Mechanics

System Finds Horizontal Location of Center of Gravity

Mass and center-of-mass data are updated at a rate of ≈267 Hz.

Marshall Space Flight Center, Alabama

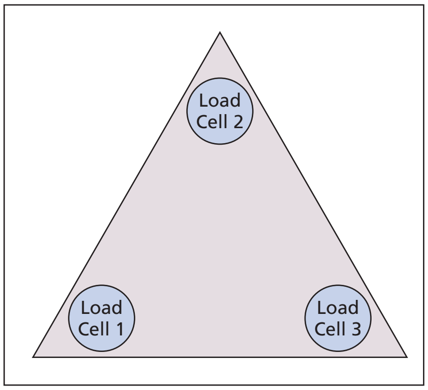

Figure 1. **Three Load Cells** measure the weights applied to three air bearings at the corners of a triangle.

An instrumentation system rapidly and repeatedly determines the horizontal location of the center of gravity of a laboratory vehicle that slides horizontally on three air bearings (see Figure 1). Typically, knowledge of the horizontal center-of-mass location of such a vehicle is needed in order to balance the vehicle properly for an experiment and/or to assess the dynamic behavior of the vehicle.

The system includes a load cell above each air bearing, electronic circuits that generate digital readings of the weight on each load cell, and a computer equipped with software that processes the readings. The total weight and, hence, the mass of the vehicle are computed from the sum of the load-cell weight readings. Then the horizontal position of the center of gravity is calculated straightforwardly as the weighted sum of the known position vectors of the air bearings, the contribution of each bearing being proportional to the weight on that bearing. In the initial application for which this system was devised, the center-of-mass calculation is particularly simple because the air bearings are located at corners of an equilateral triangle. However, the system is not restricted to this simple geometry.

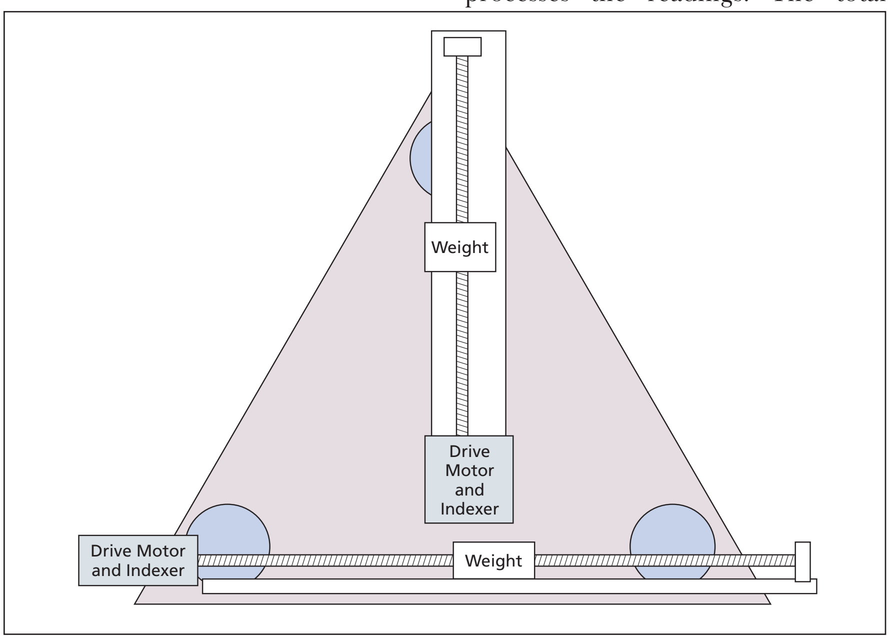

Figure 2. **Motor-Driven Lead Screws** would reposition weights, in response to load-cell readings, to counteract any deviation of the center of gravity from the geometric center.

The system acquires and processes weight readings at a rate of 800 Hz for each load cell. The total weight and the horizontal location of the center of gravity are updated at a rate of 800/3 ≈ 267 Hz.

In a typical application, a technician would use the center-of-mass output of this instrumentation system as a guide to the manual placement of small weights on the vehicle to shift the center of gravity to a desired horizontal position. Usually, the desired horizontal position is that of the geometric center. Alternatively, this instrumentation system could be used to provide position feedback for a control system that would cause weights to be shifted automatically (see Figure 2) in an effort to keep the center of gravity at the geometric center.

This work was done by Albert S. Johnston, Richard T. Howard, and Linda L. Brewster of **Marshall Space Flight Center**. *Further information is contained in a TSP (see page 1).*

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Predicting Tail Buffet Loads of a Fighter Airplane

Airframes can be designed to be more robust.

Langley Research Center, Hampton, Virginia

Buffet loads on aft aerodynamic surfaces pose a recurring problem on most twin-tailed fighter airplanes: During maneuvers at high angles of attack, vortices emanating from various surfaces on the forward parts of such an airplane (engine inlets, wings, or other fuselage appendages) often burst, immersing the tails in their wakes. Although these vortices increase lift, the frequency contents of the burst vortices become so low as to cause the aft surfaces to vibrate destructively.