The science of deceleration

by Lauren S. Shook and Jean Potvin

*The **Aerodynamic Decelerator Systems Technical Committee** focuses on decelerating manned and unmanned vehicles via parachutes, pararotors, and inflatable decelerators.*

New or improved airdrop capabilities were developed and fielded for the Defense Department in 2013, including the **High Speed Container Delivery System**, or HSCDS used in **Afghanistan**. Managed and executed by the Army Natick Soldier Research, Development and Engineering Center, the program is a Joint Capability Technology Demonstration sponsored by the Office of the Secretary of Defense and the Transportation Command.

HSCDS uses the capability of the C-17 and C-130J aircraft to fly at airspeeds of up to 250 knots indicated air speed with the ramp open. The program's objective requirements are to air drop at speeds up to 250 knots from altitudes as low as 250 ft above ground level, and to extract between two and eight container delivery system containers with total weights between 3,000 lb and 16,000 lb.

Those requirements were successfully demonstrated on both aircraft during several operational demonstrations. This capability provides greater aircraft maneuverability during an airdrop, decreased ingress and egress time, and increased payload delivery accuracy over conventional methods. Initial capabilities have been used in Afghanistan since April and are expected to continue in **2014**.

The NASA Capsule Parachute Assembly System team completed an Orion parachute development drop test at the U.S. Army's Yuma Proving Ground in Yuma, Ariz. Credit: NASA.

The **Orion** capsule parachute assembly system or CPAS project has continued, with support from the Edwards AFB 418th Flight Test Wing. Further evolution and testing of the engineering development unit included the first airdrop of the boilerplate test article from 35,000 ft mean sea level. Tests will also use the "lawn dart" drop vehicle to attain the nominal drogue deployment conditions that follow atmospheric reentry. CPAS has also delivered the hardware for the first unmanned Orion orbital flight vehicle, called Entry Flight Test 1, scheduled to fly in 2014.

The **Aerodynamic Decelerator Systems Center** at the Naval Postgraduate School, in collaboration with the universities of Alabama-Huntsville, San Jose, Idaho, Nevada-Reno, and Missouri-Kansas City, has continued to conduct flight tests of an autonomous high-altitude, high-opening parafoil delivery system. This multi-university team is studying the challenges encountered during balloon-borne, lower stratosphere deployments of ultralightweight payloads using 10-40 ft^2 canopies. The emphasis is on reliable canopy inflation, gliding performance, and landing accuracy. Such a system could find potential use in several aerospace applications, including the retrieval of weather balloon and sounding rocket payloads.

NASA JPL has been working to advance the state of the art in entry, descent, and landing systems for Mars applications, with the goal of increasing entry mass, landed mass, and landed altitude beyond the Mars Science Lab's capabilities. An example is the **Low Density Supersonic Decelerator** program, a multiyear effort to study three new types of supersonic decelerators capable of supporting future large robotic and human-precursor-class missions to Mars.

A 6-m Supersonic Inflatable Aerodynamic Decelerator was built and tested at the **China Lake Naval Air Weapons Station**, using a rocket sled system to perform structural and inflation tests. Also in development this year was the testing of over 50 subscale parachute designs for a new, 30.5-m supersonic parachute configuration and for an 8-m attached isotensoid.