▲ **SpaceX's Crew Dragon** capsule splashes down in the Gulf of Mexico in August carrying two U.S. astronauts from the International Space Station. NASA's Bob Behnken and Doug Hurley were launched in the Crew Dragon two months earlier.

NASA

Landing safely on Earth, then the moon and Mars

BY OLEG YAKIMENKO

The **Aerodynamic Decelerator Systems Technical Committee** focuses on development and application of aerodynamic decelerator systems and lifting parachutes, pararotators, and inflatables for deceleration, sustentation and landing of manned and unmanned vehicles.

Almost nine years after the final space shuttle launch in 2011, **NASA's Commercial Crew** program launched astronauts from the United States in May. In August, after 64 days in orbit, **SpaceX's Crew Dragon** Endeavour spacecraft with two men onboard floated to Earth with its two drogues and four main parachutes performing as expected. This was the first time in almost 45 years that astronauts splashed down under parachutes and the first time in the Gulf of Mexico.

Throughout the past year, NASA's Artemis program made strides toward landing the first woman and next man on the moon in 2024 with the processing of the **Orion vehicles** for **Artemis I** and **Artemis II**. In April, NASA began final integration and inspection of the 11 parachutes of the Artemis I Orion spacecraft, bound for its 25-plus-day first flight to lunar orbit in 2021. The agency completed Artemis II parachute manufacturing, packing and acceptance in August, setting the stage for Orion's first crewed mission to send humans beyond low-Earth orbit for the first time since Apollo 17 in 1972.

NASA's **Mars 2020** mission, with the 1,050-kilogram **Perseverance rover** and new technology demonstration 2-kilogram **Ingenuity Mars helicopter**, were launched from Cape Canaveral Air Force Station in Florida in July. The rover is scheduled to land on the red planet at Jezero Crater. Several new technologies will operate during entry, descent and landing, including **Range Trigger and Terrain-Relative Navigation**, while Perseverance descends under the 21.5-meter-nominal-diameter **Disk Gap Band parachute**.

In June, the U.S. Army initiated the process to develop the **Next Generation Static Line personnel parachute** for multidomain operations. The Army Combat Capabilities Development Command Soldier Center is leading the technical development and spent the end of the year identifying the capabilities of commercially available parachutes in the U.S. and allied nations. These data, along with user input, will be used to conduct a detailed analysis and determine a potential path in 2021.

CCDC SC, as the technical lead for the **Autonomous Aerial Insertion and Resupply into Dense, Urban, Complex Terrain Joint Capability Technology Demonstration**, or **AAIRDUCT**, worked to develop a way to deploy 2- to 20-kilogram payloads from a Joint Precision Airdrop System, which uses GPS and steerable parachutes. The center conducted tests at Yuma Proving Ground in Arizona in September and October in preparation for an Office of the Secretary of Defense-sponsored operational demonstration.

The Army is also looking at innovative technologies to operate in the highly contested air portion of multidomain operations. One avenue of study this year was a novel, high-offset cargo delivery mechanism under the **Squad Operations Advanced Resupply**, or SOAR, program. CCDC SC completed early testing in July at Dugway Proving Ground in Utah by dropping an expendable cargo transport prototype for resupply loads out of a commercial aircraft. The test demonstrated the prototype being dropped from the host aircraft via drogue parachute, the wing unfolding from a stowed to a deployed position, a turbojet engine starting up onboard the prototype, a powered and then gliding flight, and the prototype touching down under a used personnel parachute. A goal of additional development is to increase the distance cargo can be deployed from the target to over 800 kilometers, more than 50 times the current standoff distance. ★

Contributors: *Ricardo Machin, Jared Daum and Scott Martin*