New frontier: NASA preparing for the first satellite repair

by Marsha Freeman

Despite the national press hoopla about the misdeployment of two commercial communications satellites on the recent Shuttle flight, the primary mission objective of the National Aeronautics and Space Administration (NASA) was achieved with shining success. From the start of the Shuttle program, NASA explained that the real value of the Space Transportation System was not only that it is a reusable launch capability, but that it would enable man to go into space to work and discover on a regular basis.

By testing new equipment and new procedures, this 10th Shuttle mission laid the basis for man to go into Earth orbit to repair and build important space equipment and satellites. The successful use of the powered backpacks, and the ability of the crew to improvise while in space, has increased NASA's confidence in these unique uses of the Shuttle.

In 1980, NASA launched the Solar Maximum Mission satellite to gather data on the active phase of the Sun's solar-flare cycle. Several months after launch, the one-of-a-kind scientific satellite developed minor electrical problems which have prevented it from orienting toward the Sun and collecting the data scientists were waiting for.

On the next Shuttle mission, scheduled for an April 4 liftoff, NASA will send two astronauts out to capture the Solar Max, bring it into the orbiter's payload bay, and repair it. Without the just-completed Shuttle mission, which successfully tested the new equipment and procedures which the satellite repair will require, this next feat would not be possible. These techniques and new tools will be needed for the construction of large structures in space, and for use of the just-authorized space station.

Fixing an ailing satellite

In every space walk outside a spaceship since the first in 1965, the astronaut or cosmonaut has been tethered to the ship. The 10th Shuttle mission, however, included the first tests of Manned Maneuvering Units (MMU), powered backpacks to be used without tethers.

The Solar Max will have to be approached by an astronaut from outside the Shuttle after the commander brings the orbiter to within about 300 feet of the satellite. At that point, he will put on the MMU and go out to meet the Solar Max. He cannot be tethered to the orbiter because he would become entangled in the line as he moved.

The Solar Max satellite is now slowly spinning. The astronaut will attach himself to the satellite and stop it from rotating by pushing the attitude control button on the MMU. This will control the firing of the MMU's small thrusters until the astronaut, with the Solar Max attached, stops spinning.

At that point, the astronaut will bring the satellite to the payload bay, where it will be grappled by the 50-foot Remote Manipulator arm and be repaired in the cargo bay. If it is found that the satellite could not be fixed in space, it can be put into the bay and brought back to Earth. Without this procedure, a once important scientific satellite would eventually become a piece of space debris.

A human satellite

At 7:27 a.m. Central Standard Time on Feb. 7, Shuttle mission specialist Bruce McCandless became the first human satellite—orbiting the Earth at more than 17,000 miles per hour, free from the Challenger.

He used the MMU jets to push himself away from the orbiter at a leisurely one foot per second—which is slower than walking speed. It took McCandless about eight minutes to venture out 150 feet from Challenger. On a second trip he moved 320 feet away.

The only way the astronaut could judge his distance from the rest of the crew was to measure the apparent size of the orbiter as it became smaller the farther away he traveled. Radar onboard Challenger kept a much more precise reading on McCandless's whereabouts.

Astronaut and mission specialist Robert Stewart followed McCandless in donning the same MMU and departing from the payload bay. Because the team was running a few minutes behind on their timeline, Stewart obtained permission from mission control in Houston to go out 150 feet, stop and check his MMU propellants, and then travel the full 300-foot distance without coming back to the bay first.

On Feb. 9, the two mission specialists performed another nearly six hours of extravehicular activity (EVA) and tested a second MMU backpack. They also used a set of powered tools designed for the Solar Max repair mission and tested the procedures for refueling a satellite in space. NASA plans to be able to refuel satellites while in orbit, to extend their useful life past the seven years that are the average today.

One of the disappointments of this mission was the performance of the IRT, or Integrated Rendezvous Target. This large balloon was supposed to be filled with gas after being released from the payload bay, but it failed to inflate properly and exploded. The IRT was to be a target with which the orbiter could practice rendezvous as close as the 300 feet, which will be necessary with Solar Max.

The Shuttle crew was able to use some of the balloon debris as a target of sorts, but through the serendipity which is characteristic of most space ventures, commander Vance Brand had an opportunity to try out maneuvers with the Challenger, even without the IRT.

While the astronauts were performing their second extravehicular activity on Feb. 9, one of the plates that holds a foot restraint in the payload bay came loose and started drifting out into space. Stewart requested permission to use the MMU to go after it, but Commander Brand quickly decided to manuever the orbiter itself to chase the runaway piece.

When the piece was close enough to the bay, Stewart reached out, grabbed it with his feet, and brought it back into the payload bay. This quick response proved to Brand's satisfaction that the orbiter could be easly maneuvered in orbit, should an astronaut away from the Shuttle with an MMU have difficulty and need to be rescued.

For McCandless, this perfect first performance for the Manned Maneuvering Units held a personal satisfaction; he has worked on their development for the past 17 years. Both astronauts commented on how easy the units were to use, and NASA is confident that they will open up whole new arenas for human activity in space.

Communications satellites may be repaired

A major problem on this Shuttle flight was the incomplete deployment of the Western Union and Indonesian communications satellites. The satellites were deployed perfectly from the orbiter, but their booster stages, which take them to the 22,300-mile geosynchronous orbit, did not function properly. The McDonnell Douglas Payload Assist Modules, or PAMs, seem to have fired for only about 15 of the planned 85 seconds, which put the two satellites into highly elliptical and near-useless orbits. These satellites are not designed for on-orbit repair.

Due to the smashing success of the mission's MMU tests, however, NASA is considering repair of the two communications satellites. Fuel on board each satellite, which is used to make small adjustments in its orbit when it is functioning properly, could be used to place them in circular orbits where they could be "caught" by a Shuttle crew.

NASA will have to design a device that can grapple the satellites and place them in the Shuttle's payload bay. And, according to *Aviation Week,* this recovery mission will have to be within the next year, before their orbits decay too much for a Shuttle rendezvous.

The satellites could be brought back to Earth and re-fitted with upper stages that could boost them into their proper orbit on a subsequent flight. It is possible that it would be cheaper for Western Union and the Indonesian government to pay for this rescue mission than build another set of satellites.

Could space treat arthritis?

One of the most interesting scientific experiments aboard this last Shuttle mission was designed by Dan Weber, a student at Hunter College High School in New York City when the experiment was conceived. He has been working with scientists at the Pfizer Company to study the effect of zero gravity on arthritis.

His interest in this problem was sparked by his close relationship with his grandfather, who suffers from rheumatoid arthritis. Weber observed that his grandfather's symptoms were relieved by swimming and hydrotherapy. He has also learned that astronauts in microgravity gain up to an inch in space as their spine stretches out because gravity is not there to compress their muscles and joints.

To test his hypothosis that space might relieve the pressure on arthritic joints, Weber designed an experiment to fly six rats in the Shuttle. Three were injected with a chemical which produces symptoms similar to arthritis, and the other three were not.

All the rats were measured before the flight for weight, food, and water consumption, paw volume, and activity levels. While in flight, the crew monitored the rats, recording observations of their activity levels and other parameters. They also turned lights on and off to simulate normal Earth day cycles.

Upon their return to Earth, the rats were re-measured, and blood samples which measure the chemicals associated with arthritis were taken to determine joint deterioration.

If it is found that weightlessness relieves the arthritic symptoms which are suffered by millions of people on Earth, space may become a very attractive place for some arthritis victims to live and work.