that when powder was not being fed, the outer pipe would be rotated to a shaft angle at which the windows in the two pipes would occlude each other. The thread on the outer pipe would engage a threaded fitting on the bottom of the bellows, so that rotation of the outer pipe would compress the bellows as the powder was consumed.

The lower tank would serve as both a reactor and chamber for storing the solid waste end product (MgO) of the hydrogen-generating reactions. As the powder was fed from the upper tank to the lower tank and the bellows was compressed, the volume of the lower tank would grow, making room for the growing amount of waste material. Because fresh fuel would be dropped over the most recently reacted portion of the consumed fuel, it would always come in contact with the hottest part. There would be ample time for the fuel to react as nearly completely as possible because once the fuel was in the reactor, it would stay there. A thermally insulating layer (not shown in the figure) on the bottom of the bellows would reduce the undesired flow of heat from the reactor to the storage volume, thereby helping to suppress undesired decomposition of the MgH_2 in the storage volume.

As described thus far, the apparatus would operate in a batch mode. The upper tank could be refilled with MgH_2 powder from the top, and the MgO solid waste could be removed from the bottom. However, it would be necessary to interrupt operation during such refilling and emptying and during concomitant reverse rotation of the threaded outer pipe to reset the bellows to full storage volume. Thus, truly continuous operation would not be possible: The apparatus would operate in a quasi-batch, quasi-continuous mode.

This work was done by Andrew Kindler and Yuhong Huang of Caltech for NASA's Jet Propulsion Laboratory.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-46058, volume and number of this NASA Tech Briefs *issue, and the page number.*

Strain System for the Motion Base Shuttle Mission Simulator

Lyndon B. Johnson Space Center, Houston, Texas

The Motion Base Shuttle Mission Simulator (MBSMS) Strain System is an innovative engineering tool used to monitor the stresses applied to the MBSMS motion platform tilt pivot frames during motion simulations in real time. The Strain System comprises hardware and software produced by several different companies. The system utilizes a series of strain gages, accelerometers, orientation sensor, rotational meter, scanners, computer, and software packages working in unison. By monitoring and recording the inputs applied to the simulator, data can be analyzed if weld cracks or other problems are found during routine simulator inspections. This will help engineers diagnose problems as well as aid in repair solutions for both current as well as potential problems.

The system is located with a line-of-sight to the Motion Base for real-time on-site monitoring. In addition to local monitoring, several off-site engineering computers are loaded with software allowing the user to remotely log onto the Strain System computer, monitor the system, and adjust the software settings as required. Additional commercial software products have been programmed to automate the Strain System software. This removes the typical daily manual interaction required by the system to boot, record, stop, and save the resultant motion data for future analysis.

This work was done by David C Huber, Karl G. Van Vossen, Glenn W. Kunkel, and Larry W. Wells of United Space Alliance for Johnson Space Center. Further information is contained in a TSP (see page 1). ***.*** *MSC 24386-1*

Ko Displacement Theory for Structural Shape Predictions

Prediction system enables real-time aero-elastic aircraft wing-shape control.

Dryden Flight Research Center, Edwards, California

The development of the Ko displacement theory for predictions of structure deformed shapes was motivated in 2003 by the Helios flying wing, which had a 247-ft (75-m) wing span with wingtip deflections reaching 40 ft (12 m). The Helios flying wing failed in midair in June 2003, creating the need to develop new technology to predict in-flight deformed shapes of unmanned aircraft wings for visual display before the ground-based pilots.

Any types of strain sensors installed on a structure can only sense the surface strains, but are incapable to sense the overall deformed shapes of structures. After the invention of the Ko displacement theory, predictions of structure deformed shapes could be achieved by feeding the measured surface strains into the Ko displacement transfer functions for the calculations of out-of-plane deflections and cross sectional rotations at multiple locations for mapping out overall deformed shapes of the structures. The new Ko displacement theory combined with a strain-sensing system thus created a revolutionary new structure-shape-sensing technology.

The formulation of the Ko displacement theory stemmed from the integrations of the beam curvature equation (second order differential equation). The beamlike structure (wing) was first discretized into multiple small domains so that beam depth and surface strain distributions could be represented with piecewise linear functions. This discretization approach enabled piecewise integrations of the