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COLUMN ONE

Floating Free and Queasy

A reporter climbs aboard NASA's weightlessness-inducing jet, better known as the Vomit Comet. Two hours pass too quickly.

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ON THE NASA KC-135 — Five miles over the Gulf of Mexico, a pilot gunned the engines of a turbojet and rocketed up at more than 50 degrees, steeper than the face of Mt. Everest.

Anu Bhargava and Michael Scott, two recent Purdue University graduates, had been lying on the floor of the fuselage. Now they were pinned there. I was too. The force of the climb pooled the blood in our legs, pulled our cheeks toward the floor and made us feel as if our stomachs were mashed against our spines. We couldn't have been happier.

I had been summoned by NASA to bid farewell to its KC-135, a jet designed by the Air Force as a refueling tanker but used since 1960 to replicate weightlessness, giving astronauts a taste of space's microgravity and allowing them to test new technology. Twice a year, the plane also serves as a unique classroom for college students from across the nation who, over time, have given the plane its better-known moniker: the Vomit Comet.

This fall, the Comet is headed, in NASA's vernacular, to the boneyard, a weedy field where once-cutting-edge rocket components rest with no greater claim to virility than an old Nova jacked up on cinder blocks. It is being replaced by a newer and sleeker DC-9. This would be one of its final voyages.

As we neared the peak of our climb, Scott, 23, managed to turn his head enough to catch a glimpse of an electronic display tracking gravity inside the plane. The red numbers began to fall: 0.99 … 0.67 …

"One minute!" a NASA official barked over the din of the engines. "One minute!"

"This is it," Scott said, a serene smile spreading across his face. "Get ready."

In the 1990s, economists began to fret over a decline in the number of engineers and scientists being trained in the United States, even as other countries, such as China and South Korea, seemed to be

producing more.

Some predicted an erosion of the nation's technological edge, and NASA is among the government agencies that have shouldered the decline. A federal audit released in January 2003 concluded that NASA's "ability to perform future missions and manage its programs may be at risk" because of shortages in some skill areas, including engineering. Three days later, the space shuttle Columbia disintegrated; critics saw a direct link.

Among other things, NASA has attempted to address the engineering shortage — and buff its image — aboard the 135. Given a Clinton administration directive to foster innovation among the young and the smart, NASA opened the jet to college groups in 1997. More than 1,600 students have used it to conduct experiments that require weightlessness.

Some experiments have had practical applications for NASA. For instance, the agency is developing a program in which three or four satellites would fly together, technology that some believe could assist in weather prediction and map-making. Students' experiments have contributed to the agency's ability to teach the satellites to talk to one another, remaining in formation without being steered by humans on the ground.

During this round of student flights, Bhargava, 22, Scott and three other Purdue students were conducting an experiment in spatial orientation. Inside a wetsuit, they had attached tiny devices that vibrated randomly. Each device, called a speaker, was represented by a button on a keypad, which the students wore on their wrists. When one speaker vibrated, they attempted to punch the corresponding button on the keypad.

The task was simple on the ground. But in microgravity, it grew harder. Purdue's theory was that microgravity adds a new and perplexing "cognitive load" — in effect, it overloads the brain, which has become consumed with trying to orient the body in a strange environment.

If studies like this could help isolate problems that lead to spatial disorientation, resulting technology could have a slew of real-world applications, Scott said. Soldiers, for example, who frequently become disoriented in the heat of battle, could use such technology to figure out where their comrades were.

For now, Purdue's conclusions would be rudimentary — showing, essentially, that it is harder to figure out the pattern of the speakers in zero gravity than not. No one holds any illusions that the students' experiments have produced major contributions to science or technology. Instead, the program's value is in fostering inventiveness, said Donn G. Sickorez, the NASA official who coordinates the university program.

"What keeps us awake at night is this: Where are we going to get the next generation of engineers?" he said. "Well, here they are. These students have studied electronics and computers and engineering and project management, but this is the first time they have had to pull it all together. In the real macro view, this is about maintaining our edge in the global marketplace."

The Chamber

On one of the first days of nearly a week of training, the sun was still peeking over the horizon as 86 students with hair askew and sleep wrinkles on their cheeks stumbled into a massive hangar at Ellington Field, a small airport south of Houston used largely by the military and by NASA to house the 135.

The students were ushered into an intimidating-looking hyperbaric chamber whose walls, a NASA

official pointed out with customary optimism, were covered in flame-resistant paint. Inside, without leaving the ground, our instructors planned to simulate conditions at 25,000 feet, in case the 135 lost air pressure while we were flying.

Like any good government bureaucracy, NASA uses a lot of arcane words and its officials speak in something akin to a clubhouse code. They don't, for instance, say, "Everyone's here" before they start a meeting. They say, "We have a good manifest."

But the hyperbaric chamber elicited a bit of NASA idiolect that turned out to be quite vivid: "useful consciousness." If we lost pressure while flying, the instructors said, our oxygen-deprived brains would give us three to five minutes of useful consciousness, time when we would still have our wits about us and could do important things like latch a seat belt or find an oxygen mask.

To demonstrate the effects of hypoxia — oxygen deprivation — NASA officials told everyone to remove their oxygen masks after the simulator reached 25,000 feet. We were then given a quiz. I disregarded our instructors' admonitions that this was not a competition, and felt certain that my useful consciousness would outlast the others.

Spelling my last name backward was a breeze, as was adding 32 and 14. I appeared to be the only person in the chamber able to list six U.S. presidents in reverse order. (It was later pointed out to me that many of today's college students were born during Ronald Reagan's second term and could not be expected to remember Gerald Ford, certainly not with addled brains.)

I ran into trouble when asked to name the eight states that begin with the letter M. I realized that I was no longer sure that I could name eight states, much less eight starting with M. The last problem featured a drawing of an elephant, and this question: "How many legs does this elephant have?" Mercifully, I was told to put my oxygen mask back on after I answered, "Six."

The real elephant in the room, however, was the prospect of vomiting. Estimates of what NASA calls the "kill rate" — the percentage of passengers who throw up — range from 10% to 25%. Passengers generally get sick in zero gravity when the loss of equilibrium induces nausea; four of the 11 students on my flight would get sick.

"Weightlessness," whether it is felt on NASA's airplane or in orbit, is something of a misnomer. Technically, you weigh the same as you do on the ground, but you are in free fall, plummeting at the same rate as the machine around you.

In space, this can be achieved by flying around the Earth. In the Vomit Comet it is achieved by flying in parabolas, which is a fancy way of saying that the plane climbs steeply, 8,000 feet in 20 seconds or so, and then dives for 20 seconds — over and over again.

On the way up, passengers experience approximately two "Gs," twice the force of gravity, which pins them to the floor and makes them feel as if their weight has suddenly doubled. The effects of gravity are eliminated for about 30 seconds during the U-turn when NASA's pilots negotiate a controlled freefall.

We would be given the option of taking doses of Scop-Dex, an antinausea medication. The pills suppress your stomach's ability to contract and deaden the part of the brain stem that causes vomiting. Scott had flown once previously and knew what to expect.

"You can take the medicine or you can be a man," he told me. "I'm going to take the medicine."

I certainly planned to do the same, though our instructors made it clear that the pills don't work for everyone.

Even among some who take the medicine, "you can get so sick you think you're going to die," Sharon Sands, a NASA medical technician and instructor, told us. Then you get so sick you *want* to die, she explained. "Then you're afraid you're not going to."

We're Off

When the training ended, the students were divided into groups of 12 or so, known affectionately among the instructors as "SOBs," or "souls on board." A couple of days later, it was my group's turn to fly.

From the outside, the 135 didn't look much different than a commercial passenger jet, but inside, there were just a few rows of seats in the back. The rest of the fuselage was open for experiments. The walls were white and padded, "like an insane asylum," Scott noted.

The engines roared, and we were off. As the 135 rose over the Gulf of Mexico, we were told to unbuckle from our seats and plop down on the floor in the center of the fuselage. Within minutes, we went into a steep climb. I closed my eyes to steel myself for my first bout with zero gravity. By the time I opened them I was floating about a foot off the ground, my knees curling slowly toward my chest.

On the ground, gravity causes blood to pool in large veins, mostly in your legs. Without gravity, the blood was shifting toward my chest and head. I didn't feel top-heavy, just free, light and balanced. It's like the split second when you rise out of the seat as you hit turbulence on a commercial jet, or the peak of a roller coaster, but in zero gravity, the feeling lasts.

The closest anyone has ever come to re-creating these conditions on Earth is swimming in a pool, but even then gravity exists, and the water exudes some force on your skin and innards.

A popular misconception about weightlessness is that gravity is reversed, so you are somehow drawn toward the ceiling instead of the floor. But there is no pull at all. Floating requires no effort, and "swimming," or kicking one's legs, does nothing to propel you or keep you in the air. You won't move unless you push off. Once you do, you won't stop until you hit a wall.

"Feet down!" yelled John Yaniec, the lead test director for the KC-135. "Coming out!"

I settled slowly to the floor, in a blissful heap, as gravity returned at the end of our first parabola. In the next two hours we would do it 38 more times, and when it was over, we longed for more.

Once, I became stuck in the middle of the fuselage, floating too far from the ceiling to push off and too far from the walls to guide myself down. After a few seconds of pointless flailing, I just waited; when gravity kicked in, I settled back to the floor.

Later, Bhargava went sailing by, too wrapped up in her experiment to notice. I was shocked at how easy it was to keep her from flying toward the back of the plane; I simply cupped my hand, put it on the top of her head and gently pushed her in the other direction.

"Thanks!" she said cheerfully.

When I got the hang of it, I could take a stroll of sorts during the periods of weightlessness: across the plane's floor, right up the opposite wall, over the ceiling and back down the other wall.

It was spectacular for all the wrong reasons — not because I was walking on the ceiling, but because I felt no different walking there than walking on the floor. No blood rushed to my head. I didn't feel the need to brace myself for a fall. The mechanics of my body felt normal. I just happened to be standing on the ceiling.

Sickorez, the NASA officer who coordinates the program, bounded by toward the end of one of the last parabolas.

"I can't believe you get paid to do this," I said.

"Neither can I," he said. "Neither can I."

Back on the ground, we all had a tough time explaining what we had been through. A few of us said we felt humble — smaller, somehow, like when a child first understands how big the planet is. Most went swimming in the days after, desperate to recapture the sensation.

"I went this morning," another of the Purdue students, 21-year-old Jonathan Wolter, said later in the week. "I knew it wouldn't be the same. I just wanted to try to get close to it again. I had to."