Prolonging Microgravity on Parabolic Airplane Flights

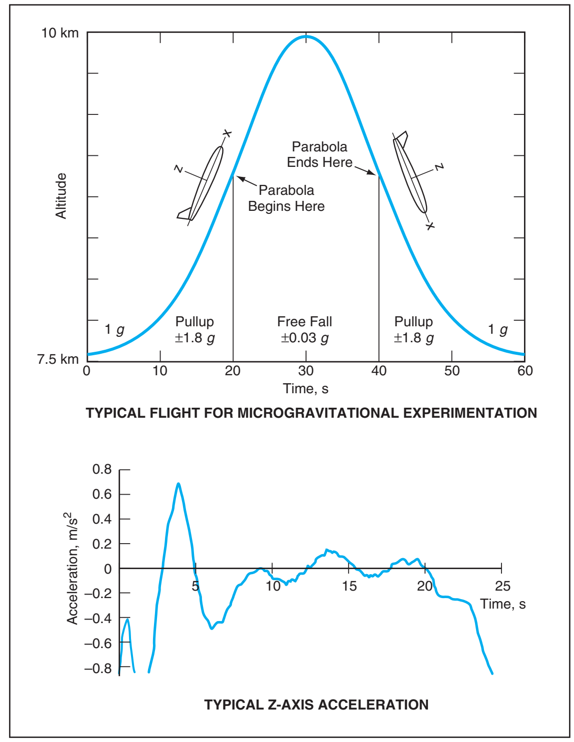
Techniques for improving the approximation of free fall are proposed.

Goddard Space Flight Center, Greenbelt, Maryland

Three techniques have been proposed to prolong the intervals of time available for microgravity experiments aboard airplanes flown along parabolic trajectories. Typically, a pilot strives to keep an airplane on such a trajectory during a nominal time interval as long as 25 seconds, and an experimental apparatus is released to float freely in the airplane cabin to take advantage of the microgravitational environment of the trajectory for as long as possible. It is usually not possible to maintain effective microgravity during the entire nominal time interval because random aerodynamic forces and fluctuations in pilot control inputs cause the airplane to deviate slightly from a perfect parabolic trajectory (see figure), such that the freely floating apparatus bumps into the ceiling, floor, or a wall of the airplane before the completion of the parabola. Heretofore, free-float times have tended to be no longer than a few seconds.

One of the proposed techniques is to release the experimental apparatus at some point along the trajectory chosen to maximize the free-float time. A statistical analysis of flight acceleration data has revealed that the best release time is the third instant, during the nominal parabola interval, when the acceleration along the z axis crosses zero. (The z axis is defined here as the floor-to-ceiling axis in a coordinate system attached to the airplane.) The analysis shows that, assuming a range of motion of 2 m along the z axis, the experimental apparatus could float freely for 8 seconds on about half of all attempts. The analysis also shows that if one is willing to accept acceleration as large as ±0.1 m/s^2 prior to release, then the time available for experimentation could be as long as 10 seconds on about one-third to one-half of all attempts.

The second proposed technique would involve mounting the experimental apparatus on a z-axis rail and damping the motion of the apparatus once it has been released. Simple damping would necessarily entail residual accelerations intermediate between those of rigid mounting and pure free floating. A statistical analysis of flight acceleration data has shown that simple damping with a damping coefficient of 1/2 could prolong experiment times by about one-fourth on average, provided that one could tolerate residual accelerations about half as large as those of the airplane.



Residual Acceleration is experienced by an object fixed to an airplane that is nominally flying along a parabolic trajectory to approximate a free fall.

The third proposed technique would be an advanced version of the second one. Instead of a simple damper, the mounting system would include (1) one or more sensor(s) for measuring position, velocity, and acceleration of the experimental apparatus along the z axis and (2) an active control system that would strive to keep the acceleration within a desired small range centered at zero while always seeking to return the apparatus to the midpoint of its range of motion. This technique would make it possible to maintain acceleration within ±0.005 g [where g = normal Earth gravitational acceleration (about 9.8 m/s^2)] for at least 10 seconds on half of all attempts, or to maintain an acceleration within ±0.01 g for 10 seconds on about two-thirds of all attempts.

This work was done by David W. Robinson of **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1). GSC-14521*

Device for Locking a Control Knob

John F. Kennedy Space Center, Florida

A simple, effective, easy-to-use device locks a control knob in a set position. In the initial application for which this device was conceived, the control knob to be locked is that of a needle valve. Previously, in that application, it was necessary for one technician to hold the knob to keep the valve at the desired flow setting while another technician secured the valve with safety wire — a time-consuming procedure. After attachment of the wire, it was still possible to turn the knob somewhat. In contrast, a single technician using the present device can secure the knob in the desired position in about 30 seconds, and the knob cannot thereafter be turned, even in the presence of harsh vibrations, which occur during space shuttle launch. The device includes a special-purpose clamp that fits around the control knob and its shaft and that can be tightened onto the knob, without turning the knob, by means of two thumbscrews. The end of the device opposite the clamp is a tang that contains a slot that, in turn, engages a bolt that protrudes from the panel on which the control knob and its shaft are mounted.

This work was done by Dave Grom of **Kennedy Space Center**. *Further information is contained in a TSP (see page 1).*
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Cable-Dispensing Cart

John F. Kennedy Space Center, Florida

A versatile cable-dispensing cart can support as many as a few dozen reels of cable, wire, and/or rope. The cart can be adjusted to accommodate reels of various diameters and widths, and can be expanded, contracted, or otherwise reconfigured by use of easily installable and removable parts that can be carried onboard. Among these parts are dispensing rods and a cable guide that enables dispensing of cables without affecting the direction of pull. Individual reels can be mounted on or removed from the cart without affecting the other reels: this feature facilitates the replacement or reuse of partially depleted reels, thereby helping to reduce waste. Multiple cables, wires, or ropes can be dispensed simultaneously. For maneuverability, the cart is mounted on three wheels. Once it has been positioned, the cart is supported by rubber mounts for stability and for prevention of sliding or rolling during dispensing operations. The stability and safety of the cart are enhanced by a low-center-of-gravity design. The cart can readily be disassembled into smaller units for storage or shipping, then reassembled in the desired configuration at a job site.

This work was done by Alan S. Bredberg of United Space Alliance for **Kennedy Space Center**. *For further information, please contact:*

Alan Bredberg
5595 Fraley Ct.
Merritt Island, FL 32953
Tel. No.: (321) 453-4671
E-mail: bredbeas@aol.com

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