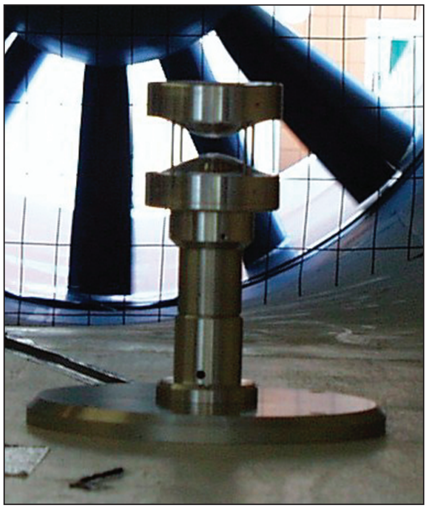

Figure 1. A **Prototype Three-Dimensional Venturi Sensor** is shown here mounted in a wind tunnel for testing at Embry-Riddle Aeronautical University, FL.

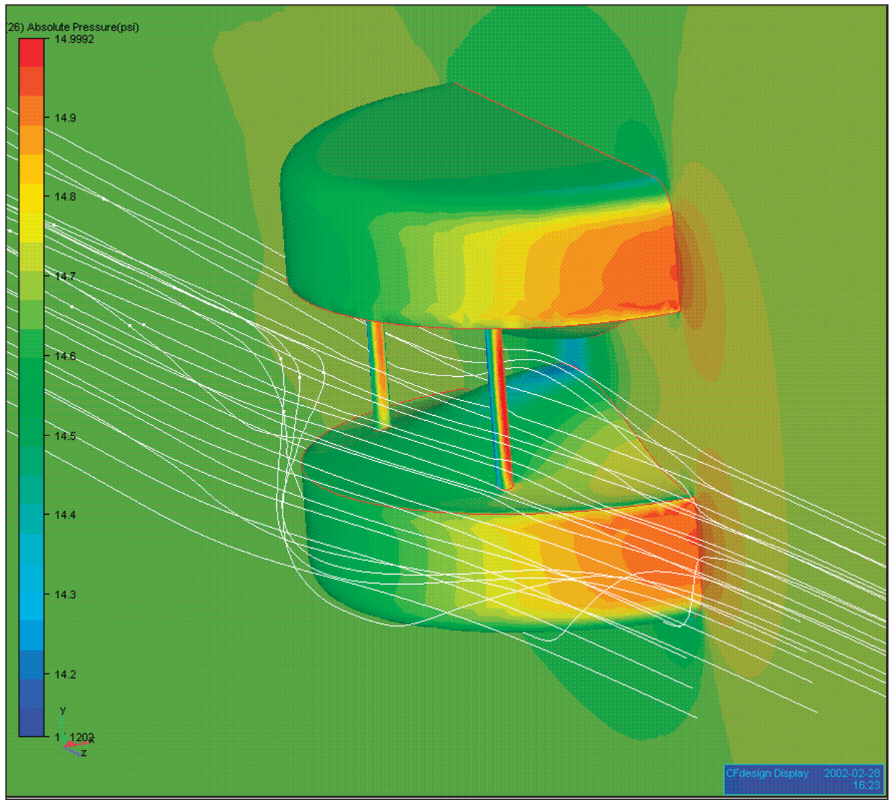

Figure 2. **Pressure and Flow Pattern Results** from simulation of the prototype 3D Venturi sensor are shown at 100-mph (45-m/s) wind velocity.

ing limited dynamic range and susceptibility to errors caused by external acoustic noise and rain.

In contrast, the novel 3D Venturi sensor is less vulnerable to wind damage because of its smaller profile and ruggedness. Since the sensor has no moving parts, it provides increased reliability and lower maintenance costs. It has faster response and recovery times to changing wind conditions than traditional systems. In addition, it offers wide dynamic range and is expected to be relatively insensitive to rain and acoustic energy.

The Venturi effect in this sensor is achieved by the mirrored double-inflection curve, which is then rotated 360° to create the desired detection surfaces. The curve is optimized to provide a good balance of pressure difference between sensor ports and overall maximum fluid velocity while in the shape. Four posts are used to separate the two shapes, and their size and location were chosen to minimize effects on the pressure measurements.

The 3D Venturi sensor has smart software algorithms to map the wind pressure exerted on the surfaces of the design. Using Bernoulli's equation, the speed of the wind is calculated from the differences among the pressure readings at the various ports. The direction of the wind is calculated from the spatial distribution and magnitude of the pressure readings. All of the pressure port sizes and locations have been optimized to minimize measurement errors and to reside in areas demonstrating a stable pressure reading proportional to the velocity range.

This work was done by Jan A. Zysko, Jose M. Perotti, and Christopher Amis of **Kennedy Space Center** *and John Randazzo, Norman Blalock, and Anthony Eckhoff of Dynacs, Inc. Further information is contained in a TSP (see page 1).*
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Swarms of Micron-Sized Sensors

NASA's Jet Propulsion Laboratory, Pasadena, California

A paper presents the concept of swarms of micron-sized and smaller carriers of sensing equipment, denoted generally as controllable granular matter, to be used in exploring remote planets and interplanetary space. The design and manufacture of controllable granular matter would exploit advances in microelectromechanical systems and nanotechnology. Depending on specific designs and applications, controllable granular matter could have characteristics like those of powders, sands, or aerosols, which would be dispersed into the environments to be explored: For example, sensory grains could be released into orbit around a planet, spread out over ground, or dispersed into wind or into a body of liquid. The grains would thus become integral parts of multiphase environments, where they would function individually and/or collectively to gather information about the environments. In cases of clouds of grains dispersed in outer space, it may be feasible to use laser beams to shape the clouds to perform specific functions. To enable the full utilization of controllable granular matter, it is necessary to advance the knowledge of the dynamics and controllable characteristics of both individual grains and the powders, sands, or aerosols of which they are parts.

This work was done by Marco Quadrelli of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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