December 2012

AEROSPACE AMERICA

2012

Year in review

A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Gossamer systems

by **Gregory L. Davis, Vaios Lappas, Nathan C. Barnes, James D. Moore,** and **Jeremy A. Banik**

This was a productive year for the gossamer spacecraft community, with exciting developments ranging from mission design and fundamental research to fabrication of hardware.

Deorbitsail is a Cubesat mission that will develop an aerodynamic drag-inducing gossamer sail system for deorbiting satellites at end-of-life. For missions having deorbiting time constraints of 25 years, this device is predicted to be effective at altitudes lower than 1,000 km for minisatellites (20-500 kg). The project is a pathfinder mission that seeks to create options for deorbiting satellites and to advocate for solar sail propulsion. The sail itself will be deployed from a standard 10x10x30-cm, three-axis-controlled Cubesat platform that will rely on the stored strain energy of coiled booms for deployment. After a design review earlier this year, the Deorbitsail booms and deployment system are being built for testing by year's end. The project is funded by the EU's Framework 7 program, a project with 10 partners from Europe and the U.S. led by the University of Surrey in the U.K. (see www.deorbitsail.com). This program builds on the successful NanoSail-D drag sail mission launched by NASA in November 2010.

JWST's first sunshade undergoes initial inspection prior to testing.

In an artist's depiction, the Sunjammer sets sail toward Lagrange Point 1.

The deployable structures team in the Space Vehicles Directorate of the Air Force Research Laboratory spent the past year conducting research in the area of thin foldable elastic composite structures. A novel pure moment-curvature flexure testing apparatus that does not use surface strain gauging was devised to characterize bending stiffness and failure strain of typical high-strength carbon and glass composite materials. This testing led to the discovery that thin flexural-loaded unidirectional composites fail at higher strains than would be expected from standard tension test regimes. To test the practical feasibility of using these materials as foldable primary structures in space, four separate prototypes were prepared; three of these are planned space-based experiments, among them a Cubesat diffractive telescope support structure that was assembled using carbon composite rollable tape elements.

In response to a technology demonstration mission call from NASA's Office of the Chief Technologist, L'Garde proposed an ambitious solar sail flight that will demonstrate the usefulness of such sails for future missions. L'Garde, with its partners the National Oceanic and Atmospheric Administration and Space Services Holdings, will develop a 1,200-m^2 solar sail with an anticipated launch date in the fourth quarter of 2014, and will subsequently fly it to a sub-L1 location. The preliminary design of Sunjammer (the sailcraft is named after a short story by Arthur C. Clarke) calls for it to be boosted to geostationary transfer orbit as a secondary payload. Once Sunjammer is released from the booster vehicle, it will perform a propulsive burn and boost itself to an Earth escape orbit. Upon reaching this trajectory, the sail will be deployed and the demonstration mission will begin (see http://www.lgarde.com/programs/space-propulsion/sunjammer/).

This year, testing of the full-sized James Webb Space Telescope sunshield has begun. The five Webb sunshield layers, each the size of a tennis court, are made of specialized Kapton material, a very thin high-performance polymer with a reflective metallic coating. Once they are tensioned, the relative separations and alignments of each of the five membrane layers are critical to achieving the desired cryogenic operating temperature of the telescope and instruments. After all five layers of the full-sized sunshield complete test and model analysis, they will be sent to Northrop Grumman's high bay in Redondo Beach, California, for tests characterizing how the sunshield deploys from its folded shape in the launch vehicle (see www.jwst.nasa.gov).