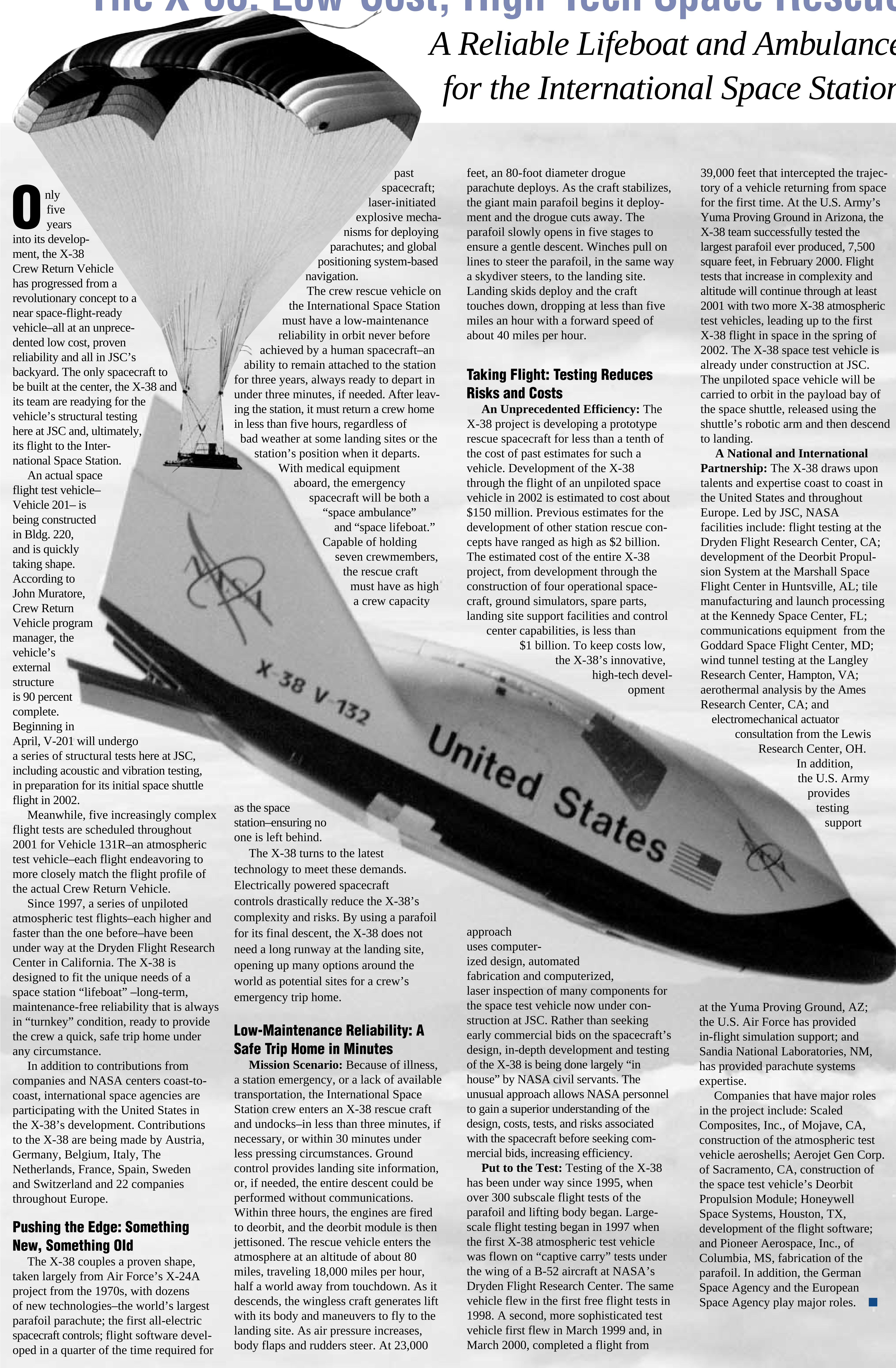
The X-38: Low-Cost, High-Tech Space Rescue

A Reliable Lifeboat and Ambulance for the International Space Station



Only five years into its development, the X-38 Crew Return Vehicle has progressed from a revolutionary concept to a near space-flight-ready vehicle–all at an unprecedented low cost, proven reliability and all in JSC's backyard. The only spacecraft to be built at the center, the X-38 and its team are readying for the vehicle's structural testing here at JSC and, ultimately, its flight to the International Space Station.

An actual space flight test vehicle–Vehicle 201– is being constructed in Bldg. 220, and is quickly taking shape. According to John Muratore, Crew Return Vehicle program manager, the vehicle's external structure is 90 percent complete. Beginning in April, V-201 will undergo a series of structural tests here at JSC, including acoustic and vibration testing, in preparation for its initial space shuttle flight in 2002.

Meanwhile, five increasingly complex flight tests are scheduled throughout 2001 for Vehicle 131R–an atmospheric test vehicle–each flight endeavoring to more closely match the flight profile of the actual Crew Return Vehicle.

Since 1997, a series of unpiloted atmospheric test flights–each higher and faster than the one before–have been under way at the Dryden Flight Research Center in California. The X-38 is designed to fit the unique needs of a space station "lifeboat" –long-term, maintenance-free reliability that is always in "turnkey" condition, ready to provide the crew a quick, safe trip home under any circumstance.

In addition to contributions from companies and NASA centers coast-to-coast, international space agencies are participating with the United States in the X-38's development. Contributions to the X-38 are being made by Austria, Germany, Belgium, Italy, The Netherlands, France, Spain, Sweden and Switzerland and 22 companies throughout Europe.

Pushing the Edge: Something New, Something Old

The X-38 couples a proven shape, taken largely from Air Force's X-24A project from the 1970s, with dozens of new technologies–the world's largest parafoil parachute; the first all-electric spacecraft controls; flight software developed in a quarter of the time required for past spacecraft; laser-initiated explosive mechanisms for deploying parachutes; and global positioning system-based navigation.

The crew rescue vehicle on the International Space Station must have a low-maintenance reliability in orbit never before achieved by a human spacecraft–an ability to remain attached to the station for three years, always ready to depart in under three minutes, if needed. After leaving the station, it must return a crew home in less than five hours, regardless of bad weather at some landing sites or the station's position when it departs.

With medical equipment aboard, the emergency spacecraft will be both a "space ambulance" and "space lifeboat." Capable of holding seven crewmembers, the rescue craft must have as high a crew capacity as the space station–ensuring no one is left behind.

The X-38 turns to the latest technology to meet these demands. Electrically powered spacecraft controls drastically reduce the X-38's complexity and risks. By using a parafoil for its final descent, the X-38 does not need a long runway at the landing site, opening up many options around the world as potential sites for a crew's emergency trip home.

Low-Maintenance Reliability: A Safe Trip Home in Minutes

Mission Scenario: Because of illness, a station emergency, or a lack of available transportation, the International Space Station crew enters an X-38 rescue craft and undocks–in less than three minutes, if necessary, or within 30 minutes under less pressing circumstances. Ground control provides landing site information, or, if needed, the entire descent could be performed without communications. Within three hours, the engines are fired to deorbit, and the deorbit module is then jettisoned. The rescue vehicle enters the atmosphere at an altitude of about 80 miles, traveling 18,000 miles per hour, half a world away from touchdown. As it descends, the wingless craft generates lift with its body and maneuvers to fly to the landing site. As air pressure increases, body flaps and rudders steer. At 23,000 feet, an 80-foot diameter drogue parachute deploys. As the craft stabilizes, the giant main parafoil begins it deployment and the drogue cuts away. The parafoil slowly opens in five stages to ensure a gentle descent. Winches pull on lines to steer the parafoil, in the same way a skydiver steers, to the landing site. Landing skids deploy and the craft touches down, dropping at less than five miles an hour with a forward speed of about 40 miles per hour.

Taking Flight: Testing Reduces Risks and Costs

An Unprecedented Efficiency: The X-38 project is developing a prototype rescue spacecraft for less than a tenth of the cost of past estimates for such a vehicle. Development of the X-38 through the flight of an unpiloted space vehicle in 2002 is estimated to cost about $150 million. Previous estimates for the development of other station rescue concepts have ranged as high as $2 billion. The estimated cost of the entire X-38 project, from development through the construction of four operational spacecraft, ground simulators, spare parts, landing site support facilities and control center capabilities, is less than $1 billion. To keep costs low, the X-38's innovative, high-tech development approach uses computerized design, automated fabrication and computerized, laser inspection of many components for the space test vehicle now under construction at JSC. Rather than seeking early commercial bids on the spacecraft's design, in-depth development and testing of the X-38 is being done largely "in house" by NASA civil servants. The unusual approach allows NASA personnel to gain a superior understanding of the design, costs, tests, and risks associated with the spacecraft before seeking commercial bids, increasing efficiency.

Put to the Test: Testing of the X-38 has been under way since 1995, when over 300 subscale flight tests of the parafoil and lifting body began. Large-scale flight testing began in 1997 when the first X-38 atmospheric test vehicle was flown on "captive carry" tests under the wing of a B-52 aircraft at NASA's Dryden Flight Research Center. The same vehicle flew in the first free flight tests in 1998. A second, more sophisticated test vehicle first flew in March 1999 and, in March 2000, completed a flight from 39,000 feet that intercepted the trajectory of a vehicle returning from space for the first time. At the U.S. Army's Yuma Proving Ground in Arizona, the X-38 team successfully tested the largest parafoil ever produced, 7,500 square feet, in February 2000. Flight tests that increase in complexity and altitude will continue through at least 2001 with two more X-38 atmospheric test vehicles, leading up to the first X-38 flight in space in the spring of 2002. The X-38 space test vehicle is already under construction at JSC. The unpiloted space vehicle will be carried to orbit in the payload bay of the space shuttle, released using the shuttle's robotic arm and then descend to landing.

A National and International Partnership: The X-38 draws upon talents and expertise coast to coast in the United States and throughout Europe. Led by JSC, NASA facilities include: flight testing at the Dryden Flight Research Center, CA; development of the Deorbit Propulsion System at the Marshall Space Flight Center in Huntsville, AL; tile manufacturing and launch processing at the Kennedy Space Center, FL; communications equipment from the Goddard Space Flight Center, MD; wind tunnel testing at the Langley Research Center, Hampton, VA; aerothermal analysis by the Ames Research Center, CA; and electromechanical actuator consultation from the Lewis Research Center, OH. In addition, the U.S. Army provides testing support at the Yuma Proving Ground, AZ; the U.S. Air Force has provided in-flight simulation support; and Sandia National Laboratories, NM, has provided parachute systems expertise.

Companies that have major roles in the project include: Scaled Composites, Inc., of Mojave, CA, construction of the atmospheric test vehicle aeroshells; Aerojet Gen Corp. of Sacramento, CA, construction of the space test vehicle's Deorbit Propulsion Module; Honeywell Space Systems, Houston, TX, development of the flight software; and Pioneer Aerospace, Inc., of Columbia, MS, fabrication of the parafoil. In addition, the German Space Agency and the European Space Agency play major roles. ■