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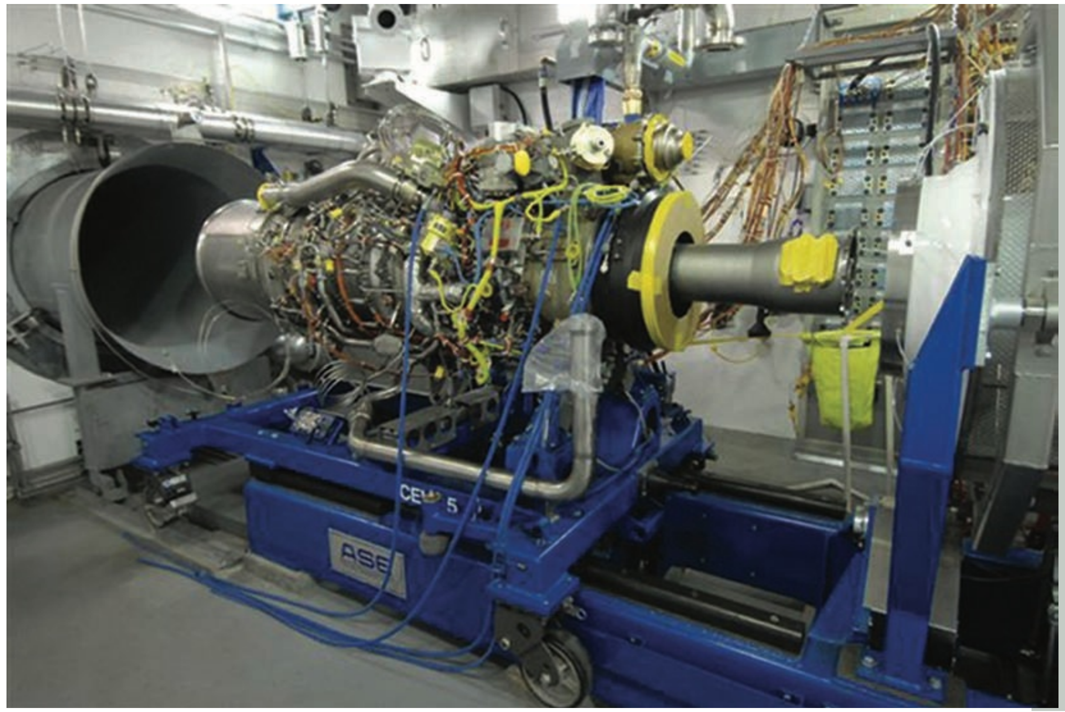
On the Cover

On course for its Critical Design Review this year, Sikorsky's CH-53K has already completed risk-reduction initiatives on its split-torque main gearbox and main rotor blade.



Factory testing of the GE38 at GE's test cell in Lynn, MA, is expected to run through 2011 in concurrence with a full military qualification test program.

operations in the world. It is deployed from **U.S. Marine Corps** amphibious assault ships to transport personnel and equipment and to carry external (sling) cargo loads. It is also the focus of **U.S. Navy** concerns in terms of fatigue life, interoperability, maintenance supportability, and performance degradation.

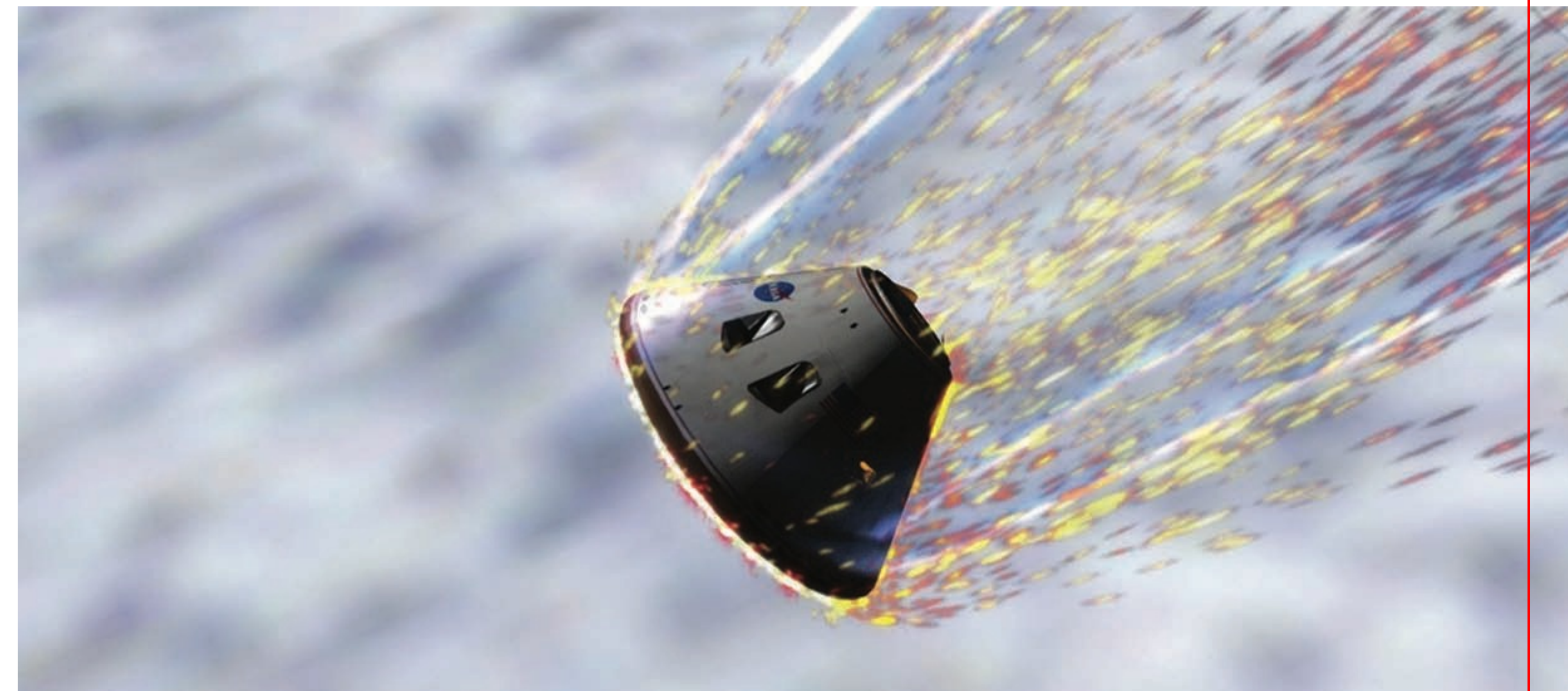
The CH-53K helicopter will maintain virtually the same footprint as the CH-53E but will nearly triple the payload to 27,000 lb over 110 nmi on a "sea level hot" (103°F) day. The CH-53K helicopter's maximum gross weight (MGW) with internal loads is 74,000 lb, compared to 69,750 lb for the CH-53E. The CH-53K's MGW with external loads is 88,000 lb, compared to 73,500 lb for the CH-53E.

Features of the CH-53K include a joint interoperable glass cockpit, fly-by-wire flight controls, fourth-generation rotor blades with anhedral tips, a low-maintenance elastomeric rotor head, upgraded engines, a locking cargo rail system, survivability enhancements, and reduced operation and support costs.

The CH-53K helicopter team has already completed several risk-reduction initiatives on two critical technologies (the split-torque main gearbox and the advanced main rotor blade) and is preparing for Technology Readiness Assessment early this year. An Initial Operational Capability milestone is scheduled for early 2016.

The CH-53K program is expected to include production of more than 200 new aircraft.

Jean L. Broge



This artist's rendition shows NASA's Orion flight crew module during re-entry into the Earth's atmosphere. The CCM, an all-composite alternative to Orion, successfully passed critical flight condition simulation tests.

Simulation

Composite Crew Module, HyperSizer both pass NASA tests

A series of critical, full-scale, physical tests have recently been completed by the **NASA** Engineering and Safety Center (NESC) at Langley Research Center accurately predicting the Composite Crew Module (CCM)'s successful performance under simulated flight conditions. The CCM is an all-composite alternative for the flight crew module Orion, which is part of NASA's Constellation program to return man to the Moon and/or Mars.

The NESC is using the CCM project to study material trade-offs between metals and composites in space structures, and the tests' successful outcome clears the way for increased use of lightweight composites in space vehicles.

HyperSizer, a structural sizing and composite analysis software from **Collier Research** Corp., was used throughout the almost three-year project to optimize the design, weight, and manufacturability of the CCM, which is constructed of honeycomb sandwich and solid laminate composites. HyperSizer was the first NASA software to be licensed and commercialized as part of the agency's effort to transfer technology to U.S. business and industry.

"The CCM is an alternative for the metallic crew module, but it has also represented an opportunity for the NASA family to get up the curve on experience with composites," said CCM Project Manager Mike Kirsch. "Our analytical models predicted the response very well, and now we're much better informed to make good material trade-offs for future spacecraft."

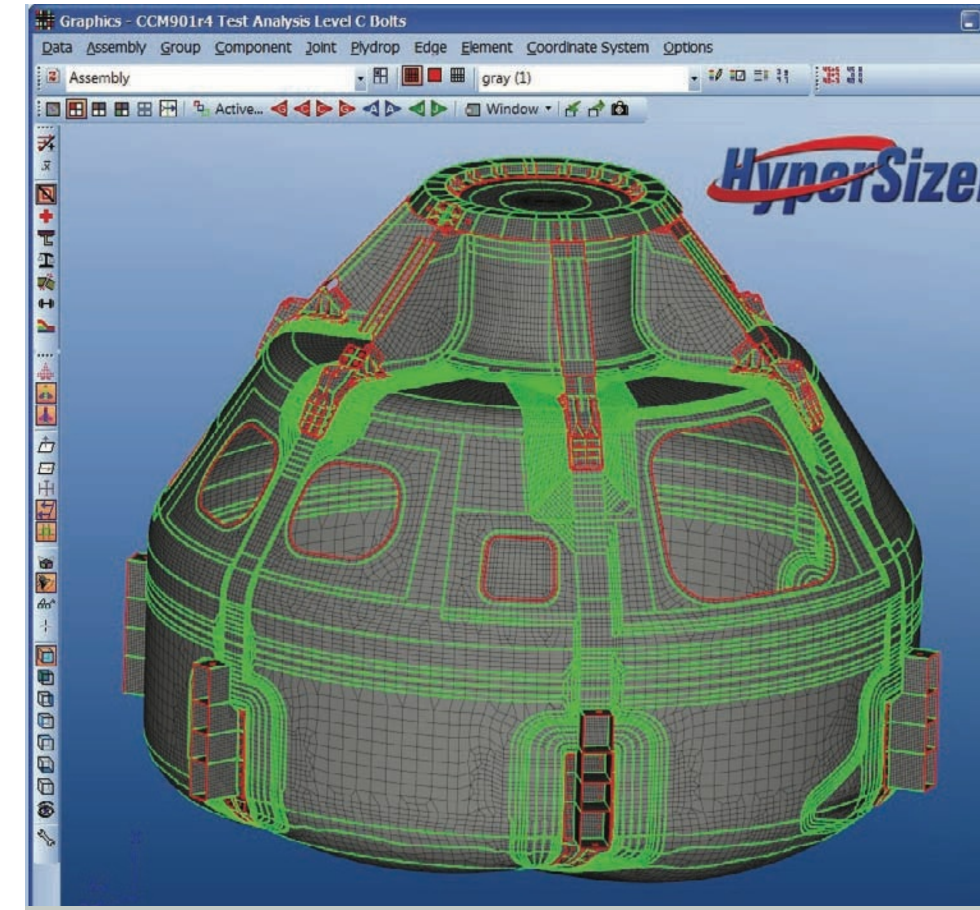
HyperSizer works in a feedback loop with FEA to automatically search for solutions that minimize weight and maximize manufacturability. Although able to be used on metallic structures, HyperSizer is particularly applicable to complex composite materials, providing the capability to optimize the architecture of large structures—such as space vehicles, aircraft, railcars, ships, or wind turbine blades—ply-by-ply and element-by-element.

HyperSizer guided design and manufacturing decisions throughout development of the CCM.

"HyperSizer gave us a view into what the physics were doing," said Kirsch. "We could zoom in on the architecture, refine the design, trade solutions, and evaluate mass and manufacturability very quickly." The software was also used to display analytical results during five different technical reviews with industry and agency experts.

"I've been working with composites for 25 years, and the CCM is the most complicated structure I've ever dealt with," said Jim Jeans, Chief Architect for NASA on the project. "The sizing and strain predictions all held up as the software predicted."

The design and construction of the NASA Composite Crew Module was optimized with the help of HyperSizer structural sizing and design analysis software. The module is pictured here with sensors attached in preparation for pressure testing.



This finite element model of the CCM displayed in HyperSizer shows the composite ply drops identified in green.

For load testing, the CCM was blanketed with 280 linear strain gauges—fiber-optic cables generating about 3000 channels of data—and 80 acoustic sensors that listened for fiber breaks in the composite layups. The structure withstood tests of loads applied to the structure to simulate launch abort and parachute deployment.

An internal pressure test required the CCM to withstand twice standard atmosphere pressure of 31 psi to meet the required NASA safety factor. Additional testing involving intentional damage of the CCM will continue into early 2010; however, passage of the internal pressure test was essential for keeping the module development program on track.

Matt Monaghan