more, the simulation environment allows the user to "single step" through its execution, pausing, and restarting at will. The system also provides for the introduction of simulated faults specific to Mars rover environments that cannot be replicated in other testbed platforms, to stress test the GNC flight algorithms under examination.

The software provides facilities to do these stress tests in ways that cannot be done in the real-time flight system testbeds, such as time-jumping (both forwards and backwards), and introduction of simulated actuator faults that would be difficult, expensive, and/or destructive to implement in the real-time testbeds. Actual flight-quality codes can be incorporated back into the development-test suite of GNC developers, closing the loop between the GNC developers and the flight software developers. The software provides fully automated scripting, allowing multiple tests to be run with varying parameters, without human supervision.

This work was done by Charles A. Vanelli, Jonathan F. Grinblat, Samuel W. Sirlin, and Sam Pfister of Caltech for NASA's Jet Propulsion Laboratory.

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-46288.

Desktop Application Program To Simulate Cargo-Air-Drop Tests

Lyndon B. Johnson Space Center, Houston, Texas

The DSS Application is a computer program comprising a Windows version of the UNIX-based Decelerator System Simulation (DSS) coupled with an Excel front end. The DSS is an executable code that simulates the dynamics of airdropped cargo from first motion in an aircraft through landing. The bare DSS is difficult to use; the front end makes it easy to use. All inputs to the DSS, control of execution of the DSS, and postprocessing and plotting of outputs are handled in the front end. The front end is graphics-intensive.

The Excel software provides the graphical elements without need for additional programming. Categories of input parameters are divided into separate tabbed windows. Pop-up comments describe each parameter. An error-checking software component evaluates combinations of parameters and alerts the user if an error results. Case files can be created from inputs, making it possible to build cases from previous ones. Simulation output is plotted in 16 charts displayed on a separate worksheet, enabling plotting of multiple DSS cases with flight-test data. Variables assigned to each plot can be changed. Selected input parameters can be edited from the plot sheet for quick sensitivity studies.

This program was written by Peter Cuthbert of Johnson Space Center. Further information is contained in a TSP (see page 1).
MSC-24014-1

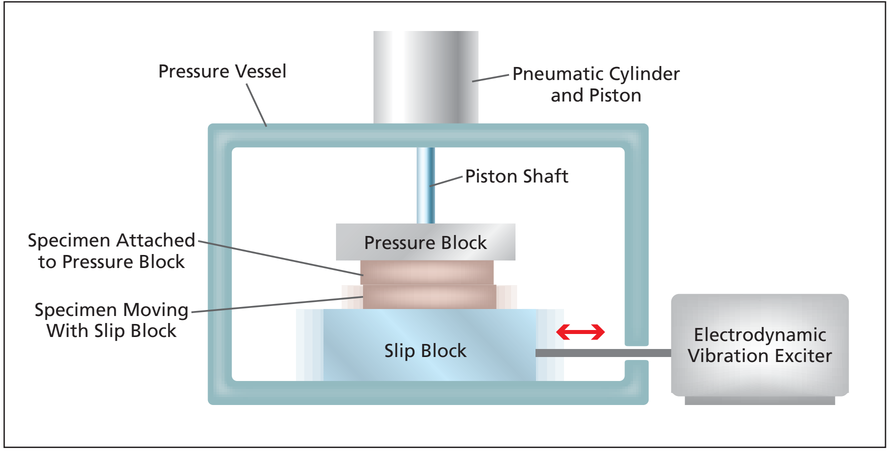
Multimodal Friction Ignition Tester

Responses of material specimens to vibrational friction in pressurized oxygen are recorded.

Marshall Space Flight Center, Alabama

The multimodal friction ignition tester (MFIT) is a testbed for experiments on the thermal and mechanical effects of friction on material specimens in pressurized, oxygen-rich atmospheres. In simplest terms, a test involves recording sensory data while rubbing two specimens against each other at a controlled normal force, with either a random stroke or a sinusoidal stroke having controlled amplitude and frequency. The term "multimodal" in the full name of the apparatus refers to a capability for imposing any combination of widely ranging values of the atmospheric pressure, atmospheric oxygen content, stroke length, stroke frequency, and normal force. The MFIT was designed especially for studying the tendency toward heating and combustion of nonmetallic composite materials and the fretting of metals subjected to dynamic (vibrational) friction forces in the presence of liquid oxygen or pressurized gaseous oxygen — test conditions approximating conditions expected to be encountered in proposed composite-material oxygen tanks aboard aircraft and spacecraft in flight.

The MFIT includes a stainless-steel pressure vessel capable of retaining the required test atmosphere. Mounted atop the vessel is a pneumatic cylinder containing a piston for exerting the specified normal force between the two specimens (see figure). Through a shaft seal, the piston shaft extends downward into the vessel. One of the specimens is mounted on a block, denoted the pres-



The **Pressure Vessel and Mechanisms** of the MFIT are depicted here in a simplified, partly schematic form emphasizing the basic principle of operation.

sure block, at the lower end of the piston shaft. This specimen is pressed down against the other specimen, which is mounted in a recess in another block, denoted the slip block, that can be moved horizontally but not vertically. The slip block is driven in reciprocating horizontal motion by an electrodynamic vibration exciter outside the pressure vessel. The armature of the electrodynamic exciter is connected to the slip block via a horizontal shaft that extends into the pressure vessel via a second shaft seal. The reciprocating horizontal motion can be chosen to be random with a flat spectrum over the frequency range of 10 Hz to 1 kHz, or to be sinusoidal at any peak-to-peak amplitude up to 0.8 in. (≈2 cm) and fixed or varying frequency up to 1 kHz.

The temperatures of the specimen and of the vessel are measured by thermocouples. A digital video camera mounted outside the pressure vessel is aimed into the vessel through a sapphire window, with its focus fixed on the interface between the two specimens. A position transducer monitors the displacement of the pneumatic-cylinder shaft. The pressure in the vessel is also monitored. During a test, the output of the video camera, the temperatures, and the pneumatic-shaft displacement are monitored and recorded. The test is continued for a predetermined amount of time (typically, 10 minutes) or until either (1) the output of the position transducer shows a sudden change indicative of degradation of either or both specimens, (2) ignition or another significant reaction is observed, or (3) pressure in the vessel increases beyond a pre-set level that triggers an automatic shutdown.

This work was done by Eddie Davis of Marshall Space Flight Center, Bill Howard of Qualis Corp., and Stephen Herald of Integrated Concepts & Research Corp. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32613-1.

Small-Bolt Torque-Tension Tester

Goddard Space Flight Center, Greenbelt, Maryland

Current torque-tension measurement techniques involve using load washers as the force measuring transducer. The disadvantage of load washers is that they are too large to be used with fasteners smaller than about size #8. The device described here measures the torque-tension relationship for fasteners as small as #0.

The small-bolt tester consists of a plate of high-strength steel into which three miniature load cells are recessed. The depth of the recess is sized so that the three load cells can be shimmed, the optimum height depending upon the test hardware. The three miniature load cells are arranged in an equilateral triangular configuration with the test bolt aligned with the centroid of the three. This is a kinematic arrangement. The three load cells define a plane and since the test bolt interfaces at the centroid of the three load cells, each load cell reacts 1/3 of the total bolt preload. Because of this, only one of the three load cells is really required with the other two being redundant. Having the additional load cells adds redundancy and confidence to the system. The signals from the three miniature load cells are read by three individual force-measurement indicators.

The test bolt interfaces to a unique bushing that is recessed from the opposite side from the load cells. The replaceable bushings used in the device allow the system to test with the appropriate in service materials if required. The deep recess (or counterbore) allows for testing of bolts that are as short as 0.38-in. (≈10-mm). The outside diameter of the bushing is threaded to interface with the threaded recessed hole. There is a hole in the center of the bushing where the test bolt passes through. The bushing material and hole size can be customized to replicate actual in-service hardware. This is important to account for the different friction coefficients at the interfaces.

As a test bolt is tightened, the bolt analyzer continually monitors and records both the torque and preload until the target preload is reached. The data are stored digitally, which allows for easy data analysis.

This work was done by Alan J. Posey of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15718-1