

Aerodynamic decelerators

This year's unveiling of the Advanced Tactical Parachute System (ATPS) demonstrates that the application of new technologies is producing significant fundamental advances in the field of aerodynamic decelerator systems. During the past year, parachute systems have benefited from continuing design improvements as well as a variety of new technologies, including guidance, navigation, and control (GNC), GPS, airbag technology, and pneumatic muscle actuators (PMAs).

Meeting basic challenges

One of the most basic challenges in the field has been the massive deployment of airborne troops, and a top priority of the Army Soldier and Biological Chemical Command has been to reduce the incidence of landing injuries. Para-Flite is developing the ATPS for the Army, which will use it to replace the venerable T-10 system that has served as its primary personnel parachute for the past 50 years. The ATPS will reduce the rate of descent by 25% (from 21 ft/sec to 16 ft/sec), resulting in a 40% reduction in impact energy and a 70% anticipated reduction in landing injuries. Development validation testing of the ATPS to meet Army requirements was completed during the past year at the Army Yuma Proving Ground (YPG).

A second fundamental challenge in this field is the precise delivery of a payload to its intended target, particularly from high altitude. The New World Vistas Precision Air Delivery (PAD) program, sponsored by the Air Force Research Laboratory Office of Scientific Research (AFRL-OSR) and managed by the Army Natick Soldier Center (NSC), is a multidisciplinary effort to address this challenge. Its immediate goal is to improve resupply methods for ground troops.

The PAD program integrates three key technologies to achieve this goal. The first is

Precision Airdrop Planning Software (PAPS), an advanced on-board airdrop planner developed by Draper Lab to improve the calculation of a computed aerial release point while en route to the drop zone. A second enabling technology is improved sensing and processing of complex wind field data. A wind field estimator called WindPADS, developed by Planning Systems, assimilates environmental data obtained in flight with forecasted weather information to produce a 3D time-dependent grid of weather data. PAPS uses these data to produce an expected trajectory that accounts for wind-induced parachute drift. The third component accounts for the inherent uncertainties by providing the parachute system with active maneuverability and GNC to maintain its expected trajectory. Known as the Affordable Guided Airdrop System, it uses PMAs developed by Vertigo. The PMAs are placed within the parachute risers to steer the system using a GNC system developed at the Naval Postgraduate School and YPG.

Airbag systems

Incorporation of airbags within parachute systems to improve their soft landing performance is an evolving technology that was demonstrated on several major projects this year. The HOPE-X reentry vehicle, which Japan's National Aerospace Laboratory and National Space Development Agency are developing for reusable space transportation, uses an airbag system designed by Irvin Aerospace. Martin-Baker Aircraft has developed an airbag system for the Beagle 2 Mars Lander that will fly as part of the ESA Mars Express mission scheduled for launch in 2003.

Under the Rapid Rigging/Derigging Airdrop System (RRDAS) program sponsored by the Army NSC, smart airbags have been investigated to replace the paper honeycomb traditionally used for impact attenuation. This year Warrick & Associates and Irvin Aerospace performed design, testing, and simulations of prototype RRDAS airbag systems. Another approach for reducing landing impact, also being developed under



The Advanced Tactical Parachute System will replace the T-10 as the Army's primary personnel parachute.

by **Michael L. Accorsi**

the RRDAS program, is retraction soft landing. Here the payload is pulled upward toward the parachutes just before landing to reduce velocity. Warrick & Associates is developing a stored gas pneumatic system, while Vertigo is developing a system using a large PMA with a pyrotechnic gas generator.

Parafoil decelerators

Parafoil-type decelerator systems were also prominent this year. Although used for a variety of diverse applications, a common requirement for these systems is the development of GNC schemes for autonomous flight. A new powered parafoil system developed by MMIST was demonstrated by the Special Operations Command (SOCOM) and the NSC to serve as an inexpensive, rapidly deployable unmanned aerial vehicle for precise delivery of payloads up to 600 lb. The system uses an airborne guidance unit and GPS to reach its targets accurately, deliver its payloads, and return to a preplanned landing site. The ALEX parafoil system was developed and flight tested by the Institute of Flight Research of the German Aerospace Center. The primary goals of these tests were to perform system identification using the acquired flight data and to develop robust GNC algorithms for autonomous landings.

The seventh free-flight test of the X-38 prototype with the world's largest parafoil was performed on July 10 and was highly successful. The goal of the program, led by NASA-Johnson, is to provide an emergency recovery vehicle for astronauts aboard the International Space Station. A 7,500-ft² parafoil designed by Pioneer Aerospace is used in the final descent phase to position and decelerate the recovery vehicle for a smooth landing. Several parafoil maneuvers were executed during the July test to evaluate the GNC software developed by the ESA and Southwest Research Institute.

After the successful launch of the Genesis spacecraft on August 8, scientists from JPL will have to wait over two years before its precious cargo is recovered by a spectacular parafoil midair retrieval. The goal of the Genesis program is to collect and return small amounts of solar material on highly fragile collector arrays and to perform compositional analysis that will provide fundamental information about the birth of our solar system. The midair retrieval method developed by Vertigo was considered the only feasible method for recovering the capsule without jeopardizing its contents, and successful

proof-of-concept tests took place this year. Packed within the capsule is a 420-ft² parafoil. Designed by Pioneer Aerospace, the parafoil will provide the steady glide descent needed to capture the capsule in midair with a specially equipped helicopter.

Other new systems

The technical challenges associated with space exploration and development continue to inspire innovative solutions for aerodynamic decelerator systems. The first flight test of an Inflatable Reentry and Descent Technology (IRDT) system was performed successfully last year. The IRDT system uses a cone-shaped inflatable shield that functions as both a heat shield and aerodynamic decelerator, thus providing a lightweight, economical method to return payloads to Earth. The IRDT system is being developed by Babakin Space Center in Moscow and Astrium in Bremen, with support from ESA and the European Commission, via the International Science and Technology Center. The second flight test of the IRDT system was scheduled for October and will incorporate several improvements to the inflatable shield and a high-performance flight measurement system. Work on an operational IRDT system to be used for payload return from the International Space Station also began this year.

Autonomous precision airdrop technology investments are increasing around the world. Several such systems, of varying levels of maturity, were showcased at the Precision Airdrop Technology Conference and Demonstration at YPG. This large event, sponsored by the NSC, AFRL-OSR, YPG, SOCOM, NASA-Johnson, and the Marine Corps Warfighting Laboratory, took place September 10-14 with many presentations and demonstrations. Similar events are expected to take place every year to ensure a maximum level of communication and collaboration in this rapidly expanding technology area. ▲



The Army powered parafoil system uses self-guided navigation to serve as an inexpensive unmanned aerial vehicle.