

Technology update

Getting fired up for hypersonic flight

The X-51A program, managed by the **Air Force Research Laboratory** Propulsion Directorate, is a consortium of the **U.S. Air Force**, **DARPA** (Defense Advanced Research Projects Agency), **NASA**, **Boeing**, and **Pratt & Whitney Rocketdyne** (PWR) to demonstrate hypersonic flight capability and scramjet engine technology within the Mach 4.5 to 6.5 range. In late May, the X-51A WaveRider scramjet engine demonstrator completed a critical design review (CDR) and fired its engine for the first time—two major program milestones

nated SJX61-1, powered the first X-51A simulated flight at the **Langley Research Center** test facility. During the successful firing of the demonstrator engine, test engineers used a full-authority digital engine controller to simulate flight conditions at Mach 5 and orchestrate complex fuel controls and transitions. Test of the hydrocarbon-fueled scramjet engine also demonstrated a closed-loop thermal management system in which JP-7 fuel both cools engine hardware and regulates fuel for the engine's combustor. The X-1

"This successful test is a critical step in the development of the X-51A integrated propulsion system. In addition, this marks the first time ever that the scramjet engine has been tested in a simulated 'full flight' propulsion configuration, which includes a Boeing-designed full vehicle fore-body/inlet and nozzle," said Charlie Brink, U.S. Air Force Research Laboratory's X-51A Program Manager.

"The CDR and engine test are key validation points for the X-51A program," said George Muellner, President of Boeing Advanced Systems. "The X-51A [program] will answer many questions necessary for the development of future hypersonic propulsion vehicles that can be used for delivering payloads to space as well as for atmospheric flight applications."

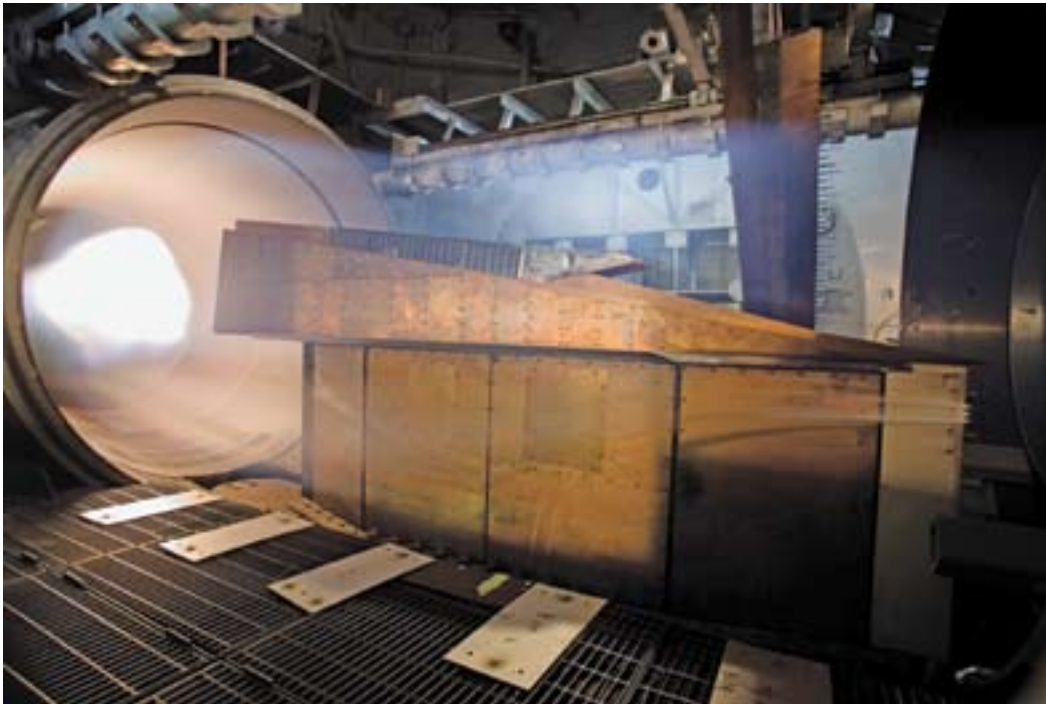
Additional tests this year and early 2008 will verify engine performance and operability across the X-51A flight envelope and characterize the closed-loop thermal management system in preparation for its first flight tests in 2009.

Next, the X-51A team will develop a pre-first flight risk assessment that includes finalizing schedules and addressing remaining procurements, manufacturing, assembly, and flight test planning.

When completed and flown, the X-51A will demonstrate scalable scramjet engine propulsion technology, high-temperature materials, airframe/engine integration, and other key technologies. The X-51A will set the foundation for several hypersonic applications including access to space.

Work for the Boeing X-51A WaveRider is being performed by Boeing Advanced Network and Space Systems in Huntington Beach, CA.

Jean L. Broge



Pratt & Whitney Rocketdyne's X-1 scramjet engine powered the first Boeing X-51A simulated flight at the Langley Research Center test facility.

necessary for first flight.

The CDR allowed government and industry officials to review and validate the vehicle's design, assembly, integration, and flight test plan. The review is a critical part of the program where specifications are verified to indicate that the vehicle's design has matured to its requirements. Procurements, manufacturing, and assembly processes also are established.

PWR's X-1 scramjet engine, design-

is the first of two ground test engines proposed for the program.

"The performance of X-1 in a test environment has exceeded our predictions, and is a major step toward bringing hypersonic flight into practical use," said Mike McKeon, PWR Manager of Hypersonics and Advanced Programs.

Testing was conducted at Langley's 8-ft, high-temperature tunnel in Hampton, VA, from December 2006 through this past April.

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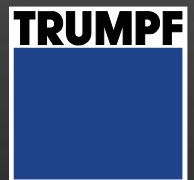
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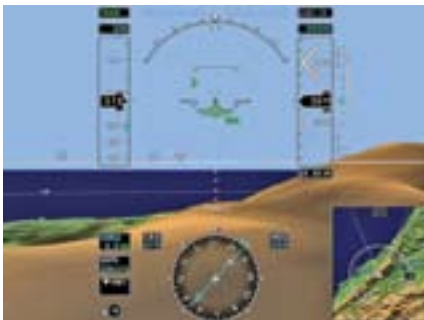
Technology update

Taking a wider view on synthetic vision

Honeywell's Integrated Primary Flight Display (IPFD) integrates existing flight deck information with performance-based head-up display symbology, giving the flight crew a 3-D, real-time synthetic vision display of the outside world. The display is generated from Honeywell's Enhanced Ground Proximity Warning System (EGPWS) terrain database and advanced graphics generators. The EGPWS database has



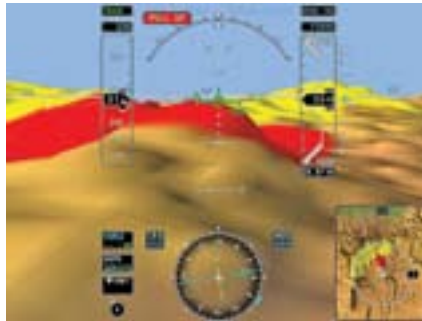
Honeywell says that its Integrated Primary Flight Display (IPFD) synthetic vision system uses cues that pilots understand to provide them with a visual flight rules environment regardless of the time of day or weather conditions.



Engineers have conducted extensive human-factors testing on the IPFD during its development, which began in 1999.

more than 750 million hours of proven operation on commercial, business jets, and helicopters.

"IPFD brings together terrain, obstacle, and runway information coupled with aircraft position and altitude information in a display that replicates a clear view out the window under any weather conditions," said Bob Smith, Vice President, Advanced Technology, Honeywell.



IPFD is considered a tactical tool that helps the pilot make necessary short-term decisions needed during flight.

Future versions of the IPFD synthetic vision system could include a 3-D airport map feature. Airport maps on IPFD would allow the pilot to clearly see the entire airport surface, such as runways and taxiways, as they appear outside the airplane, irrespective of weather conditions and time of day.

"We are exploring a future functionality expansion for IPFD, and when these features are fully defined, we believe it will further increase pilot situational awareness during airport operations," Smith said. Rushing to market is

not in the plan, however. "Only when we are satisfied with the technology readiness level and our customers tell us we've got it right, will we bring it to market."

The new airport maps functionality is being tested in simulators and flight tested on Honeywell aircraft, with engineers gathering feedback from flight crews for incorporation into the system. The testing allows maturation of the functionality and paves the way for future products in the IPFD family, says Honeywell.

Earlier this year, Honeywell also announced it is developing from scratch the technology needed to expand its synthetic vision portfolio for potential rotor wing applications, accumulating flight test hours to further its design and development. IPFD has accumulated more than 700 hours of flight-simulator testing and 400 hours of flight test on Honeywell aircraft.

The company is on track for initial certification of its IPFD technology by the end of 2007. The first application of the synthetic vision product will be the **Gulfstream SV-PFD** (synthetic vision—primary flight display) that is expected to be available as an option on all Gulfstream PlaneView-equipped aircraft.

Honeywell developed the IPFD by performing extensive human-centered design studies. Development of the product also included rapid prototyping in the Honeywell lab simulators and extensive flight testing with hundreds of pilots.

Jean L. Broge

Snecma readies Silvercrest core

The first ground test of Snecma's Silvercrest core demonstrator engine is slated to take place in the last quarter of this year. Silvercrest is a family of future Snecma engines (thrust levels from 9000 to 12,000 lb) for business aviation applications designed to offer a 50% margin over the NOx emissions standard (CAEP 6) and a 25 dB(A) margin

over current noise standards (Stage 3). Further design aims are to reduce fuel consumption by 15% and provide 20% more thrust in the climb than the current generation of typical business jet engines.

Snecma announced in May at the European Business Aviation Convention and Exhibition in Geneva that a dedi-

cated test cell will be used for core engine testing—simulating the low-pressure modules—to obtain all the critical data needed to validate the core architecture and performance parameters. Tests will be at the company's Villaroche facility.

Components for the engines are being produced via the same processes

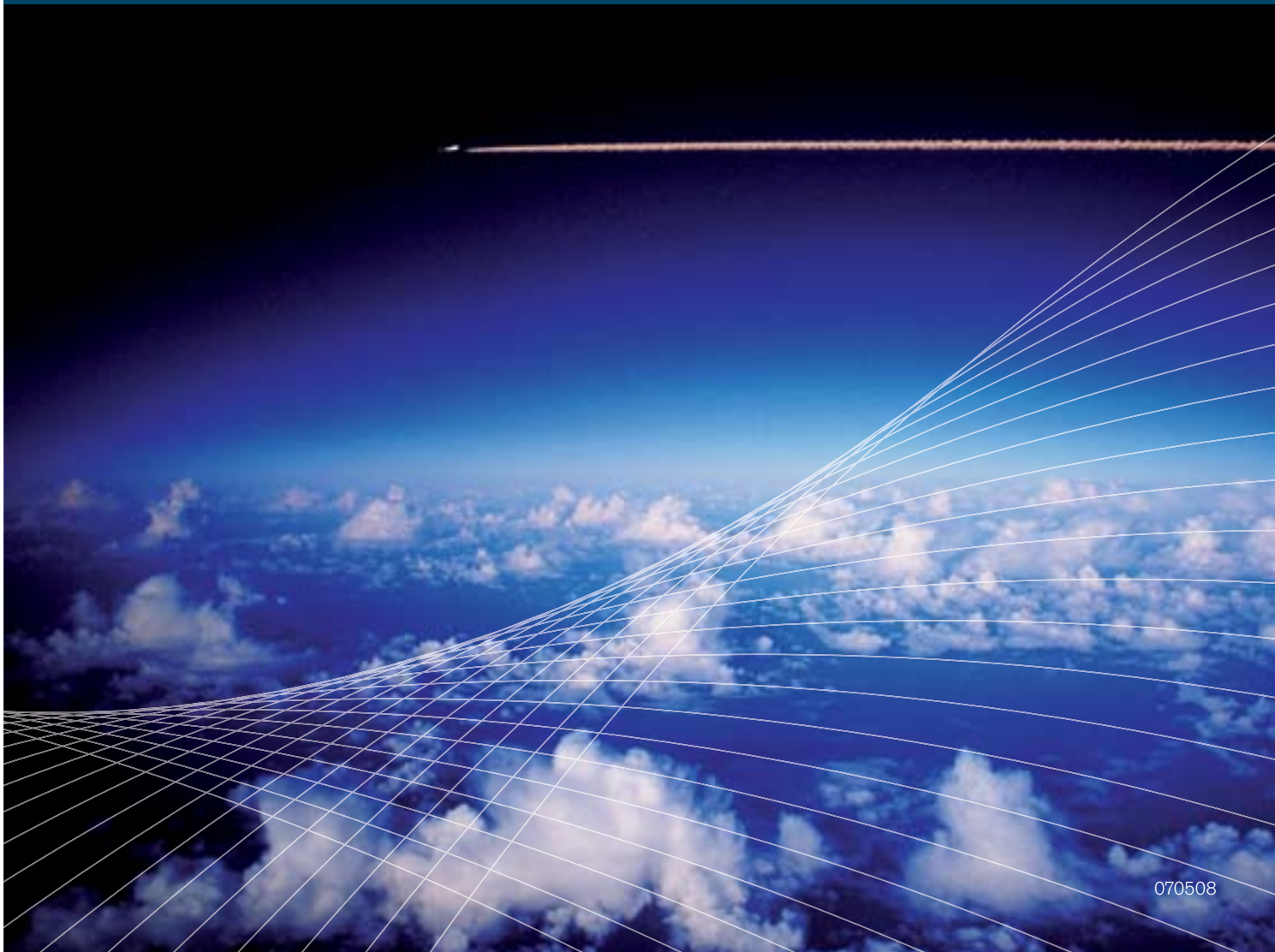
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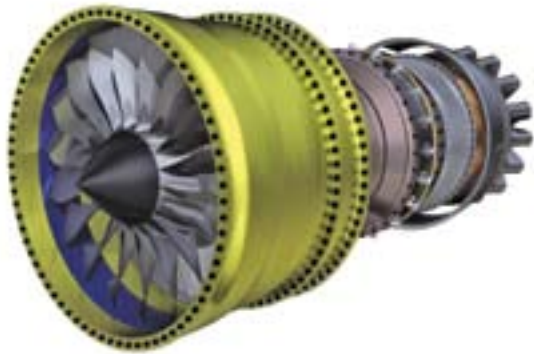
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Snecma's Silvercrest business jet engine range will produce between 9500 and 12,000 lb of thrust.

and facilities used to manufacture the long-established CFM56 powerplant, designed and produced in equal partnership with **GE Aviation** via **CFM International**. The Silvercrest blisks (single-piece integrally bladed disks) are made of titanium, and the turbine blades and guide vanes use single crystal alloy as found in the company's military engines.

Silvercrest design teams are now

studying the use of thermostructural composites designed for the Ariane launcher engine to replace traditional metallic parts on their engine. Advantages would include lower weight and higher performance, as well as a reduction in the cooling cycle for more environmentally friendly performance.

Thermostructural composites form a unique family of high-performance materials, combining the refractory and structural properties of graphite and ceramics with the "highly tailorable" properties of fibrous reinforcement composites, according to the company. A new concept based on self-sealing ceramic matrix composites (CMC) has been developed to meet the need for lightweight materials offering very long service life (typically several thousand hours) on aircraft gas turbine engines. A number of potential applications are now being studied on aircraft engines: combustor liners, turbine inlet guide vane and shroud, mixer, and nozzle

flaps. But there is a need to reduce costs for wide applications.

At present, the M88 engine that powers **Dassault Aviation's** Rafale fighter uses a secondary nozzle flap made of thermostructural composites. M88 endurance tests are now under way on a full CMC primary nozzle. CMCs have also been tested on a CFM56 combustor, and a CFM56-5C mixer has undergone ground endurance testing with "very satisfactory" results, according to Snecma.

Snecma has invested some \$100 million in development of the Silvercrest core. The Silvercrest engine is sized for maximum take-off weights of 45,000 to 60,000 lb, and the company is focusing on powering super midsize to large cabin aircraft. The engine design integrates specific features that will also meet the needs of 40- to 60-seat regional jets.

Stuart Birch

New facility for UAV electrical systems research

An aerospace-industry-supported experimental facility to develop and evaluate ultra-compact and intelligent electrical networks for use in UAVs has been unveiled at the **University of Manchester** in the UK. The facility is within the School of Electrical and Electronic Engineering and is jointly funded by **Rolls-Royce** and the Systems Engineering Autonomous Systems

Defence Technology Centre (SEAS-DTC) program coordinated by **BAE Systems** and sponsored by the **UK Ministry of Defence**. It will complement the university's existing Rolls-Royce University Technology Centre (UTC).

"We will see a rapid growth in the use of uninhabited land, sea, and air vehicles for military, civil, and public use," said Stephen Long, Facility Project

Manager at Rolls-Royce. "The electrical systems' requirements for these platforms are particularly demanding because they need to be compact, flexible, and intelligent."

Phill Cartwright, Head of Electrical Systems at Rolls-Royce, explained that the quest for enhanced electrical technologies was being driven by customer demands for improvements in performance, capabilities, and services. "Emerging electrical technologies have the potential to meet these demands by enabling major improvements in systems integration and product functionality."

Sandy Smith, Director of the Rolls-Royce UTC at Manchester, added "Increased use of electrical technology in aerospace means the next-generation aircraft will have highly sophisticated electrical systems that offer greater operational flexibility, improved fuel consumption, and lower environmental emissions."

Stuart Birch

BAE Systems' Taranis UCAV (unmanned combat aerial vehicle) technology demonstrator. BAE is one of the companies involved with the newly opened UK experimental facility for research into intelligent electrical networks for UAV applications.



Technology update

Boeing 777 freighter design halfway there

Engineers at **Boeing** recently completed 50% of the design for the new 777 freighter, which means that half of the detailed design is defined and has been released to Boeing factories and its suppliers to begin building parts, assemblies, and tools for the new cargo airplane.

Boeing is on schedule to complete the detailed design work and is on track

to meet its commitments for the 777 freighter's performance capabilities, according to Kim Pastega, Deputy Program Manager and Engineering Leader, 777 Freighter Program, Boeing Commercial Airplanes.

The 777 freighter will have a revenue payload capability of 229,000 lb and a range of 4885 nmi with a full payload and general cargo market densities,

making it the longest-range twin-engine freighter. Boeing launched the 777 freighter in May 2005 with an order from **Air France** for five freighters. Boeing continues to work closely with Air France and other customers including traditional cargo operators, airlines, and leasing companies to complete the new cargo airplane's design.

Air France will receive its first 777 freighter in the fourth quarter of 2008. To date, Boeing has 71 orders for the aircraft from 11 customers, including Air France, **Avion Group**, **Emirates**, **FedEx Express**, **Qatar Airways**, **Guggenheim Aviation Partners**, **Korean Air**, **GE Commercial Aviation Services**, **Oak Hill Capital Partners**, and two unidentified customers.

Cargo operation between the 777 and 747 freighters will be complementary, with the ability to transfer shipments directly between the two airplanes. The main cargo door of the freighter will be sized to accommodate 10-ft-high pallets for easy interlining with 747 freighters. The 747 freighter fleet comprises about half of the world's freighter capacity, according to Boeing.

The 777 freighter, the sixth and newest model of the 777 family, is based on the 777-200LR Worldliner passenger airplane. It will share the aircraft family's advanced features such as state-of-the-art flight deck, fly-by-wire design, and an advanced wing design that includes raked wingtips.

The airplane will be powered by **GE Aviation's** GE90-110B1L engine, a derated version of the GE90-115B commercial jet engine. It will also feature **AirWeights**, an onboard weight and balance system from **Crane Aerospace & Electronics**. The **AirWeights** system will use the 777's landing gear struts as scales to determine the load-bearing pressure at each strut to calculate weight and center-of-gravity measurements in real time. The system can also quickly validate manual weight calculations.



Boeing says its 777 freighter will provide more capacity than any other twin-engine freighter and the lowest trip cost of any large freighter.



The 777 freighter is the first commercial aircraft program to incorporate Crane's **AirWeights** onboard weight and balance system.