LiOH to last until Flight Day 30 before CO_2 levels become unacceptable. That takes us to Friday, February 14th."

"So, Valentine's Day is the deadline," said Hale. "How do we bring them home? What repair or rescue options do we have?"

"I'm not aware of any viable repair options," said Garabedian. *"Can* Columbia *make it to the ISS?"*

"Impossible," said the flight dynamics officer, Richard Jones. "Columbia *and the Space Station are in different orbital inclinations. Russian Soyuz won't work for the same reason."*

"So, we'll have to go up and get them," Hale said, "and for that, we just might have a chance. Angela?"

Angela Brewer, the launch processing flow director at Kennedy, nodded. *"Atlantis* is currently in the Orbiter Processing Facility, undergoing preparations for a launch on March 1st. Its three main engines are already installed, and there's no cargo yet in the payload bay. The solid rocket boosters are already attached to the external tank. By working three round-the-clock shifts seven days a week, expediting vehicle checks, and consolidating or skipping less critical tests, *Atlantis* could be ready for launch by February 9th."

"This sounds promising," said a new voice on the phone. Hale recognized the speaker as Ron Dittemore, the manager of the Space Shuttle program. *"But it's predicated on two big assumptions. First, that in the expedited launch processing we make no mistakes and don't break anything on* Atlantis*, and second—maybe more importantly—that we're willing to expose* Atlantis *to the same risk of debris strike that's crippled* Columbia."

"I think it's a mistake, launching again without fully understanding what happened the last time," said Garabedian. *"Do we really want to throw another crew up there?"*

"I can guarantee you," Wayne Hale said slowly, "that we're going to have astronauts lined up around the block to volunteer for this mission."

* * *

Aboard Columbia
Flight Day 8
23:18 UTC, January 23, 2003

Ben Hernandez, the commander of *Columbia*, distributed printouts of the power-down procedures to the crew.

"Willie, K.C., Yael, and I will be responsible for power-down of the flight deck and middeck," he said. "First, the general purpose computers. We leave GPC1 on for vehicle control and GPC3 running at 25 percent for systems monitoring. GPC5 will be in sleep mode, and the remaining GPCs will be turned off. We'll stow the Ku-band antenna, deactivate fuel cell three, and power down cooling loop two.

"K.C. and Yael, I need the two of you in the middeck to deactivate the avionics bay instrumentation, set the cabin air fan to low speed, and power-down the galley."

"We're on it," said the flight engineer, Kalpana Chawla.

"Mike, Laurel, and Dave, the three of you will be responsible for powering down the SPACEHAB. All payloads and related equipment are to be powered off, including all cameras, TV monitors, and video equipment."

"Understood," said mission specialist Michael Anderson.

"And Mike, the lab animals in the SPACEHAB . . . they'll need to be euthanized."

Anderson pursed his lips and nodded grimly.

* * *

Kennedy Space Center
Headquarters Building
6:55 P.M. EST, January 24, 2003

The phone rang. Wayne Hale recognized the Houston number.

"Wayne, how are you? It's Ron Dittemore."

"What can I do for you, Ron?"

"I was a bit surprised to hear you on the call yesterday, and also by the way you ended up taking charge of the discussion. Or maybe, I shouldn't have been surprised. It's not your job anymore, but … well, I guess, you just can't keep your nose out of flight ops, can you?"

"I guess not," Hale conceded.

"Wayne, let me get to the point," Dittemore continued. *"If this rescue mission is to have any chance of success, it's all hands on deck. We're going to need every ounce of experience and knowledge we can get, from everybody."*

Hale gripped the handset tighter, feeling a familiar frisson.

"I'd like you back here, Wayne. Back in Mission Control, back in the flight director's chair. Would you consider coming back to Houston?"

* * *

Orlando International Airport
6:37 P.M. EST, January 28, 2003

"Thank you for your patience. We will commence pre-boarding for Flight 1052 nonstop service to Houston in about five minutes. General boarding will follow."

A crowd was gathered in front of the television in the gate waiting area. Wayne Hale squinted at the screen, then made his way to the airline agent at the podium.

"Excuse me." Hale pointed. "Can you turn up the volume?"

"Sorry sir, I don't control the TV," the gate agent said. "There's nothing I can do about the volume."

"I understand," Hale said. "Thanks anyway."

She looked at him. "Do you work for NASA?"

"Yes, I do."

Her expression changed. "Look, if there's time before boarding, I'll try calling someone at the airport authority, see if they can do anything."

"That would be great. Thanks again." Hale left the podium to join the crowd in front of the TV.

"It is a solemn day at NASA as the space agency recognizes the anniversaries of the Challenger *explosion in 1986 and the Apollo 1 launch pad fire in 1967, while struggling with the current crisis of seven astronauts stranded in space aboard the damaged* Columbia.

"In the midst of the darkness, there was a welcome ray of hope as NASA approved a daring rescue mission. The Space Shuttle Atlantis *was rolled out of the Vehicle Assembly Building this morning and began its journey to the launch pad."* Under a "recorded earlier" caption, the Shuttle orbiter stacked with its external tank and solid rocket boosters rode atop the massive crawler vehicle. *"NASA will complete launch preparations at the pad, working toward liftoff on Sunday, February 9th on a mission to rescue the crew of* Columbia."

The volume came up. Hale turned to the gate agent and waved. She nodded and smiled.

"We have a video from NASA that shows how the rescue will work. Atlantis *will rendezvous with* Columbia *about a day after launch."* On the animation, *Columbia* was upside down with its payload bay toward the Earth. *Atlantis* approached from behind and below *Columbia*, payload bay facing upward, the vehicle oriented perpendicular to its sister ship. *"The ninety-degree orientation will enable the two shuttles to get as close together as possible, less than twenty feet apart, without their tails hitting each other.*

"Once in position, two spacewalking astronauts from Atlantis *will connect a tether to* Columbia *to facilitate transfers between the ships. They will provision* Columbia *with extra spacesuits and carbon dioxide scrubbers, and then they will begin transferring crewmembers from* Columbia *to* Atlantis. *The process is expected to take up to nine hours."*

* * *

Mission Control Houston
NASA Johnson Space Center, Building 30
9:01 P.M. CST, February 9, 2003

Wayne Hale watched Steve Stich's flight control team in action from the glassed-in VIP area

behind and above the Mission Control room. The screen showed an image of *Atlantis* on the pad at Kennedy, glowing in the darkness under the illumination of spotlights.

Joyce Seriale-Grush came into the VIP box, shuffling across the row of chairs. She went up to Hale and gave him a hug. "Welcome back, Wayne. We're all so glad you're here."

"Thank you."

"Atlantis, *you have a 'go' to close and lock your visors,"* said Stephanie Wilson, the capsule communicator.

"Roger that," said *Atlantis* commander Mike Bloomfield. *"And please tell the crew of* Columbia . . . *Tell them we're coming."*

The screen showed a view of *Atlantis* on the launch pad, steam rising and lights glistening in the darkness.

"T-minus 31 seconds. We have a 'go' for auto sequence start. The five computers on Atlantis *are now in control."*

The screen switched to a close-up shot of the engine nozzles at the base of *Atlantis* beneath its tail.

"…eight, seven, we have a 'go' for main engine start …"

Orange-red flames spewed as the engines roared to life, quickly turning a translucent bluish-white as the combustion of the liquid hydrogen fuel became complete.

"…three, two …"

The flame suddenly disappeared.

"…and …we have main engine cutoff."

Hale's eyes widened. Joyce Seriale-Grush gasped.

"We have an RSLS abort. GLS safing and APU shutdown are in progress."

Hale raced to follow the acronym-filled chatter between Mission Control, the Launch Control Center in Florida, and the crew aboard the shuttle. There were references to the ground launch sequencer and the redundant set launch sequencer and the auxiliary power units. The screen switched to a close-up of *Atlantis*. Water was being sprayed on the engine nozzles.

"Flight, Booster."

"Go ahead, Booster," said Steve Stich.

"Flight, I'm getting a report from the LCC that the MPS fire detectors have tripped."

"Copy, Booster," Stitch said with deliberate calm. *"Flight controllers, listen up. We are in a Mode One Egress situation."*

Seriale-Grush put a hand to her mouth.

"The main propulsion system fire detectors went off," Hale said grimly. "They are evacuating the crew."

* * *

Mission Evaluation Room
NASA Johnson Space Center, Building 30
11:23 P.M. CST, February 9, 2003

"What the fuck just happened?" Maria Garabedian demanded.

"The preliminary assessment from Marshall and Rocketdyne indicates a catastrophic failure of the high-pressure liquid hydrogen turbopump in the number two engine," Steve Stich said, "triggering the RSLS abort at T-minus 1.9 seconds." He spread his hands. "I can't even describe how bad this could've been. If this'd happened two or three seconds later, after we lit the solid boosters, we could have lost the vehicle, the pad, the crew . . . everything."

"How long to replace SSME-2?" Garabedian asked.

"We'll need to change out all three engines," said Angela Brewer on the speaker phone from Kennedy Space Center, *"because they all fired and the subsequent water damage."*

"How long?"

"Three weeks. Minimum."

"The crew will be dead in five days," said Garabedian.

A terrible, oppressive silence gripped the Mission Evaluation Room.

After a while, Wayne Hale said quietly, "We'll have to revisit the repair option. The crew will

need to fix the damage somehow, and attempt to come home themselves."

Every pair of eyes turned to Hale.

"We've looked at this, Wayne. They have no repair materials. They're physically and mentally exhausted." Garabedian shook her head. "Wayne, you're asking for the impossible."

Hale closed his eyes. When he spoke again, it was in such a soft voice that people strained to hear.

"Gene Kranz is a hero of mine, as I'm sure he is for many of you. Back in the day, on Apollo 13 . . . well, you all know. They had the greatest catastrophe in space, but it turned out to be the greatest day ever for Mission Control because they saved the crew and snatched victory from the jaws of defeat." Hale looked about the room. "We have an opportunity, here and now, to be able to say that too. Let's give ourselves an opportunity for a great day."

Joyce Seriale-Grush said, "Are you going to channel your inner Gene Kranz and say something about failure not being an option?"

Hale managed a weak smile. "Failure is always a possibility. But giving up, that's not an option. For my part, I will never give up, and I mean never."

People looked at each other and nodded. In ones and twos, and then in small groups, the engineers stood. They all got up, and with quiet, dignified resolve, went back to work.

* * *

Johnson Space Center, Building 1
10:30 A.M. CST, February 10, 2003

"To paraphrase Wayne Hale," said the Space Shuttle program manager Ron Dittemore, "we just might—*might*—have an opportunity for a great day. Joyce?"

Hale watched Joyce Seriale-Grush move to the front of the conference room. She looked exhausted but pressed ahead.

"Our team has devised a repair scenario that we believe to be logistically feasible, making use of existing materials aboard *Columbia*. However, given the critically short timeline, the physiological condition of the crew, and the high number of uncertainties, our team considers the scenario to be high risk with low probability of success."

Seriale-Grush put up a series of screenshots from a computer animation. "The crew will fill a stowage bag with pieces of metal scavenged from the cabin—metal tools, bits of titanium, cutlery . . . any metal they can find. Two astronauts will conduct an EVA, taking the metal scraps and the middeck ladder to use as a work platform, to the site on the left wing."

She pointed to a rendering of two spacesuited figures at the end of a ladder, hovering over an area of the wing highlighted in yellow. "They will stuff the stowage bag of metal into the hole, and then put a contingency water container over it and secure everything with kapton tape. We will maneuver *Columbia* to orient the left wing toward deep space, cold-soaking the patch and freezing the water. *Columbia* will then attempt a modified reentry profile, one that minimizes heating of the left wing, hoping to survive long enough to reach bailout altitude."

There was stunned silence.

"A bag of scrap metal and a bag of ice?" Maria Garabedian exclaimed. "That's not going to stop three thousand degree plasma!"

"No, it's not," Seriale-Grush said, in a trembling voice that betrayed despair. "All we're trying to do is buy time. With the thermal mass of the metal and ice, and the frozen water container partially restoring leading edge wing geometry to delay the tripping of the boundary layer, we might—*might*—delay the burn-through of the wing spar, delaying the structural failure of the wing for as long as possible. Maybe—just maybe . . . long enough for the crew to bail out."

Dittemore stared at the screen. Finally, he asked, "What needs to happen next?"

"Four things," replied Hale. "First, we need a team to come up with an EVA procedure for the crew. Second, we need a team to develop the software load for the modified reentry profile. Third, we need to interface with the navy for the rescue and recovery effort."

"Because—"

"The reentry trajectory will be based on the profile for a landing at Edwards Air Force Base in California," Hale explained. "After the crew has bailed out, we'll need to ditch *Columbia* into

the Pacific."

"Because we don't want debris falling over Texas. Understood. What's the fourth thing?"

"Someone will need to brief and to also . . . um, 'manage' the management, here as well as at Headquarters in Washington."

"Let me take care of the politics." Dittemore pointed at the screen. "I need you and Joyce to make *that* happen."

* * *

Aboard Columbia
Flight Day 27
13:12 UTC, February 11, 2003

For the first time in weeks, Michael Anderson felt truly awake and alert. He and David Brown were wearing masks and had been inhaling pure oxygen for the past four hours. This prebreathe protocol was standard practice in preparation for spacewalks, needed to purge nitrogen from their bodies and prevent the bends. For Anderson and Brown, it was also a welcome respite from the CO_2-induced malaise that had tormented the crew the past nineteen days. He felt a refreshing, almost icy sharpness when he inhaled, and slowly his headache began to clear.

Kalpana Chawla and the Israeli astronaut Yael Dahan had secured a stowage bag and an empty contingency water container to the middeck ladder with tie-wraps, and were in the process of taping towels over one end of the rails. Willie McCool was doing the same with the boots of the spacesuits. Laurel Clark floated about with another stowage bag, filling it with whatever bits of metal she could scavenge from the crew cabin and the SPACEHAB module.

Anderson watched his crewmates with growing concern. In contrast to his regained state of alertness, he saw they were clearly lethargic and perhaps even cognitively impaired.

Ben Hernandez and Willie McCool helped Anderson and Brown don their cooling and ventilation garment, and then slid their legs through the lower torso assemblies with the towel-covered boots. The pair then entered the cramped airlock and wiggled into their upper torsos. With help from Hernandez and McCool, they locked the two parts of their spacesuits together. Finally, they put on their communications caps and helmets.

Dahan and Clark passed the ladder, the bag of scrap metal, and a number of extra water containers and stowage bags into the airlock. They began to close the hatch.

"Hey stop, *stop!"* Brown exclaimed. He held out his hands. "Gloves, people. *Gloves!"*

Anderson stared down at his own bare hands, shocked. Seven pairs of eyes, seven people with checklists, seven of the smartest people in the world, had somehow managed to miss something that obvious. It was an inauspicious start to the spacewalk.

* * *

Mission Control Houston
NASA Johnson Space Center, Building 30
8:49 A.M. CST, February 11, 2003

"Flight, EVA," said Victor Tsang, the extravehicular activity officer. "They are coming out now."

"Copy, EVA," acknowledged Wayne Hale.

The screen showed a shot from a handheld camera operated by *Columbia's* flight engineer Kalpana Chawla, looking out the aft flight deck windows that had a view into the payload bay. Since the contingency spacesuits worn by Michael Anderson and David Brown had no cameras, this was the only way Mission Control could see them, and even this view would disappear when the astronauts went over the side of the payload bay to attempt the repair.

"Columbia, Houston," said Stephanie Wilson. "We see Mike and Dave outside."

* * *

Aboard Columbia
15:08 UTC, February 11, 2003

Mike Anderson and David Brown floated from the airlock to a tool storage container at the forward-left corner of the payload bay. Brown retrieved a tool caddy called a mini-workstation and attached it to the front of his spacesuit. Anderson took out a payload retention device, a pair

of scissors, and a roll of kapton tape, and mounted them to a caddy on Brown's suit.

Anderson keyed his radio. "Houston, we are proceeding to the work site."

The two spacewalkers floated to the portside longeron sill, tethering themselves to a slide wire that ran the length of the payload bay. Each holding an end of the ladder, they used their free hands to pull themselves along a set of handrails. It was a grueling traverse. The stiffness of their inflated gloves and suits made it a physical effort just to maintain a grip.

Anderson and Brown stopped about two-thirds of the way down the length of the payload bay and climbed over the portside door. They flipped the ladder over the edge and carefully maneuvered it until the end touched the left wing, securing the top rung to a door latch using the payload retention device.

"So, there's our work platform." Brown was breathing heavily. "Let's. . . . let's harvest ourselves some thermal blanket."

"Are you all right?" Anderson asked.

"F-fine. Let's go."

They returned to the longeron handrails and continued to the back of the payload bay. *Columbia's* tail and bulbous engine pods towered over them. After several frustrating attempts, Anderson managed to cut a jagged eight-by-seven-inch piece of insulation blanket from the aft bulkhead. They returned to the ladder hanging over the edge of the payload bay.

Anderson climbed down. The grey leading edge of *Columbia's* left wing filled his vision. On the curved bottom of a reinforced carbon-carbon panel was a gaping black hole. His eyes widened as he surveyed the extent of the damage.

Brown was now on the ladder behind him. "Will you look at that?"

"Houston, we are proceeding with the repair," said Anderson. He tried looking inside the hole but was unable to determine the extent of internal damage. Brown handed him the bag of scrap metal, which he gently stuffed into the cavity.

"I'll be back with the CWC and the hose," Brown said.

Anderson took deep breaths, fighting fatigue and willing himself to stay alert as he waited for Brown's return. The Earth passed beneath him, and he watched the approaching coast of western Africa with tired apathy.

Brown handed Anderson a contingency water container with a hose attached. Anderson gently placed the container into the hole over the bag of metal.

Anderson waited for orbital sunrise, then called Kalpana Chawla inside *Columbia*. "All right, K.C. You can start the water."

As the container inflated, Anderson kneaded the white, thick-skinned pouch like a giant lump of dough, trying to achieve a good fit. The expanding container began to press against the edges of the hole.

"Hey K.C., you can stop now," said Anderson.

There was no response. The bag kept growing.

"Kalpana, *stop,* please," Brown called out in a louder voice. The flow of water halted.

"She's exhausted," Anderson said on a private channel.

Anderson disconnected the hose from the water bag. Brown handed him the crude patch of insulation blanket, which he put over the water bag, tucking the sides against the edges of the hole. Finally, Anderson secured the blanket with strips of kapton tape.

"Houston, I think we're done," he said at last. "We've done everything we can."

* * *

Mission Evaluation Room
NASA Johnson Space Center, Building 30
4:02 P.M. CST, February 11, 2003

"Good job, everyone." said Wayne Hale. "Now, we bring them home. Status, please."

"*Columbia* is in the cold-soak attitude," reported Mike Sarafin, the guidance and navigation lead. "The vehicle is oriented with the port wing toward deep space, away from Earth albedo."

"Thank you," Hale said. "Richard, where are we with reentry?"

"Given the need to cold-soak for as long as possible, and the Friday deadline for consumables,

the only reentry opportunity is Thursday evening, Houston time," said Richard Jones. "Deorbit burn will take place over the Indian Ocean at 04:05 UTC, that's 10:05 P.M. here in Houston. The vehicle will reenter at forty-five degrees nose-up, versus the nominal forty-degree angle of attack. The ditching zone is a 2.5 mile by 1.3 mile ellipse in the Pacific Ocean, centered about 80 miles southwest of Los Angeles. *Columbia* is expected to descend to the safe bailout altitude of 34,000 feet about eighteen miles short of the ditching zone. The Navy's recovery task force will be led by the USS *Essex* out of San Diego, with support from the Coast Guard and the Maritime Search and Rescue Unit of the Mexican Navy."

"Okay, thanks. What about software?"

"We're using the Ops 3 flight code from STS-111 as a template," said the software engineer David Deschênes, referring to the last Space Shuttle mission to have landed at Edwards Air Force Base in California. "Changing the reference alpha to forty-five degrees is requiring significant changes to the code. We'll have *something* ready for uplink by Thursday, but I don't have to tell you the code will hardly have been verified. There could be a bug in there that could send them to Mars."

"Wouldn't that be something," Joyce Seriale-Grush muttered.

* * *

Aboard Columbia
Flight Day 29
01:07 UTC, February 13, 2003

The cabin of *Columbia* seemed to become a smaller place as the crew installed their seats in preparation for the deorbit burn and reentry. On the flight deck, Ben Hernandez and Willie McCool assumed their respective commander and pilot positions, with Laurel Clark and Kalpana Chawla sitting behind them. Below in the middeck would be seated Michael Anderson, David Brown, and Yael Dahan.

Anderson and Brown were in the middeck, going through the procedure to install the escape pole. The device would deploy to its full length of fourteen feet after they blew the hatch, curving outward and downward away from the vehicle. Its purpose was to prevent the evacuating astronauts from—ironically—hitting *Columbia's* left wing as they bailed out. Brown would serve as the jumpmaster, helping his crewmates slide down the pole to presumed safety.

On the flight deck, Hernandez, McCool, and Chawla were completing the power-up and deorbit preparations.

"Houston, *Columbia,"* said Hernandez. "Power-up is nominal. We have three good fuel cells, all five GPCs are up, and the Ops 3 Mod 1 flight control software is loaded."

* * *

Mission Control Houston
10:05 P.M. CST, February 13, 2003

"All right, everyone," Wayne Hale said. "Let's bring them home."

The propulsion officer Arnold Fagan counted down. ". . . 3 . . . 2 . . . 1 . . . we have OMS ignition. The deorbit burn has commenced."

* * *

Aboard Columbia

The view out the cockpit windows began to change from the blackness of space to a diffuse orange-yellow glow. Over the course of a few minutes, the faint glow steadily brightened to the white-hot intensity of a blast furnace. Wispy, swirling sheets of fiery plasma streaked across the windows.

But the cockpit was quiet. There was no vibration, no wind noise. Except for the occasional perfunctory report from Ben Hernandez to Mission Control, no one said a word.

* * *

Mission Control Houston

On the screen, *Columbia's* reentry track was plotted on a map as a green curve, arcing from the southern Indian Ocean to the Pacific seaboard of the southwestern United States. A

red triangle indicated *Columbia's* position as it crept toward the coast of California.

"Altitude 90,000 feet, speed 4,308 miles per hour," reported Richard Jones.

"Flight, MMACS," called Jeff Kling, the mechanical and systems officer.

"Go ahead, MMACS," Wayne Hale said.

"Flight, we've just lost four temperature transducers on the left side of the vehicle, two of them on system one and one in each of systems two and three."

"Copy," said Hale. He turned to Joyce Seriale-Grush. Her face was ashen.

"It's started," she whispered.

* * *

Aboard Columbia

"Altitude 43,000 feet, speed 806 miles per hour," Willie McCool called out.

Laurel Clark turned and saw blinking red-and-white aircraft lights out the left-side window, just past Kalpana Chawla's helmet.

"Houston, *Columbia,"* Ben Hernandez radioed. "It looks like we have company."

"Roger, Columbia," said Stephanie Wilson. *"That would be Mike Bloomfield. He promised to come for you, and here he is."*

* * *

Mission Control Houston

A new window appeared on the screen, showing the feed from a night-vision camera aboard the T-38 chase plane flown by astronaut Mike Bloomfield. *Columbia* appeared as a ghostly image in shades of green against a black sky with greenish-white speckles of stars.

Audible gasps went through the room. Some of the flight controllers stood from their consoles like an honor guard.

The hole in *Columbia's* left wing was now an obsidian gash. There were black streaks over the wing and along the fuselage, and dark splatters on the left engine pod and tail—cooled residue of molten metal. The rudder and elevon were deflected, physical manifestation of the flight control system struggling to keep the ship steady.

A chill went down Wayne Hale's spine. *Columbia* was mortally wounded, but she was still alive, still fighting to bring her crew home. She was simply a beautiful, magnificent, heroic flying machine.

"Don't do it."

Hale blinked. Had he said something aloud?

"Don't anthropomorphize the vehicle," said Joyce Seriale-Grush. "She doesn't like it."

* * *

Aboard Columbia

A buzzing vibration shook *Columbia* as it passed below the speed of sound.

"Altitude 42,000 feet, and we are now subsonic," reported Willie McCool.

"All right, everyone," said Ben Hernandez. "Final verification of your sea survival gear, and have your breakup/LOC cue card handy."

* * *

Mission Control Houston

"Cabin venting complete," reported Katie Rogers from the EECOM console.

"Altitude 34,120 feet," said Richard Jones.

"That's close enough," Wayne Hale said. "CAPCOM, get them out of there."

"Columbia," Stephanie Wilson called, "you are 'go' for Mode One Egress."

* * *

Aboard Columbia

"Blow the hatch!" Ben Hernandez ordered.

There was a muffled bang as the middeck door jettisoned and the escape pole deployed.

"Jumpmaster is in position," David Brown called from the middeck.

"Houston, *Columbia."* Hernandez made the final report. "Initiating bailout procedure."

* * *

Mission Control Houston

"Flight!"

Wayne Hale looked up and watched *Columbia* die.

The left wing simply disintegrated. *Columbia* rolled over violently, pitched down, and then went into a flat spin. The tail snapped off, and then the right wing and the main fuselage came apart, throwing the crew cabin clear.

For a moment, the image disappeared as the debris fell away from the field-of-view of the night-vision camera. Then the camera found the targets again and started tracking downward, following the pieces of wreckage like giant, greenish-white snowflakes tumbling toward the water below.

"Recovery, how many?" Hale asked.

The screen showed a view from a night-vision camera aboard the *USS Essex*. The dark ocean blossomed with a greenish-white plume every time a piece of wreckage hit the water. On an adjacent telemetry screen, there was no more data, only the letter "S" for "static" or "NaN" meaning "not-a-number."

Joyce Seriale-Grush was crying.

Hale wiped his eyes with the back of his hand. "How many, Recovery?"

"Three, Flight," came the answer at last. "There were three parachutes. Rescue forces will begin moving into the recovery zone as soon as debris has stopped falling."

* * *

Ellington Field Joint Reserve Base, Texas
April 14, 2003

Wayne Hale watched the honor guard carry the flag-draped caskets of Ben Hernandez, Willie McCool, David Brown, and Laurel Clark down the cargo ramp of the U.S. Air Force C-130 transport. He followed the procession into a hangar where family, friends, colleagues, and dignitaries had gathered. In the front row were seated the families of Hernandez, McCool, Brown, and Clark, next to President Gore and the First Lady with NASA Administrator Sean O'Keefe and Aby Har-Even, the director general of the Israel Space Agency. To their right were the surviving *Columbia* astronauts and their families. Michael Anderson, his right arm in a sling, sat with his wife and two daughters. Kalpana Chawla held hands with her husband. Yael Dahan, sitting between her husband and daughter, was quietly sobbing.

The caskets were placed on a raised platform in front of large-sized portraits of the fallen astronauts. Hale turned to survey the crowd. Stephanie Wilson and Mike Bloomfield were buried in a sea of blue flight jackets. It looked like the entire NASA astronaut corps was here.

President Gore took the podium.

"Today, we honor the brave astronauts of the Space Shuttle *Columbia*—those who are with us, and especially those who are not. The *Columbia* Seven are a reflection of humanity at its best. They knew the dangers but faced them willingly, knowing they had a high and noble purpose in life. They assumed great risk in the service of all humanity, and their courageous spirit will be engraved in our hearts forever with respect and gratitude. The cause of space exploration will continue. Humanity is led into the darkness beyond our world by the inspiration of discovery and the longing to understand. Our journey into space will go on."

Hale found Joyce Seriale-Grush at the post-memorial reception.

"What's on your mind, Wayne?" she asked.

"Gene Kranz. Apollo 13. The greatest day ever for Mission Control." He pursed his lips. "Our day wasn't quite as great, was it?"

"We did everything we could."

"But maybe we could have done more. Maybe we could have saved all of them."

She patted him on the shoulder. "Are you sticking around? In Houston?"

Hale nodded. "There's no need for a launch integration manager at Kennedy if we're not launching for a while. But like the president said, the program will continue. I want to be here."

Seriale-Grush smiled. "In that case, see you at work tomorrow."

Wayne Hale put on his shades and stepped outside into bright sunshine and cloudless blue

sky. It was typical Houston weather, befitting of a great day.

"The Greatest Day" is adapted from a novelette that will appear in the forthcoming alternate history anthology Other Covenants, *to be published in 2020 by ChiZine Publications. Eric Choi is an aerospace engineer and award-winning writer and editor based in Toronto, Canada. He coedited the hard SF anthology* Carbide Tipped Pens *(Tor) with former* Analog *editor Ben Bova and the Prix Aurora Award winning Chinese-themed anthology* The Dragon and the Stars *(DAW) with Derwin Mak. His short stories have appeared in over 20 publications. In 2009, he was one of the Top 40 finalists (out of 5,351 applicants) in the Canadian Space Agency's astronaut recruitment campaign. Please visit his website* http://www.aerospacewriter.ca *or follow him on Twitter @AerospaceWriter.*