Intelsat rescue saga may alter training

Last week, three astronauts emerged from the space shuttle Endeavour, placed themselves just below a wayward, 9,000-pound satellite and reached out with gloved hands to snare the massive communications craft. That feat, a last-ditch effort to rescue the errant Intelsat-6 and place it in its proper orbit, marked the first time that so many astronauts had ever ventured out in space together. But the successful maneuver, which came after two failed attempts, also spotlighted the differences between ground training and the challenge of working in space.

Astronauts need "better ways to train, so when we get up there the learning curve isn't quite so steep," noted mission commander Daniel C. Brandenstein from orbit. During two days of the flight, which ended May 16, astronaut Pierre J. Thuot tried to manipulate the pincer-like claws of a tool called a capture bar in order to grasp a ring on the satellite's bottom. But he managed only to jar the spinning craft so that it began to wobble.

"The satellite was much more responsive [to touch] than indicated on the ground," says engineer Calvin Seaman at the Johnson Space Center in Houston. He notes that on Earth, crew members attached the capture bar to a stand-in for Intelsat-6 that floated on cushions of air above a laboratory floor, simulating weightlessness in space. But unlike the vacuum of space, air has resistance, or friction, which slows the motion of objects when they are pushed. (Astronauts also rehearsed tasks while immersed in a tank of water, another medium that has resistance.) In orbit, the satellite reacted to even small forces exerted by crew members as they tried to grab the craft.

NASA's W. Michael Hawes cites another limitation: air cushions permit motion along the plane of the floor, but not up and down. "In space, it's a three-dimensional problem," he notes.

A key challenge in orbit, says Seaman, was the interaction among several bodies: the satellite, the astronauts, the capture bar, a robot arm extending from the space shuttle and the shuttle itself. "The dynamics of all those bodies was not what we expected," he says, adding that no simulation on the ground could completely mimic the complex interplay. Due to Earth's atmosphere, notes Seaman, the spacesuits worn during ground training can't easily simulate the stiff, highly pressurized suits that astronauts must wear during space walks. Those suits make it difficult to bend arms or elbows — movements vital for many routine tasks.

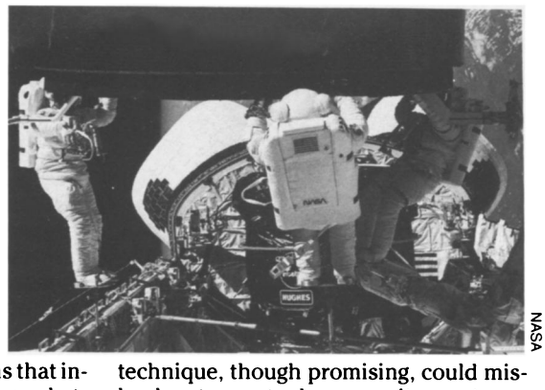
Seaman says the problems in space could modify training for construction of the Freedom space station, as well as a mission to repair the Hubble Space Telescope. But last week's activities had an important difference, he notes: The smooth surface of Intelsat-6 — unlike Hubble — lacks hooks that equipment can grab onto.

"This satellite was never designed to be touched by humans," Seaman says.

Some researchers say sophisticated computer simulations that invoke the concept of virtual reality can better mimic orbital conditions. But Stephen Ellis of NASA's Ames Research Center in Mountain View, Calif., warns that this technique, though promising, could mislead astronauts because it creates a highly specific environment, parts of which may differ from space.

— R. Cowen

Astronauts grab the elusive satellite.



NASA

DNA solves AIDS epidemiological whodunit

When Florida dentist David Acer was accused in 1990 of passing on the AIDS-causing virus (HIV) to seven of his patients, the case raised many nagging questions. People wondered whether a visit to the doctor or dentist was still safe. Policymakers debated whether HIV-infected health care workers should continue to see patients.

But epidemiologists, and later lawyers, faced probably the most vexing and fundamental question: Had the dentist really infected those seven people?

When the Centers for Disease Control (CDC) in Atlanta conducted its initial investigation, the results were suggestive but far from conclusive. Two of the seven infected patients had engaged in behavior that put them at risk for HIV, whereas the other five had not. Investigators knew they'd have to dig deeper for answers.

"Without being able to look at the virus," says CDC epidemiologist Harold W. Jaffe, "it would be very hard to say for sure what the source of infection was."

Now, Jaffe and other CDC researchers have done just that. In some novel genetic detective work, the group has studied the virus' DNA to determine whether the Florida dentist actually infected his patients with HIV. The group's findings, reported in the May 22 SCIENCE and the May 15 ANNALS OF INTERNAL MEDICINE, confirm their initial suspicions: The five patients not at risk for HIV infection contracted the virus from Acer; the other two patients did not.

"This is a pioneering study," says physicist Temple F. Smith of the Biomolecular Engineering Research Center at Boston University. "It's an attempt to look at the DNA and say: Can you actually tell who infected whom?"

The epidemiologists' conclusions hinge on two previous observations about HIV. First, because its genetic data are constantly shuffling, HIV comes in many varieties. Second, HIV strains in people who directly infect each other — for example, sex partners, mothers and their infants, blood donors and recipients — look more genetically alike than HIV strains in people with no contact. Thus, the researchers reasoned that persons whose HIV looked genetically similar to the dentist's had been infected by him.

To find out, the CDC team isolated three short genetic segments from HIV in Acer, his seven patients and 35 HIV-infected Floridians who had had no contact with Acer.

Using a technique called polymerase chain reaction (PCR), the scientists then multiplied and sequenced all these segments. The sequences were analyzed statistically and compared to one another. The only sequences matching Acer's were the ones belonging to the five patients with no prior risk for HIV.

Although both CDC studies taken together seem to resolve the "who infected whom" question, several mysteries remain. One of the most frustrating, says Jaffe, is that CDC researchers still don't know exactly when or how the dentist infected his patients. Investigators conclude, however, that neither deliberate infection nor sexual contact caused the HIV transmission.

Furthermore, although the DNA analysis techniques used in the study look promising, some scientists believe they're not yet accurate enough to use as evidence in court or as a basis for public policy. "If I was on trial," says Smith, "I would not want data used that has some of the potential problems this may have." But someday, he adds, these techniques will become the "ultimate method for identification."

As for the safety question raised by the Acer case, CDC researchers point out that this is the first known case of a health care worker infecting a patient. In fact, they calculate that an HIV-infected surgeon would infect a patient just once every 42,000 to 420,000 procedures.

— M. Stroh