action would be effected through coordinated lengthening and shorting of the struts. Inasmuch as there would be no head, visual and/or other data needed for navigation would be obtained by means of a distributed sensor network inside the structure. A sample for return could be collected by a process, illustrated in Figure 2, that would lead to retention of the sample in a tetrahedral compartment defined by stretchable fabric covering all its faces.

The amorphous rover could, in principle, be designed and built using currently available macroscopic electromechanical components. In addition, the basic amorphous-rover concept admits of a numerous design variations, including ones involving extreme miniaturization through exploitation of microelectromechanical systems (MEMS), nanoelectromechanical systems (NEMS), and perhaps even the use of carbon nanotubes. Any or all of these variations could include control systems based on evolvable neural software systems.

This work was done by Steven A. Curtis of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-14850-1

Space-Frame Antenna

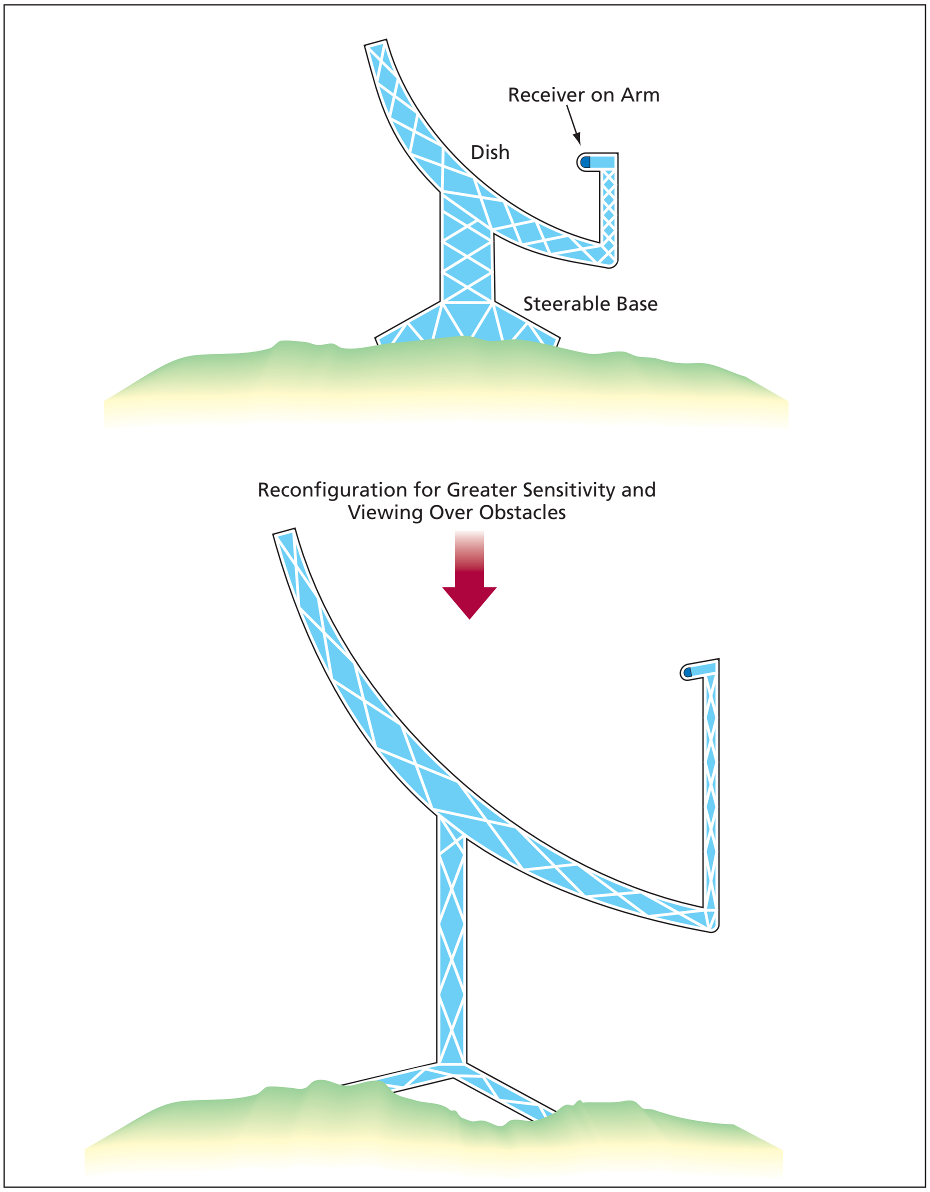
The structure could be deformed to a desired size, shape, and orientation.

Goddard Space Flight Center, Greenbelt, Maryland

The space-frame antenna is a conceptual antenna structure that would be lightweight, deployable from compact stowage, and capable of deforming itself to a size, shape, and orientation required for a specific use. The underlying mechanical principle is the same as that of the amorphous rover described in the immediately preceding article: The space-frame antenna would be a trusslike structure consisting mostly of a tetrahedral mesh of nodes connected by variable-length struts. (The name of the antenna reflects the fact that such a structure has been called a "space frame.") The deformation of the antenna to a desired size, shape, and orientation would be effected through coordinated lengthening and shorting of the struts. In principle, it would even be possible to form the space-frame antenna by deforming another space-frame structure (e.g., the amorphous rover) in this manner.

Typically, the space-frame antenna would be configured as a dish-type reflector with an arm holding a receiver, all on a steerable base. Examples of exploiting the space-frame concept to reconfigure the antenna for a specific use include making the base taller (for viewing over obstructions) and making the dish wider (for greater sensitivity), as illustrated in the figure.

Like the amorphous rover, the space-frame antenna could be designed and built using currently available macroscopic electromechanical components or by exploiting microelectromechanical systems (MEMS), nanoelectromechanical systems (NEMS), or perhaps even carbon



The **Antenna Could Be Widened and Heightened** as shown here for better viewing and greater sensitivity. It could also be twisted, reoriented, and/or otherwise deformed to aim it in one or more different direction(s).

nanotubes. An initial version made from currently available components would likely have an areal mass density of the order of 1 kg/m^2. More-advanced versions made from MEMS, NEMS, or nanotubes could have areal mass densities ranging from about 100 to as little as 10 g/m^2. Also as in the case of the amorphous rover, any or all of these versions could include control systems based partly on evolvable neural software systems.

This work was done by Steven A. Curtis of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-14849-1

Gear-Driven Turnbuckle Actuator

This tool allows for continued adjustments to turnbuckles without the need to remove them.

John H. Glenn Research Center, Cleveland, Ohio

This actuator design allows the extension and contraction of turnbuckle assemblies. It can be operated manually or remotely, and is extremely compact. It is ideal for turnbuckles that are hard to reach by conventional tools. The tool assembly design solves the problem of making accurate adjustments to the variable geometry guide vanes without having to remove and reinstall the actuator system back on the engine. The actuator does this easily by adjusting the length of the turnbuckles while they are still attached to the engine.

Made out of metal, the actuator has three components: a gear case, a locking mechanism, and a driver bar. It operates by attaching the gear case around the turnbuckle, then securing the gears with the locking mechanism, and finally making adjustments by turning the driver bar. The gear case consists of two gears and a stabilizing arm. The first gear, the ratcheting gear, is used to make adjustments. The second gear, the turnbuckle gear, operates the turnbuckle, and the stabilizing arm secures the gear case in place. The gear rivet nut of the driver bar fits into the adjustment gear. Manually turning the driver bar rotates the adjustment gear, which in turn engages the turnbuckle gear. As the turnbuckle gear rotates, adjustments are made to the turnbuckle. The stabilizing arm prevents the turnbuckle case from rotating when the driver arm is operated, and the arm is securely attached to the turnbuckle assembly.

The **Tool Assembly** adjusts the length of the turnbuckle while it is still attached to the engine, eliminating the problem of removing and installing the actuator system back onto the engine.

To prevent gear movement due to vibration, a locking mechanism secures the gears once adjustments are made. Tool operation is straightforward — the driver bar is turned either clockwise or counterclockwise to lengthen or shorten the turnbuckle. The angle of the guide vanes is read out using encoders mounted on the engine. When the desired offset angle is reached, the locking mechanism is engaged, thus securing the length of the turnbuckle. What would originally have taken a day to accomplish is now done in approximately ten minutes, and with greater accuracy, because the turnbuckle is never removed. The effectiveness of this tool is best appreciated when one considers a typical engine, with four or more turnbuckles, where each turnbuckle requires several configurations to make vane readings.

This work was done by Ricky N. Rivera of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18427-1.

In-Situ Focusing Inside a Thermal Vacuum Chamber

This method would enable less expensive, faster focusing for IR imaging cameras and spectrometers.

NASA's Jet Propulsion Laboratory, Pasadena, California

Traditionally, infrared (IR) space instruments have been focused by iterating with a number of different thickness shim rings in a thermal vacuum chamber until the focus meets requirements. This has required a number of thermal cycles that are very expensive as they tie up many integration and test (I&T)/ environmental technicians/engineers working three shifts for weeks. Rather than creating a test shim for each iteration, this innovation replaces the test shim and can focus the instrument while in the thermal vacuum chamber.

The focus tool consists of three small, piezo-actuated motors that drive two sets of mechanical interface flanges between the instrument optics and the focal- plane