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Jetman Yves Rossy, with his experimental wings, frames AirVenture

2013, ground zero for grassroots avionics innovation. Largely free from FAA certification rules, the experimental and light-sport aircraft markets are home to big ideas at low prices.

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COVER STORIES

46 Austin Meyer, developer of the X-Plane simulator and Xavion emergency landing application for the iPad, tests Xavion in his Columbia 400 single-engine aircraft in this image by Jeff Amberg Photography. Meyer also provides the Xavion software to nascent avionics maker Vertical Power for the VP-400 backup flight display and "runway seeker" package that automatically guides an aircraft to the best-fit runway after an engine failure or pilot incapacitation. VP-400 is being offered to the experimental aircraft market. AW&ST also talked to four other companies that design, build and market innovative, low-cost avionics largely for the experimental and light-sport sector.



32 All eyes are on France as its air force places the first delivered A400M into service.



42 Mitsubishi says the MRJ has been designed to very high levels of precision, with the aim of easing assembly and thereby cutting production costs.

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On the Web

A round-up of what you're reading on AviationWeek.com

When the **U.S. government shut down** last week, **3,000 aviation safety inspectors** got word that they **were considered nonessential** (see page 24). Read analysis of the situation in our **Things With Wings** blog and **weigh in with your opinion** (ow.ly/psrBy). **AviationWeek.com/ThingsWithWings**

The U.K. Royal Air Force has been celebrating a decade of operations with its AW101 Merlin helicopters. Read about the history and future of the aircraft on our Ares blog (ow.ly/pss7T). **AviationWeek.com/Ares**



TONY OSBORNE/AW&ST

ECONOMIES OF SCALE

FedEx showed off its new **Boeing 767** recently, the **first of 46** planned to replace older widebodies. **See the photos** on Things With Wings: ow.ly/pssSt

READER COMMENT

On an article about **China's plans for a super-heavy launch vehicle**, 'Coastal Ron' wrote: "Just as I have no doubt that the U.S. can build a modern rocket with the capabilities of the Saturn V, **I don't have much doubt that China could either**—with the usual qualification of "given enough time and money." ow.ly/psr4I



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NOT ALL TIME IS EQUAL

As an airline transport captain with a few gray hairs, I'd like to weigh in on the well-considered Viewpoint by Jeff Schneider about whether possession of an ATP makes a pilot and airline safer (AW&ST Sept. 9, p. 62).

The new Airline Transport Pilot (ATP) rules are all about numbers, regardless of actual experience, and will never address the real issues of pilot qualification and professional conduct. Suggesting there is a simple numbers point at which a pilot becomes capable of taking seat in a modern airliner cockpit is either naive, foolish or both. And truly, 1,500 flight hours takes no account of an individual's maturity and professionalism.

The new rule is indeed flawed, and the pairing of two low-time pilots is just one concern. Logging 1,500 hr. by towing a banner up Miami Beach and then calling yourself an airline pilot is rubbish. If I were to find myself seated next to a first officer with 300 hr. of approved school training, including heavy emphasis on multicrew, multi-engine, high-density airport operations via an appropriate simulator, I would be infinitely more assured.

The contents of certain cockpit voice recorder transcripts show a tragic lack of professionalism and leadership, regardless of the number of hours flown. Willful and continual ignorance and violation of a federally mandated sterile cockpit regulation gives me no confidence in an aircraft commander's ability to effectively lead and mentor.

Fighting complacency, fatigue and other safety-related concerns in the cockpit calls for extreme self-discipline and focus. Ignoring basic safety of flight-driven rules, regulations and company standard operating policies is surely a reckless act.

The captain must absolutely set the tone of the cockpit-working atmosphere. The airline has an obvious, though not always practiced, responsibility to select the right individuals, and not just be scrambling to satisfy the number-of-hours farce that is this new regulation.

Rory F. Kay

GUERNSEY, CHANNEL ISLANDS

REJECTING THE PREMISE

It is clear from Cathy Buyck's article "Accept or Reject" (AW&ST Sept. 9, p. 22) which side of the argument she is on. The description (and misquotation)

of the European pilot lobby's stance is as deceptive as it is disappointing. The European Aviation Safety Agency regulations are a very clear dilution of U.K. flight-time limitations (FTL). Although many member states' FTL rules will be improved by these regulations. Generally, the countries with the most aviation activity have the more restrictive regulations.

As such, the quote by European Union Transport Commissioner Siim Callas: "We are determined to see stronger, safer rules applied across Europe," is surely the deceptive one. Scientific studies of human performance and circumstantial evidence in the form of recent hull losses would suggest that the campaign slogan of the British pilots' lobby—"Tired Pilots Risk Lives"—is a truism.

Capt. John Goodyer

SUSSEX, ENGLAND

TIME-CRITICAL TARGETS

I agree with the premise that Bill Sweetman puts forth in "Blast from the Past" (AW&ST Sept. 30, p. 17) that, when applicable, previously tested concepts should be reexamined. A possible



solution for today's time-critical targets was within our grasp during the height of the Cold War. The High Speed Strike Weapon of the 1960s was the Douglas

AGM-87A Skybolt, a hypersonic Mach 12.4 (9,500 mph) air-launched ballistic missile. Strategic Air Command Boeing B-52s would have carried four Skybolts, and launched the 11,000-lb. missiles at a standoff range of 600-1,000 mi.

Even though Skybolt was only tested for a short period of time, Defense Secretary Robert McNamara grew impatient and abruptly canceled the program on Nov. 7, 1962. In his haste to do so, he failed to consult with the British, who had invested £27 million to modify RAF Vulcan bombers to carry Skybolt. We must wonder whether McNamara realized the full potential of an air-launched hypersonic missile.

Sweetman's concept of combining

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a hypersonic delivery system with modern advanced reentry vehicle technology is sound. What would have been a daunting problem for Soviet air defenses during the 1960s, has the same relevance today. After all, the primary goal of deterrence is to present a complex defensive problem to your adversaries.

Erik Simonsen

CHINO HILLS, CALIF.

OLD BECOMES NEW

"Textron's Gamble" (AW&ST Sept. 16, p. 22) could prove fruitful. The company could have taken a page from Alexander Kartveli, designer of the Republic P-47 who was brought out of retirement to design the Fairchild Republic A-10 Thunderbolt II ground attack aircraft, where he kept the engines high and behind the low wing and tail for protection from ground fire. I wish Textron better luck than Beech, with their AT-6, which lost, even when offered in response to an actual U.S. Air Force solicitation.

Robert J. Stewart

SAVANNAH, GA.

DUAL-PANE COCKPIT CLUE

The photograph that appears on page 47, which accompanies "The Shock of the New" (AW&ST Sept. 30, p. 44), is certainly not of a Lockheed TriStar. It appears to be a Vickers VC10.

Bob Orlove

PROSPECT, KY.

(The reader is correct—Ed.)



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Lew Jenkins

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Alexander Mikheev (see photo) has been appointed CEO of Moscow-based *Russian Helicopters*, a part of Rostec State Corp. He was deputy CEO of Rosoboronexport and succeeds **Dmitry Petrov**, who will continue to work within Rostec.

John Allen has become vice president/chief safety officer of *JetBlue Airways*. He recently retired as FAA director of flight safety standards.

Franz Josef Kirschfink (see photo) has been appointed managing director of *Hamburg Aviation*, which includes Airbus, Lufthansa Technik and Hamburg Airport. He succeeds **Walter Birkhan**, who is retiring. Kirschfink has been director of technology projects for Lufthansa Technik and had been chief operating officer of subsidiary Alitalia Maintenance Systems in Rome.

Paul Sinton has become managing director for the Belfast, Northern Ireland-based European Space Propulsion subsidiary of *Aerofjet Rocketdyne*. He was an executive for analysis, test and senior program management with Thales Air Defense, also in Belfast.

William H. Hernandez (see photo) has been named to the board of directors of the Falls Church, Va.-based *Northrop Grumman Corp.* He is a retired senior vice president/CFO of PPG Industries Inc.

USAF Brig. Gen. Veralinn Jamieson has been appointed director of intelligence at Air Combat Command (ACC) Headquarters, Joint Base Langley-Eustis, Va. Jamieson was special assistant to the deputy chief of staff for intelligence, surveillance and reconnaissance at USAF Headquarters at the Pentagon and succeeds Brig. Gen. **Bradford J. Shwedo**. He has been named director of capability and resource integration at U.S. Cyber Command, Headquarters, Fort Meade, Md. Brig. Gen. **John L. Dolan** has been appointed assistant deputy commander of U.S. Air Forces Central Command/assistant vice commander of the ACC 9th Air Expeditionary Task Force, Shaw AFB, S.C. He was commander of Kandahar Airfield, Afghanistan, Headquarters International Security Assistance Force/commander of the ACC 451st Air Expeditionary Wing, also at Kandahar. Brig. Gen. **Jacqueline D. Van Ovost** has

been named deputy director of Politico-Military Affairs (Europe) at the Pentagon. She was vice commander of the USAF Expeditionary Center of Air Mobility Command, Travis AFB, Calif. Brig. Gen. **John S. Shapland** has been appointed senior defense official and defense attache at Tel Aviv. He was special assistant to the commander of the 3rd Air Force, U.S. Air Forces in Europe, Ramstein AB, Germany.

Victoria Pender (see photo) has become executive vice president-communications of U.K.-based *Cobham plc.* She was group director for government and corporate affairs for Network Rail and has been director of communications for Tube Lines Ltd.

David O'Neill has been appointed director of sales for the *Premier Aviation Overhaul Center*, Trois-Rivieres, Quebec. He was vice president of international sales and marketing for Aeroframe Services.

Samar Nath (see photo) has been named Mumbai-based CEO/country manager for Indian operations for *DHL Global Forwarding*. He was executive vice president and managing director for India and South Asia at CEVA Logistics and has been managing director for India and South Asia at APL Logistics.

Roger Launius of the Space History Div. has become associate director for collections and curatorial affairs at the *National Air and Space Museum* in Washington. He succeeds **Peter Jakab** of the Aeronautics Div., who is now chief curator.

Brent Monroe (see photo) has been named Dallas-based vice president for Western North American sales for the *Gulfstream Aerospace Corp.* He was head of aircraft sales in Texas for Bombardier Aerospace.

HONORS AND ELECTIONS

Alix C. Deymier-Black of Washington University in St Louis is one of five young scientists who have received First Award Fellowships from the Hous-

ton-based *National Space Biomedical Research Institute* (NSBRI). Through this two-year program, the scientists will conduct biomedical research with the aim of helping to protect astronaut health during long-duration spaceflights. She will be a member of the NSBRI Musculoskeletal Alterations Team, as will **James M. Kuczmarski** of Texas A&M University. The other three winners are: **Julianna C. Simon** of the University of Washington, who will be a member of the Smart Medical Systems and Technology Team; **Torin K. Clark** of the Massachusetts Eye and Ear Infirmary, the Sensorimotor Adaptation Team; and **Justin S. Lawley** of the University of Texas Southwestern Medical Center, Cardiovascular Alterations Team.

Lew Jenkins (see photo), longtime chief of air traffic services for Airways New Zealand, has been named to receive the Jean Batten Memorial Award from the *Guild of Air Pilots and Air Navigators* on Oct. 23 in London. He is being honored for "outstanding individual contribution to New Zealand aviation, in training and leading professionals in his chosen discipline of air navigation services."

Former U.S. Secretary of Transportation **Ray LaHood** has received the first WTS Navigator Award from Washington-based *WTS International*, the association for the advancement of women in transportation.

He was cited for standing "behind our mission and creating new opportunities for a diverse and inclusive workforce." He was noted for having set the gender diversity issue in the transportation industry on an accelerated path. ☺

AIR TRANSPORT

CSeries Quietness Measured

Bombardier collected the first noise data on its CSeries airliner during its Oct. 1 second flight from Mirabel International Airport, near Montreal. The data will help CSeries customer Porter Airlines build its case for lifting the ban on operating jets from Toronto's downtown island airport. The 90-min. flight was similar to the 2.5-hr. first flight on Sept. 16, says Bombardier. Flight-test aircraft FTV1 retracted its landing gear and reached a speed of 230 kt. and altitude of 12,500 ft. The flight was "exceptionally clean," says Rob Dewar, Bombardier's CSeries vice president and general manager. There was a single snag on the first flight, an erroneous message from an aircraft subsystem. Explaining the gap between first and second flights, the company says it took time to "meticulously review the 14,000 data points collected on the first flights, to reconfigure some parts of the aircraft and make software upgrades for the next flights." On its Oct. 3 third flight, the aircraft flew for almost 4 hr. and reached 425 kt. airspeed and 25,500 ft. altitude, according to observers.

Norwegian Blue

Low-cost operator Norwegian Air Shuttle is expected to return its grounded Boeing 787-8s to service early this month after the manufacturer implemented an aggressive "get-well" campaign to beef up spare-parts provision, maintenance and engineering support. The situation at Norwegian appeared to have come to a head by the end of September, following several weeks of reliability problems in the power distribution system, hydraulics, oxygen system and brakes. Boeing has meanwhile accepted that the initial in-service experience of the 787 has fallen short of its hopes, despite concerted efforts to overcome a continuing series of reliability issues. Commenting in Santiago, Chile, where Boeing officials were discussing the company's current market outlook, Commercial Airplanes Marketing Vice President Randy Tinseth said, "Today, the reliability of the 787 is better than 95 percent. It's not as good as we'd like to see it. It's not as good as our customers would like to see it. So we're looking at ways to improve that reliability over time." The airline, which has eight 787-8s on order, has contracted with Boeing to

Water and Perchlorate Found on Mars

Early peer-reviewed results of soil-sample analysis by an instrument on the Curiosity Mars rover hold potentially good news for future human explorers who will need to live off the land as much as possible, and bad news for scientists looking for evidence of past life on the planet.

A scoop of geologic fines—dust and finely grained soil—collected for the Sample Analysis at Mars (SAM) instrument suite inside the rover body detected water molecules that some day may be recovered by astronauts practicing in-situ resource utilization (ISRU). But the fines also contained perchlorate, a salt already discovered at the planet's north pole that will make it harder to detect organic carbon compounds in the search for life.

"This may change the way we search for organics on Mars," says NASA astrobiologist Daniel Glavin, lead author of a paper in the *Journal of Geophysical Research: Planets* that outlines the perchlorate findings.

The SAM instrument heats samples to 1,535F and uses a gas chromatograph, mass spectrometer and tunable laser spectrometer to identify its components. In the first scoop of soil delivered to its furnace, the SAM instrument found evidence of water, carbon dioxide, oxygen and sulfur, as well as perchlorate.

"About two percent of the soil on the surface of Mars is made up of water, which is a great resource and interesting scientifically," stated Laurie Leshin of Rensselaer Polytechnic Institute, lead author of one of five papers on the SAM finding published in *Science*. While that finding likely will shape ISRU development for future human Mars explorers, who may be able to use the water for life support and propellant, the perchlorate discovery in Curiosity's equatorial location suggests the chemical covers the planet. When heated above 392F, perchlorate breaks down into chlorine and oxygen. The oxygen will react with organic molecules, essentially burning them to produce carbon dioxide.

The SAM instrument still has a low-temperature analysis capability that uses liquids to break down samples in the search for organics. That technique has not been used yet. Researchers believe traces of organic molecules detected in the initial bake-out originated in the SAM instrument itself, and not on Mars.

provide engineering, spare-parts and maintenance services for its 787s. These services are managed by Boeing, collaborating with qualified maintenance, repair and overhaul (MRO) providers. Boeing says it is "working tirelessly to provide support to Norwegian. We regret the inconvenience and disruption caused to the airline and its passengers as a result of this process." Norwegian leased an Airbus A340 to cover its flight schedule.

Stretch Goals

Boeing has completed initial airworthiness tests of the stretched 787-9 and accumulated more than 40 flight hours in the run-up to the start of flutter tests, which are expected to begin later this month. Initial aircraft handling qualities are good and systems appear to be robust, says 787 Chief Pilot Randy Neville. Speaking to Aviation Week on the sidelines at the Society of Experimental Test Pilots symposium in Anaheim, Calif., he adds that progress has been rapid, thanks to careful preflight test preparations, lessons learned from the 787-8 and good performance of systems during four days of "gauntlet" ground tests in which flight operations were simulated in the run-up to the maiden

flight on Sept. 17. First flight of the first aircraft, ZB001, took place Oct. 2, with a full complement of flight-test engineers.

EMB-120 Down

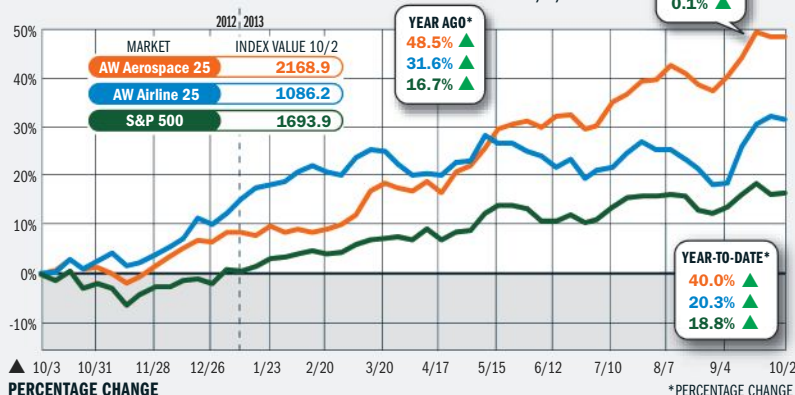
Nigerian authorities are investigating the crash of an Associated Aviation Embraer EMB-120 Pratt & Whitney Canada PW100-powered twin-turboprop on departure from Lagos, Nigeria, on Oct. 3, killing 16 of the 20 people onboard. Witnesses to the crash told local media the aircraft "was making a lot of noise" when it descended, and pilots appeared to maneuver to avoid a residential area.

ROTORCRAFT

Karem Designs Tiltrotor

Karem Aircraft is to design a tiltrotor to meet U.S. Army future utility-rotorcraft requirements under one of four contracts awarded for Phase 1 of the Joint Multi Role technology demonstration (JMR TD). JMR is a precursor to the Army's planned Future Vertical Lift (FVL) Medium program to replace first the Sikorsky UH-60 Black Hawk utility helicopter and later, the Boeing AH-64 Apache attack rotorcraft, beginning in the mid-2030s. The Army has signed

AW&ST/S&P Market Indices as of 10/2/2013



cost-sharing technology investment agreements with AVX Aircraft, Bell Helicopter, Karem and a Sikorsky/Boeing team. The contracts give the four teams nine months to complete preliminary design of their high-speed rotorcraft, after which the Army will review the designs and authorize the construction of two competing demonstrators to fly in 2017. Karem is designing the TR36TD demonstrator, an optimum-speed tiltrotor with twin 36-ft.-dia. variable-speed rotors powered by existing turboshaft engines. Bell is designing a tiltrotor, the V-280 Valor; AVX, a coaxial-rotor, ducted-fan compound helicopter; and Sikorsky/Boeing, a coaxial rigid-rotor, pusher-propeller design. Karem says a production version of the TR36TD would have a level flight speed of 360 kt. Bell's V-280 has a 280-kt. cruise, while the AVX and Sikorsky/Boeing designs are aimed at 230 kt.

SPACE

Indian Mars Mission

India on Oct. 2 moved its Mars Orbiter to the launch pad at Sriharikota for its scheduled liftoff to the red planet on Oct. 28. After a series of tests, scientists at the India Space Research Organization (ISRO) approved transport of the 1,340-kg (3,000-lb.) orbiter to the pad for integration with the 350-ton rocket. It is an extended version of the space agency's workhorse launcher, the Polar Satellite Launch Vehicle (PSLV-XL), an ISRO scientist says. The first stage of the PSLV-C25 with strap-on boosters has been assembled, with the rocket ready for satellite integration by Oct. 10. India's Mars Orbiter is expected to search the red planet's atmosphere for methane,

considered a precursor chemical for life. The satellite, named Mangalyaan, will carry five instruments to study the Martian atmosphere, climate, geology, origin and evolution, as well as its past and current habitability. The schedule calls for insertion into the Mars orbit in September 2014. India's first mission to the red planet comes five years after its first Moon mission (Chandrayaan-1) in October 2008. The Mars Orbiter is set to carry out terrain imaging and mapping in an operation similar to the one designed for Chandrayaan-1.

Space Race

NBC will broadcast a reality TV competition called "Space Race" that will offer a trip for its winner to the edge of space on the suborbital Virgin Galactic SpaceShipTwo, which is now in flight test. The U.S. broadcast network signed a deal with Virgin Galactic and One Three Media. The production team will have "unprecedented access" to Virgin's operations at Spaceport America, near Truth or Consequences, N.M., and will begin distribution activities at an upcoming marketing conference in Cannes, France. SpaceShipTwo is designed to take tourists and scientists to about 100 km (62 mi.), where they will experience the black sky above most of the atmosphere and the microgravity of free fall.

Naval Research on ISS

The nonprofit Center for the Advancement of Science in Space (Casis) has awarded a U.S. Naval Research Laboratory (NRL) a \$250,000 grant to use the station's hyperspectral imager to study harmful algal bloom in coastal areas around the world. Also known as red tide, the algal bloom releases

toxins that are harmful to humans and marine life. The NRL plans to use the facility mounted on the exposed "porch" of the station's Kibo Japanese Experiment Module to refine techniques for detecting and classifying the algal blooms, including generating algorithms to speed the process.

UNMANNED SYSTEMS

Flexible Friend

The first set of flexible wings on the X-56A Multi-Utility Technology Testbed (MUTT) are being installed in readiness for the flight tests designed to probe to the edge, and beyond, of the destructive flutter envelope. Built by Lockheed Martin Skunk Works, the 28-ft.-wingspan unmanned aircraft has been designed to test control technologies to counter flutter; a potentially catastrophic aeroelastic instability to which aircraft with slender, high-aspect ratio wings are particularly vulnerable. The research is vital as long, thin wings are considered key to the design of many potential unmanned, long-range surveillance systems and fuel-efficient transport concepts. The U.S. Air Force Research Laboratory and NASA plan to use the MUTT to evaluate flutter suppression and gust-load alleviation technologies. However, before this work can begin, initial flight testing has been underway to characterize the basic flying qualities and clear the envelope of the X-56A with conventional wings.

BUSINESS

Sequestered Ban

At least one captain of industry thinks the Defense Department could lift its ban on prime U.S. contractors acquiring each other now that lower annual budgets appear locked in for years. "I don't see the department . . . standing in the way of consolidation," Exelis CEO David Melcher says. The expressed ban on the Top 5 contractors—Lockheed Martin, Northrop Grumman, Raytheon, Boeing and General Dynamics—merging stems from Pentagon policy crafted before the Budget Control Act and its threatened sequestrations became law in August 2011. Most executives and officials openly believed Congress would avoid the law's full cuts until this year when political impasses solidified them. That uncertainty is fading and a lower budget paradigm is becoming clearer.



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By Richard Aboulafia

Contributing columnist
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Washington.

COMMENTARY

The Scorpion Fallacy

Textron's privately funded combat/ISR jet targets a phantom market

Textron, in partnership with Airland Enterprises, recently unveiled the Scorpion, a largely clean-sheet light combat/ISR jet that is being prepared for a first flight this month (see photo). New military aircraft are so scarce that any new prototype is bound to garner attention, including an Aviation Week cover story (*AW&ST* Sept. 16, p. 22), and it's good to see innovation make an appearance in the aerospace and defense industry. Yet, despite all the talk of paradigm shifting, low costs and "80% solutions," what exactly is the market for this product?

For the U.S. Air Force, Scorpion is not an 80% solution, it's a solution to a problem that does not exist. Close-air support is not a pressing requirement for the service; it has been trying for years to retire its A-10 fleet (see page 54). The

A-10s have been extensively modernized and are far more effective at destroying land targets than Scorpion would be. Scorpion would cost less to operate, but keeping the A-10s would have no impact on the procurement budget; their payload is much larger and effectiveness, much greater.

Similarly, if the Air Force wanted a good small ISR (intelligence, reconnaissance and surveillance) platform, it would not be thinking about retiring its MC-12W/Beechcraft King Air fleet, recently acquired under Project Liberty. When you retire a brand-new asset, it is not because you think you can find a lower-cost aircraft to replace it.

Another mission identified for Scorpion is air patrol. But to provide any kind of air patrol capability, Scorpion will need to offer a radar and supersonic performance. In the 1980s, the Air Force looked at Northrop's F-20 as a basic air-defense fighter. It



TEXTRON

had both a radar and supersonic performance, but the service rejected it in favor of the more capable F-16.

The Air Force does have one firm requirement for an aircraft in this class: fulfilling the T-X program to replace the T-38. Two decades ago, Cessna took a similar approach when it created a tandem-seat trainer candidate using its CitationJet to compete for the Defense Department's Joint Primary Aircraft Training System (JPATS) contract. Two prototypes were built, but the Pentagon rejected the offering. Scorpion is roughly in that JPATS class in terms of configuration and engine power. To perform the T-X mission, it would need more powerful engines and a wing with at least some sweep. In effect, Textron would need a different aircraft.

The King Air has become the ISR platform of choice, in the U.S. and abroad. A turboprop offers good range

and endurance, good low-altitude performance, and plenty of room for sensors and operator consoles. It's far from clear what a jet would bring to the mission or how it would avoid a cost disadvantage. It's more likely that countries will look to save money with remotely piloted aircraft (RPA) in this role.

This leaves the attack mission, again, solely for export customers. Once, U.S. companies did a brisk business selling attack jets such as the A-37, A-4 and A-7, along with light fighters like the F-5. Cessna's A/T-37 alone brought sales of more than 1,250 aircraft, including 272 exports. But that market all but disappeared in the 1980s as most countries that operated light planes grew richer, and the rest grew relatively poorer or less inclined to spend on military equipment. Major A-4 and F-5 customers included Israel, Kuwait, Turkey, the Netherlands, Saudi Arabia, South Vietnam, Spain, South Korea, Canada, Switzerland and Brazil. All have moved on to more capable aircraft, while some light-combat aircraft customers, such as Kenya or Argentina, have moved in the other direction.

Another reason the light fixed-wing attack market collapsed is the rise of the dedicated attack helicopter. The rest of the light-attack space is filled by inexpensive light-attack turboprops, such as Embraer's Super Tucano. This niche is good for roughly 8-16 aircraft annually. Increasingly, RPA are performing in a light-attack role, too.

Finally, light-combat demand collapsed because of a disconnect between trainers and combat aircraft. Nations once procured dual-use platforms such as the F-5/T-38 or A-37/T-37. Trainers themselves were often dual-use assets; even wealthy countries, like Israel or the U.K., gave some jet trainers a secondary combat role. Today, most countries either buy something inexpensive or outsource their pilot training altogether.

In short, Textron is to be commended for investing its own money to develop a new aircraft. It's possible the company backed the Scorpion because it had a likely launch customer. But even with a notional customer, it is hard to see where this aircraft fits into the global market. ☐

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EADS

COMMENTARY

Engineering Biofuels

Can industrial-scale algae provide a global answer to aviation's sustainable jet-fuel needs?

We are told there is no silver bullet for aviation biofuels, and that the best choice of feedstock-to-fuel pathway will be regional, even local, not global, as petroleum-based jet fuel is today. But there is an option the aviation industry hopes could work pretty well, almost anywhere, and that is algae.

For all its promise, there is work to be done before jet fuel can be produced from algae in commercial quantities, at competitive prices. Since flying a Diamond DA42 on algal biofuel in 2010 (see photo), EADS has continued research into a system to produce jet fuel from algae on an industrial scale, economically and globally.

Now the European giant has teamed with the Technical University of Munich (TUM) to build a facility to scale up production of biokerosene from algae, and adapt its system to different environments so it can produce the same drop-in replacement for kerosene anywhere in the world.

Jointly financed by EADS and the Bavarian government under the AlgenFlugKraft (AFK) project, the €10 million (\$13.5 million) algae technical center is being built at the Ludwig Boelkow Campus on EADS's Ottobrun site, near Munich, and is planned to begin producing jet fuel in 2015.

While EADS and Airbus have biofuel projects underway around the world involving several different feedstocks, producing the volumes needed to replace even a small percentage of the more than 200 million metric tons a year of kerosene consumed globally by aviation is a huge challenge. "Substituting even 10 million tons is far from

negligible," says Odile Petillon, head of energy and propulsion for EADS Innovation Works. The AFK project will produce biomass on the 1,000-kg (2,204-lb.) scale as a step toward commercializing algae-derived biokerosene within the next 5-7 years.

Biofuels currently approved for aviation are hydrotreated vegetable oils. "The problem is that oil-producing plants grow slowly, are harvested once a year and compete with food production for land and water," says Thomas Bruck, TUM professor and leader of the algae project. Algal biofuel would not compete with food, and economic large-scale production looks promising. "Algae grow 12 times faster than plants and have 20 times more lipid yield per hectare," he says. "We can use waste water for cultivation and cultivate almost anywhere, on degraded land. And algae are three to five times more effective in their use of CO₂ than terrestrial plants."

The AFK project covers all steps in the feedstock-to-fuel chain, from selecting algae strains and scaling up cultivation, to harvesting the biomass, extracting the oil and turning it into kerosene. The project has selected open-pond cultivation as being simpler and less costly than closed photobioreactors, but that requires algae adapted to the local environment.

"Closed bioreactors are independent of the contamination issue," says Bruck. "For open ponds, we selected extremophile algae that grow in a hypersaline environment and have a flexible temperature tolerance." A high salt concentration ensures contaminants such as bacteria and fungi will not grow. A hypersaline solution also holds a higher concentration of CO₂ for algae to convert.

Global cultivation is a major issue. "Kerosene needs to be available in different places, with different climatic conditions. So we must choose algae strains that grow fast, with high lipid yield, and are adaptable to climates in different parts of the globe," explains Bruck. The technical center will expose open ponds to different levels of light, temperature and moisture simulating different climates.

The team is developing a single integrated production process "that uses every part of the biomass." The algae is harvested by flocculation, oil is extracted by filtration then hydrogenated with catalysts adapted to produce hydrocarbons in the kerosene range. Hydrogen for this process is typically produced from petroleum, but the AFK process converts waste biomass to produce the hydrogen.

"It is a continuous, closed-loop process," says Bruck, and using all the biomass makes it more economical. Also, only jet fuel is produced. "We do not make different products, so there is no need to address purification" or the regulatory requirements for producing animal feed from the biomass. At the quantities needed to meet jet-fuel demand, producing feed as a byproduct would flood the market. "A 10-to-12-percent substitution in European aviation would produce quantities of feed much higher than the current market," says Petillon. ☼

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By Pierre Sparaco

*Former Paris Bureau Chief
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aviation and aerospace
since the 1960s.*

COMMENTARY

Alitalia's Swan Song?

Italy's formerly preeminent airline might not survive its latest crisis

Once gain, Alitalia, the perennially ailing Italian carrier, finds itself in the unenviable position of needing to restructure. It must come to terms with the fact that it needs new investors and a strong partner. Being a SkyTeam member has not brought about the salvation the carrier hoped for, and the survival plan put in place in the late 1990s, although welcome, certainly does not ensure a workable future. In the short term, Alitalia, which posted a €294 million (\$397 million) loss in the first half of 2013, reportedly needs €400-500 million to avoid bankruptcy.

The Air France-KLM group acquired a 25% stake in Alitalia in 2008 and indicated it could negotiate at any time the acquisition of a controlling stake. However, then-Italian Prime Minister Silvio Berlusconi adopted a personal stance, fiercely opposing the Franco-Dutch takeover plan based solely on economic patriotism. Berlusconi and his team wanted Alitalia to remain a full-fledged traditional flag carrier.

Now the winds of change have taken care of the Berlusconi impediment, but "new" Alitalia (Compagnia Aerea Italiana) is again posting dramatic losses—its coffers will soon be empty—and solutions must be defined without further delay. Another recovery plan, or more reductions in personnel apparently would not be enough, since these measures would not produce immediate results.

The government of Prime Minister Enrico Letta acknowledges a far-reaching agreement with Air France-KLM would be a workable solution in his administration, and it would ensure a consolidation initiative that would preserve Alitalia's identity.

Just such a result was achieved when Air France acquired KLM. Both companies are owned by the same parent and national regulations, French and Dutch, are enforced in parallel.

In other words, this soft consolidation model could well be reproduced.



ALITALIA

Alitalia's recently rejuvenated fleet includes Airbus A330-300 long-range twinjets.

As a first step, it is understood Air France-KLM could increase its stake in the Italian carrier to 50% or more while a common strategy would be devised. The North-South axis would make sense, airline analysts say, with Amsterdam-Paris-Milan (or Rome), a unified group that is strong enough to acquire bigger shares in the highly contested market. But, ironically, Air France-KLM's coffers are now empty too, the ongoing recovery plan has not produced the desired results quickly enough, despite massive job cuts and the envisioned termination of unprofitable short-/medium-haul routes.

In addition, the group's newly reshuffled managing team is hesitant. Alitalia's financial woes have consis-

tently made headlines, social unrest is frequent and, in the last few years, weak strategic choices have further complicated the carrier's attempts to better defend itself against aggressive low-fare carriers.

Italy is a complex marketplace as confirmed by Lufthansa's failure to ensconce a local subsidiary, Lufthansa Italia, a short-lived "Italianized" affiliate. In the same vein, Air One, Alitalia's short-haul/low-cost subsidiary, could not efficiently counter Ryanair, EasyJet and the Italian railway company's increasingly dynamic strategy, which is based on high-speed trains serving key domestic routes.

Moreover, Alitalia's revamped strategy was—and still is—largely based on the business priority granted to the Rome hub. The nation's capital, nevertheless, appears like a shaky choice because Italy's strongest economic forces are centered in Milan and in the country's northern region.

There is an urgency to making plans now that involve Alitalia joining the Air France-KLM group, obtaining a cash infusion from the new shareholder, harmonizing its strategy with the new partners and creating a more efficient company structure that will further reduce direct operating costs. Unfortunately, no such plan has been announced, and in all likelihood, is not even pending.

Italian Transport Minister Maurizio Lupi and his French counterpart, Frederic Cuvillier, met late last month in Paris, but their informal discussion was inconclusive.

In France, speculation is growing. If no agreement is obtained, a unique opportunity to implement a consolidation initiative could be lost because of the right strategy appearing at the wrong time. Bailout funding is absolutely forbidden by the European Commission's strict regulations so the future largely hinges on the attitude of the nation's bankers. And they have zero reasons to express interest in the unprofitable European airline industry. Moreover, Air France and Alitalia in the past several years have shown how far and how fast a few missteps can go in a rapidly changing environment. Decisions must be made, but, alas, there are no workable solutions in sight. ☹

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COMMENTARY

Fringe Benefits

When the NextGen Advisory Committee came out with a prioritized list of NextGen capabilities Sept. 19 to help the FAA decide how best to spend under shrinking budgets, “wake recategorization” made the Tier 1A cut, along with performance-based navigation and multiple-runway operations. Tier 1A is the gold standard of rankings, reserved for capabilities that are “shovel-ready” and provide maximum benefit for minimum money.

Wake recategorization—a change to the minimum separation between landing and departing aircraft based on wake analysis of aircraft types rather than maximum gross weight—is about as low-cost as improvements come. Airlines can enjoy the benefits without

buying any new hardware or software. The FAA rolled out the program for FedEx and other carriers at Memphis, Tenn., in November and plans to offer “recat” at other airports in the near future. Eventually, the agency plans to roll out a “dynamic” recat that will give controllers the tools to customize separation between any two arriving or departing aircraft based on the weather, aircraft parameters and trajectory.

Although some pilots initially expressed concern on Internet forums that decreasing the spacing between aircraft on landing was a recipe for wake encounters and upsets, the operational experience at Memphis appears to be free of such flaws.

The magnitude of the success,

however, can vary depending on what is measured. FedEx reports that the new procedures have increased “called” arrival rates, which indicate a maximum theoretical capacity of the airport, by as much as 25% for a two-runway configuration, and 17% when the airport is using three runways.

Mitre Corp., which is analyzing Memphis metrics for the FAA, measured an actual departure rate increase of 12% based on early-morning departure rates over 15-min. intervals (when approximately 145 FedEx cargo jets leave the hub).

The bottom line for FedEx is that it has reduced its taxi durations by 27% and time in Memphis terminal airspace by 2-6 min. per flight. ☺

Merkel Momentum

The price of European Union carbon dioxide allowances (EUA) under the EU Emissions Trading System made strong gains in September in the run-up to and following German elections Sept. 22. The national vote handed Chancellor Angela Merkel a resounding victory, with her conservative Christian Democrats (CDU) attracting 41.5% of the vote, the party's best result in 23 years but still a few seats short of an overall majority.

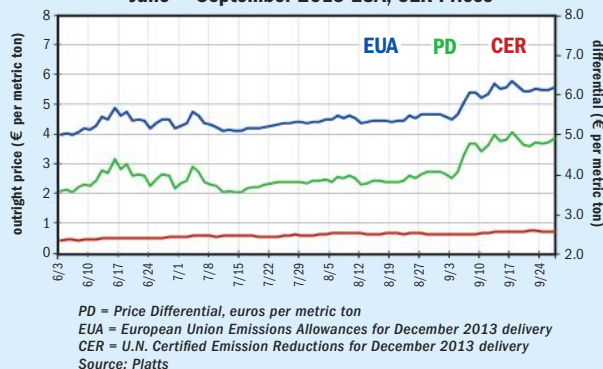
Crucially, the CDU's former governing partner, the Free Democrats (FDP), earned only 4.8%, just short of the 5% mark needed to gain any seats in the lower house, a situation not seen since 1949.

For the carbon market, what matters is the potential for a clear German position on market intervention and reform. The result means Merkel must seek a new partner to form a coalition government, a process expected to take several weeks.

The FDP's economy minister, Philipp Roesler, was critical of proposed carbon-market intervention; his replacement is likely to shift Germany's overall position in favor of intervention—a bullish factor for the carbon market.

In the months preceding the election, Merkel said the country must reform its renewables law and hinted that the carbon price has been too low to encourage a shift from coal-fired power to gas-fired generation. This suggested a recognition of the need for short-term intervention in the carbon market.

Daily Emissions Price Assessments
June — September 2013 EUA, CER Prices



Carbon's rally to €5.70 (\$7.45) per metric ton Sept. 17 from €4.40 on Sept. 3 suggested that the market had already priced in the probable shift in the German position.

December 2013 EUA prices jumped as high as €5.55 per metric ton on Sept. 23, a day after the German election, and were quoted at €5.50 per metric ton at the close on Sept. 26, according to Platts assessments. ☺

—Frank Watson/Platts/London

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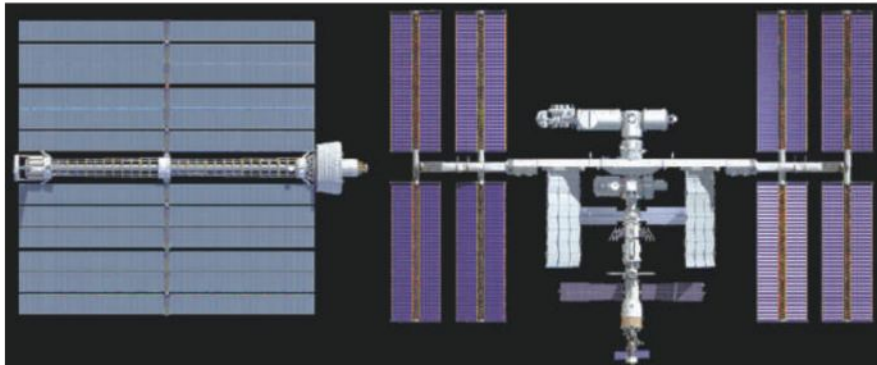
COMMENTARY

Mass Metrics

Building ISS was comparable to a Mars mission

There always has been a clear objective for potential human space explorers who are alive today—Mars. After the lunar landings, the red planet was the next natural goal. If the papers presented in Beijing at the 64th International Astronautical Congress (IAC) are an indication—and they are—nothing has changed in the subsequent 40 years.

INTERNATIONAL ASTRONAUTICAL FEDERATION



It also is clear that putting humans on Mars will be an international endeavor. The federal funding imbroglio in Washington is another reminder that no single nation can afford to go it alone to Mars. For the past decade, a group of spacefaring nations has been working on a “global exploration road map” that suggests ways to divide the work. From the beginning, the model for that collaboration has been the International Space Station (ISS).

As it happens, the ISS also is a pretty good predictor of just how much effort an international partnership would have to make to land a crew on Mars, and perhaps even what it would take to sustain Martian exploration with human scientists over a meaningful period of time. The key is a metric called injected mass to low Earth orbit (Imleo), which is exactly what it sounds like.

According to a fascinating paper presented at the IAC by Michael Raftery and Kirk Shireman, deputy ISS program managers for Boeing and NASA, respectively, the Imleo for the Apollo program was 1,732 tons. That includes all the work that led up to the Apollo

11 landing—seven Mercury missions, 11 Gemini missions and seven Apollo orbital test missions. Apollo 11 itself required 136 tons of Imleo; all seven Apollo lunar missions together required 959.

The space station, by comparison, was a much larger undertaking. The Imleo for assembly alone—transporting station modules, solar arrays, truss segments and other structures to orbit—was 2,800 tons. Add the logistics necessary to keep crews alive through the nominal shutdown date of 2020, and the total jumps to 4,500 tons, according to Raftery and Shireman. Those figures include the weight of the orbiters in 37 ISS missions launched from 1998-2011, and taper off dramatically after station assembly-complete was reached.

The Imleo for the latest Mars-mission concepts using the expendable heavy-lift Space Launch System (SLS), it turns out, could be lower than for the ISS.

“Today, we think around 800 to 1,000 tons need to be put into low Earth orbit in order to make the Mars mission happen,” says Raftery. “That’s the general consensus, and when you think about the ISS, it’s much, much more than

that. This is very significant. What it says is that the effort it took to make the ISS happen is in the same rough order of magnitude as what it will take to get to Mars.”

In addition to the Imleo of building a spacecraft capable of taking humans to Mars, the analysis includes a like amount of Imleo for the precursor work to develop and test the necessary hardware, much as Mercury and Gemini did for Apollo. At the low end of the Imleo estimates are missions using nuclear-thermal or solar-electric propulsion to move a crew between the planets.

In the solar-electric concept, a vehicle drawing power from solar arrays more than twice as large as those powering the station (see illustration) would carry an Orion capsule for the crew’s ascent to low Earth orbit and reentry, a Mars lander (with an inflatable heat shield) and a habitat for the transit. Raftery says it would take three full SLS launches to assemble a Mars vehicle, probably in high Earth orbit, which likely would require some sort of infrastructure there to sustain the assembly crew. With logistics, the total would rise to six SLS launches to reach Mars, according to the paper he and Shireman wrote.

While the vehicle would require an Imleo “on the same order of magnitude” as the ISS, Raftery says, “it’s likely it will be built quite differently. We have a large launcher in SLS, so it’s likely we’ll launch these things in large pieces.”

Also on the agenda for precursor work would be flights to the ISS for the kind of technology development already underway there in areas such as life support, and missions with Orion to familiarize crews and ground control with deep-space operations in cislunar space or near-Earth asteroids. A practice landing on the Moon might also be needed, Raftery says, and so might logistics flights on commercial cargo carriers like the Dragon and Cygnus vehicles just starting to serve the ISS.

The ISS experience is an encouraging precedent, say the two deputy station program managers.

“The ISS . . . effort is very similar to what we have in front of us for exploration, so we ought to have confidence that this is a program that we can do,” says Raftery. ☼



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This page was updated after the printing of the magazine.

COMMENTARY

While China Works . . .

U.S. shutdown has wide-ranging impact on aerospace, defense and aviation

Roughly 97% of NASA employees were not working as of last week, sidelined by the federal government shutdown that began Oct. 1. Remember that fact if, and when, you see Chinese astronauts walking on the Moon, while Americans are still stuck in low-Earth orbit.

While politicians will rue that day, in NASA circles, concern centers more immediately on two planetary spacecraft trying to stay on schedule for their launch windows. The Mars Atmosphere and Volatile Evolution (Maven) spacecraft was already at Kennedy Space Center preparing for a Nov. 18 launch.

But the shutdown effectively closed access to the spacecraft. Before their exile from federal grounds, technicians from prime contractor Lockheed Martin purged the probe's instruments with nitrogen and put it into a safe mode to be monitored remotely, which they can do off-site as they keep working under funds provided earlier. But the optimal launch window for Mars is only 20 days this year, plus another 16 that would be less than ideal. After three days, NASA obtained an emergency waiver to restart Maven preparations.

Also of concern is the James Webb Space Telescope's Integrated Science Instrument Module (ISIM), a key component for the deep-space infrared observatory designed to keep its IR sensors super cold while preventing its electronics from freezing. The ISIM was undergoing cryogenic testing, and technicians found a way to maintain test temperatures during the shutdown. But testing itself was put on hold, and contractors are busy devising ways to recover lost time as they work toward a 2018 launch date for the \$8.8 billion spacecraft.



Remember the U.S. shutdown if, and when, you see Chinese astronauts walking on the Moon.

Of course, the shutdown also sidelines less-mature, albeit higher-profile development efforts. "If the government shuts down, I won't be going to work the next day," Todd May, NASA program manager for the heavy-lift Space Launch System, noted the week before the shutdown.

The Chinese, meanwhile, forge on. ☛

CLOUDY FORECAST

The FAA's furloughing of its 3,000-strong flight-standards inspector workforce caught many by surprise, given that most inspectors were kept on the job during government shutdowns in the 1990s. The agency says it will recall inspectors on an as-needed basis and could ultimately bring back most of the safety employees if the shutdown drags on. The closure of the FAA's registration branch in Oklahoma City—which also remained open in the 1990s—is delaying deliveries of passenger, business and general aviation aircraft.

Airbus was unable to deliver an A321 to JetBlue Airways, and two US Airways-bound A330-200s are also expected to be held up. Boeing's delivery plans face the same hurdle. And the Gen-

eral Aviation Manufacturers Association says deliveries of about 135 aircraft, worth nearly \$1.4 billion, could be at risk.

The FAA's decision to deem the registration office nonessential had a whiff of political shenanigans. "To declare the FAA registry nonessential flies in the face of logic," opines David Warner, a Seattle-based aviation attorney. "But if you're trying to make the dispute as painful as possible for the American people, then yes, you close it."

While Warner's assertion could be debated, several important federal functions such as auditing and inspecting, arguably, remain important, even if they are not necessary to immediate governance. For instance, the NTSB's inspection team has been cut from 135 to three. The board pulled back a team that was investigating the crash of a Cessna 525A CJ2+ business jet on Sept. 28 at Santa Monica (Calif.) Airport that killed all four aboard. ☛

CLOSE TO HOME

If the shutdown continues, thousands of aerospace workers could find themselves temporarily out of work. Sikorsky Aircraft, which produces the Black Hawk helicopter, plans to furlough 2,000 workers at three plants Oct. 7 due to the absence of Defense Contract Management Agency (DCMA) inspectors who audit and approve manufacturing. Sikorsky parent United Technologies warns that another 2,000 workers could be furloughed from its Pratt & Whitney and Aerospace units.

Other defense contractors were drawing up similar plans. "A number of our member companies have notified me that if this shutdown continues, which is affecting all of the [Defense] Department functions involved in contracting, it will force them to furlough thousands of workers," Aerospace Industries Association President Marion Blakey tells Defense Secretary Chuck Hagel.

Blakey emphasizes how much contractors rely on DCMA approvers. "The manufacturing process must stop if these inspections and certifications are not performed," she says. "Within days, many of our members will have no choice but to halt certain defense manufacturing production and furlough employees indefinitely, absent government guidance and payment." ☛

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AVIATION WEEK

Testing, Testing

Upgraded Falcon 9 completes mission, but some new capabilities do not work

Guy Norris **Los Angeles** and Amy Svitak **Paris**

SpaceX engineers will have some changes to make on the company's new Falcon 9 v1.1 launch vehicle before its next mission, following lessons learned from its Sept. 29 demonstration flight.

A preliminary test of an innovative reusable-booster concept intended to hold down costs showed the need for more work after an uncontrollable spin apparently hampered pre-splash-down braking. The vehicle also aborted a planned restart of its upper-stage engine during the otherwise successful debut of the upgraded rocket.

With more than \$1 billion in commercial-launch backlog, restarting the Merlin 1D vacuum engine that powers Falcon 9's upper stage is critical

to delivering government and commercial satellite payloads to geostationary transfer orbit (GTO), the destination of most commercial telecom spacecraft. But SpaceX CEO/Chief Technology Officer Elon Musk downplayed the upper-stage restart, characterizing it as an "optional" part of the flight profile.

"We essentially saw the engine initiate ignition, get up to about 400 psi, and then it encountered a condition it didn't like, and we think it may have been due to an extended spin start—maybe, this is speculative—and so it initiated an abort of the restart," Musk said post-launch. "We have all the data from the restart, so I'm confident we'll be able to sort it out and address it before the next flight."

That mission is expected to loft the new rocket's first GTO mission—the SES-8 telecommunications satellite for fleet operator SES—late this month.

Longer term, SpaceX wants to reuse hardware to hold down costs. The Falcon 9 v1.1 flight included an attempt to slow the hypersonic first stage for a controllable descent to the Pacific Ocean. Before launch,

The stretched Falcon 9 lifted off on the first SpaceX mission to launch from a rented pad at Vandenberg AFB, Calif., last week.

Musk gave this only a slim chance of working on the demo flight, but it seems it was at least partially successful.

Following main-engine cutoff, burn-out and separation, with the stage likely slowing well below Mach 10, three of its nine engines were intended to fire to decelerate the booster for its initial descent. A single engine was then due to fire to perform a final braking maneuver just before the stage impacted the ocean at a slow, landing-like speed.

While the initial high-altitude retro-fire sequence appeared to work to plan, Musk said the stage "actually ended up spinning to a degree that was greater than we could control with the gas thrusters, and it centrifuged the propellant. It caused the boost stage to run out of propellant before hitting the water. So it hit the water relatively hard."

The stage lacked the landing gear that Musk says would help stabilize a reusable unit. SpaceX's reusability plan builds on a vertical landing and recovery system that has undergone initial tests at the company's facility in McGregor, Texas, using the Grasshopper demonstrator. Although only a foreshortened Merlin 1D-powered first stage, the Grasshopper's precise maneuvers and landings have bolstered confidence in the concept.

"Between this flight and Grasshopper tests, we now have all the pieces of the puzzle to bring the rocket back home," said Musk. "If things go super well, then we will be able to re-fly a Falcon 9 stage before the end of next year."

SpaceX plans to test a larger version of the Grasshopper, also dubbed the Falcon 9R (reusable)—with nine 1Ds more representative of the upgraded production launch vehicle—at a specially constructed site at Spaceport America in New Mexico.

As for the upper-stage abort, Musk said the Merlin 1D has been successfully reignited "dozens of times" during ground tests, but he conceded the company still needs to address minor technical issues associated with operating the engine in the vacuum of space.

"We just need to iron out the differences between restarting in vacuum and in microgravity versus restarting on the ground," he noted. The issue could delay the launch of the SES-8 satellite by "a few extra weeks, to make sure we're super-confident of the second-stage restart," he added.

Musk said the Falcon launch vehicle

that will loft SES-8 is at SpaceX's Cape Canaveral AFS launch facility.

"We're ready to go with SES, with a steady cadence of launches thereafter," he said, which would include the Thaicom 6 anticipated later this year, followed by SpaceX's third cargo resupply mission to the International Space Station (ISS) in February.

SES is discussing the reignition abort with SpaceX, and at press time it had not yet shipped the Orbital Sciences Corp.-built spacecraft to the Cape, which ceased operations last week with the U.S. government shutdown.

Beyond reusability and upper-stage reignition, there were several other key milestones for the upgraded Falcon 9. It successfully delivered the first of six payloads into orbit 14 min. after it left the pad. These included the Canadian-built CASCade, Smallsat and IONospheric Polar Explorer (Cassiope) satellite, Canada's first space environment sensor suite.

Major modifications to the new Falcon include the more powerful Merlin 1D engines, arranged for the first time in an "Octaweb" pattern with a central engine surrounded by eight other engines, rather than the former 3 X 3 configuration of previous Falcons. The Octaweb thrust structure also supports the higher thrust of the Merlin 1D, each of which develops 147,000 lb. thrust at sea level, rising to 161,000 lb. at altitude. Total thrust at launch is 1.3 million lb., increasing to 1.5 million lb. in vacuum.

Each kerosene-fueled engine is fed via a single-shaft, dual-impeller turbopump. The fuel is also cycled to provide regenerative cooling of the thrust chamber and expansion nozzle, as well as serving as the pressurized fluid to control the thrust vector actuators.

The 227-ft. vehicle incorporates extended fuel tanks as well as improved avionics and a larger, 43 X 17-ft.-dia. payload fairing. The demo was the first SpaceX flight from space launch complex SLC-4E, a former Titan 4 pad the company is leasing from the Air Force.

Aside from the faster-than-hoped-for splashdown of the first stage, the flight was not without its share of drama. Reports based on information from SpaceTrack, a satellite tracking and space situational awareness service, indicated a larger-than-expected debris field in the orbital path of the vehicle, with up to 20 discrete objects in view. The tracking data led to speculation that the second stage may have disintegrated

shortly after payload deployment.

"We have no reason to believe there was an explosion of any kind," SpaceX declared, noting that following insertion of the satellites to the correct orbit, "the Falcon 9 second stage underwent a controlled venting of propellants and the stage was successfully safed. During this process, it is possible insulation

came off the fuel dome on the second stage, and is the source of what some observers incorrectly interpreted as a rupture in the second stage."

The company adds that it "will continue to review to help identify the source of the extra debris, but our data confirms there was no rupture of any kind on the second stage." ☛



NASA/SC

Special Delivery

Orbital Sciences' Cygnus berths at ISS to complete COTS demo

Mark Carreau **Houston**

Orbital Sciences Corp. will begin fulfilling its \$1.9 billion cargo resupply contract as early as December, after satisfying its Commercial Orbital Transportation Systems (COTS) program requirements with a successful berthing of the Cygnus resupply capsule with the International Space Station (ISS).

The first of Orbital's eight Commercial Resupply Services (CRS) missions is tentatively scheduled to lift off from the Mid-Atlantic Regional Spaceport in Virginia on Dec. 8, says Alan Lindenmeyer, COTS program manager.

Orbital intends to step up its mass per mission to 1.5-2 tons on the next three CRS missions, then 2.5 tons on the final deliveries. The Dulles, Va.-based company also plans to reduce the 2-3-day baseline rendezvous trajectory to one day over the early CRS flights, according to Frank Culbertson, Orbital's executive vice president.

Cygnus shook off a GPS navigation-software mismatch with the ISS that prevented a Sept. 22 rendezvous, and approached instead on Sept. 29 for a robotic-arm capture by ISS astronauts Luca Parmitano of the European Space

ISS robotic arm prepares to grapple the Cygnus cargo carrier, paving the way for commercial operations.

Agency and NASA's Karen Nyberg.

They completed the operation by commanding the Canadian arm to place Cygnus and its 1,543-lb. non-critical cargo of crew provisions and science equipment at the U.S. segment Harmony berthing port, managing to get ahead of schedule for the task.

"They've demonstrated a system that certainly can deliver," says Lindenmeyer. "There will be no delays in proceeding toward the next mission."

Cygnus was launched atop an Orbital two-stage Antares rocket on Sept. 18 on the final demonstration mission flown under the company's \$288 million COTS agreement, a qualifier to begin the CRS contract activities. It will remain berthed until Oct. 22, and then depart with trash for a destructive reentry into the Earth's atmosphere.

Orbital now joins SpaceX, of Hawthorne, Calif., in NASA's CRS stable to take on an ISS resupply role, filled by NASA's shuttle fleet until the winged orbiters were retired in 2011. SpaceX already has started its 12-flight, \$1.6 billion CRS work. ☛

Space Shutdown

J-2X engine will go on the shelf as tight funds slow exploration

Frank Morring, Jr. **Beijing**
and Mark Carreau **Houston**

The upper-stage J-2X engine, once considered the pacing item for the next U.S. human-rated rocket, will be mothballed after development testing wraps up next year because it will not push humans toward Mars for years.

Conceived as a way to use Apollo-era technology to hasten development of a replacement for the space shuttle, the J-2X is emblematic of a long series of funding-related setbacks that have slowed exploration work to a snail's pace. Just last week, the U.S. government shutdown forced NASA to terminate a three-day workshop on its planned asteroid-redirect mission, which also was devised as a way to stretch exploration dollars.

Unveiled in NASA's budget plan for the fiscal year that began

Oct. 1, the asteroid mission faced an uphill fight in Congress before the agency ran out of appropriated funds at the start of the new fiscal year. But even the heavy-lift Space Launch System (SLS), which Congress forced the Obama administration to start developing in 2010, is straggling.

While NASA is actively seeking other missions for the SLS in the planetary science and military arenas, most human flights it has in sight probably can be accomplished with an upper stage powered by the RL-10 engine instead of the J-2X.

"The J-2X for certain [design reference missions] is somewhat overpowered," Todd May, NASA's SLS program manager, told Aviation Week in Beijing at the 64th International Astronautical Congress, where spacefaring nations gathered to discuss their latest plans for space exploration.

An upgrade of the Saturn V upper-stage engine, the all-cryogenic J-2X generates 294,000 lb. thrust with its gas-generator cycle. While it almost certainly will be needed to send men and women to Mars, the equally venerable RL-10 is beginning to look like a better powerplant for the SLS upper stages that will be needed before that far-off flight.

Congress ordered an SLS able to lift 130 metric tons to low Earth orbit (LEO), which is a generally accepted requirement for launching a Mars mission. But for missions to the Moon, where a lot of Mars-precursor shakeout cruises are being planned, a 105-ton SLS is probably sufficient, according to

MAKING A COMEBACK

Amy Svitak

Russia's Proton M launch vehicle returned to flight Sept. 30, nearly two months after a July 2 mishap sent the heavy-lift rocket and three Russian Glonass M satellites crashing to the ground at the Baikonur Cosmodrome in Kazakhstan.

Managed by commercial launch services provider International Launch Services (ILS) of Reston, Va., and majority shareholder Khrunichev Research and Production Space Center of Moscow, the Baikonur mission orbited the Astra 2E commercial telecom satellite for Luxembourg-based SES, the world's second-largest fleet operator by revenue. The mission marked the fifth for Proton this year, including the July 2 mishap managed by the Russian federation involv-

ing a Proton M/Block DM3 that failed after an engineer improperly installed three angular rate sensors on the rocket's first stage.

The crash grounded the Proton fleet for nearly two months and moved a planned July 20 launch of the 6,000-kg (13,000-lb.) Astra 2E spacecraft to Sept. 17. The date then slipped to Sept. 30 after a technical problem was discovered on the rocket's first stage. Kazakh government concerns over environmental safety also contributed to the delay, according to ILS, though Moscow is taking steps to avoid such complications in the future. Construction of the new Vostochny Cosmodrome in the far east of the country has been underway since 2011, in an effort to reduce Russia's reliance on Baikonur for geostationary transfer orbit missions. The site is scheduled to be fully operational by 2020 and launch nearly half of all Russian missions, including the new Angara family of rockets that is expected to succeed Proton and other Soviet-era launchers. ☒



Steve Creech, May's deputy, who is responsible for finding other applications for the big new rocket.

One way to achieve that capability would be with a "dual-use upper stage" carrying three or four RL-10s. All of them would ignite to loft the payload—an Orion crew capsule, in-space habitat or lunar lander—into LEO, and then some subset of that number would fire for the translunar injection to send the payload toward the Moon.

NASA has not ruled out using the J-2X for that portion of the trip, but it may be faster to develop the dual-use stage than the originally planned SLS upper stage powered by the J-2X, and a cryogenic propulsion stage (CPS) to reach lunar orbit. "To try to save costs and accelerate mission capability, [we've looked at] combining the functions of our upper stage and the CPS so that we just have to have one stage," says Creech.

Development of the J-2X started under the George W. Bush administration's Constellation Program, which envisioned a human-rated launcher called the Ares I that used a shuttle-derived solid-fuel first stage and an upper stage powered by the J-2X. Initially, the J-2X was expected to be the most time-consuming element of the Ares I, although its Saturn heritage was selected to minimize development complexity.

Now, the engine has been built, using drawings and some hardware retained by NASA and Aerojet Rocketdyne, and is in development testing at Stennis Space Center, Miss. Those tests are scheduled to end next year, and then work on the J-2X will halt "until we're ready" to integrate the engine with an SLS upper stage, May says.

"Under constrained funding, the number of simultaneous developments is limited, and that's why we've essentially ended up with the architecture we did, because we only have the core to develop," he explains, referring to the SLS first stage. "And if you can do a dual-use upper stage, you can actually get to a very capable rocket with only one more major development—not an upper stage and then a CPS."

That make-the-best-of-a-bad-situation approach is standard these days in NASA's Human Exploration and Operations (HEO) directorate, which is forging ahead with plans for human spaceflight in cislunar space despite the funding uncertainty. Planning is underway to send the first two tests of the initial 70-ton SLS variant—the core stage, powered by surplus RS-25 space shuttle main engines, with a Delta IV upper stage and Orion capsule—to a distant retrograde orbit (DRO) around the Moon (see illustration). That is also where NASA wants astronauts to meet an asteroid nudged there by a solar-electric tug (*AW&ST* Sept. 23, p. 26). The test flights—one with a crew—are set for 2017 and 2021, and the asteroid redirect mission would follow by 2025.

If the asteroid mission is canceled, it will still have served a valuable function as a focus for flight engineering, according to William Gerstenmaier, associate administrator for HEO and a master of the make-do approach to human-exploration development. Just as the basic principles of operating in LEO were worked out in the early days of spaceflight, the prospect of working in DRO or at the Earth-Moon libration points L-1 and L-2 is driving planning that can be useful for decades to come.

"We developed all these safety techniques to operate with this huge gravity vector from the Earth," he says. "So now we're in this different region where we don't have that huge gravity vector. What are those rendezvous and prox-ops techniques that we ought to be developing in that environment?"

An Orion crew in DRO might have to wait as long as five days to return to Earth in an emergency, and Gerstenmaier says the use of lunar gravity assists will become "routine," not just in such cases, but also to move around cislunar space. Other ideas for the asteroid mission—including the possibility of snatching a boulder from the surface of a large asteroid instead of grabbing a small space rock and nudging it into DRO—were to have been discussed at an invitation-only Asteroid Initiative Ideas Synthesis Workshop in Houston last week, hosted by the Lunar and Planetary Research Institute.

The J-2X engine will not be needed to send humans into lunar orbit, but lunar gravity assists will be "routine" in cislunar space.



Some 140 participants showed up from around the U.S. and 16 other nations, selected after a general announcement of the opportunity to submit proposals, only to have the plug pulled by the government shutdown. The B612 Foundation, a private group set up to map potentially threatening near-Earth asteroids, invited the participants to continue their discussions at a nearby hotel.

While the big aerospace contractors urged use of their hardware and experience to save money for an asteroid mission, smaller operators suggested completely different approaches. Joel Sercel, of ICE Associates Inc., a Los Angeles aerospace consultant and former New Millennium manager at the Jet Propulsion Laboratory, urged the agency to place more emphasis on a public/private partnership strategy that would emphasize a national economic return rather than a door to deep space for human explorers. Sercel's proposed Honeybee mission would rely on a Falcon 9 launch to retrieve a smaller near-Earth object than NASA proposes and assess it for potential resources as it is steered into a stable lunar orbit.

NASA intends to formulate more detailed plans for its proposed 2015 budget. In 2014, the agency will seek a \$105 million down payment to step up asteroid detection and characterization capabilities, while advancing Solar Electric Propulsion and capture technologies. That assumes, of course, that there will be some funding for the mission. ☼

Quality Questions

Inspector general's report reveals that Pentagon quality management is not cut and dry

Amy Butler **Washington**

A consumer buying a car views the quality of the product simply: Does it work as promised and will it last? But the Pentagon inspector general's (IG) recent review of the Defense Department's most costly procurement program reveals that the military's definition of "quality" in its weapon systems is far more nuanced and tricky to manage.

The audit cites 363 quality-control issues with hardware on the F-35 fighter program, raising questions about what the Defense Department is getting for its \$124 million per jet five years into

ernment overseers of the nearly \$400 billion fighter program and prime contractor Lockheed Martin.

Since the Pentagon signed the Joint Strike Fighter development deal in 2001, it has been criticized for allowing Lockheed too much control in the process. This led to a series of problems that demanded rework, including an overweight F-35B model, design shortcomings (such as a faulty bulkhead) and, as production began, parts shortages and component durability issues.

But the IG's latest findings specifically focus on quality assurance and con-

"quality." In Pentagon contracting parlance, "quality" refers largely to whether a part conforms to specifications and standards. The catch is that a part can conform to standards but not do the job it was intended to do, as with the faulty bulkhead that developed a crack in a B-model jet. In this case, the part was up to quality standards but the spec fell short. Ultimately, rework was required.

The IG found that "the F-35 program did not sufficiently implement or flow down technical quality management-system requirements to prevent the fielding of nonconforming hardware and software," the report says.

The auditors studied quality assurance and conformance to standards at Lockheed Martin, as well as key suppliers: Northrop Grumman, the center fuselage builder; BAE Systems, aft fuselage producer; L-3 Communications, panoramic cockpit display system manufacturer; Honeywell, Onboard Oxygen Generation System maker; and United Technologies Corp., landing gear provider. The IG intended to review the F135 engine built by Pratt & Whitney, but cuts from sequestration forced that effort to be scrapped, says a JPO official. Rear Adm. Randolph

The F-35 is assembled by Lockheed Martin in Fort Worth, but the preponderance of quality problems were found in the supply chain that the company manages.

Mahr, deputy F-35 program manager, says none of the items are critical to safety of flight.

Part of the IG's work was to assess manufacturers' abilities to comply with standards, such as the AS9100 standard used by the aerospace industry.

Mahr notes that "early on" in the program, there were quality deficiencies on aircraft being fielded. Now, however, he says, "Lockheed Martin is taking positive steps to fix that."

"The quality of this program is as good or better than legacy platforms," says Eric Banyan, Lockheed Martin vice president of program management for the F-35. He explains that quality is an "element of pride and reputation" for the company. One measure for this is "scrap and rework," or the amount of time spent redoing items on the aircraft to correct deficiencies.

About 13% of total hours are spent on F-35 scrap and rework at Unit 100, fewer than on the F-22 at Unit 100, Banyan



production, and why delivering a completely defect-free product is more difficult than it seems.

The foremost quality problems arising before the government accepts delivery of aircraft include incorrect hardware installations (such as loose nuts, hardware stacked improperly and safety wires installed backwards); missing hardware (such as bolts, brackets and clamps); and cracked or chafed tubes and hoses, according to Lockheed Martin spokeswoman Laura Seibert.

The Sept. 30 report, "Quality Assurance Assessment of the F-35 Lightning II Program," is the latest complaint of shoddy management by both the gov-

ernment overseers of the nearly \$400 billion fighter program and prime contractor Lockheed Martin. Since the Pentagon signed the Joint Strike Fighter development deal in 2001, it has been criticized for allowing Lockheed too much control in the process. This led to a series of problems that demanded rework, including an overweight F-35B model, design shortcomings (such as a faulty bulkhead) and, as production began, parts shortages and component durability issues.

However, the review is based on a tightly controlled definition of the word

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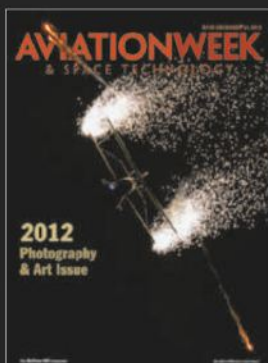
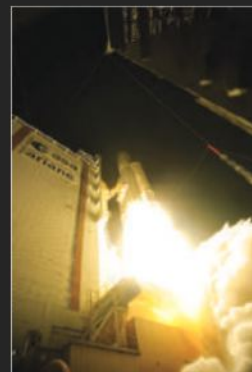


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says. He projects that with the 600th F-35, the program will reach the 6% scrap-and-rework milestone achieved by the F-16 program at Unit 2,500.

One goal of the IG's review was to better align the oversight of the JPO and the Defense Contract Management Agency (DCMA). The IG will conduct such reviews of various programs, but the F-35 came first because it is the largest Pentagon acquisition program.

The JPO was unable to ensure that Lockheed and its primary subcontractors were applying "rigor to design, manufacturing and quality-assurance processes," the IG finds. Likewise, the JPO was not flowing down critical safety items and ensuring that their own officials, as well as those from Lockheed Martin, communicated technical and quality-assurance requirements throughout the supply chain. The DCMA is also to blame for not properly managing quality control, the IG reports.

The review was welcomed by program leaders at the Pentagon, Mahr says. "We didn't wait to work the findings," he notes. Seventy-eight percent of the items are already resolved or are being worked, according to JPO officials. Mahr adds that language is updated in each production contract in compliance with changes to standards.

The JPO did take issue with one of the IG's findings, however: "The Joint Program Office stated that it does not have the resources to perform process proofing of all critical processes nor has the responsibility or resources to perform requirement flow-down verification throughout the F-35 supply chain," the report says.

The IG says this job falls squarely within the JPO's area of responsibility. "It is the Joint Program Office's responsibility to ensure contractual compliance to prevent nonconformances," the report states. Roughly 2,600 government workers are assigned to the program; 800 are on the testing team and another 1,800 are helping to manage the program from various locations.

Orlando Carvalho, Lockheed Martin Aeronautics vice president, established a quality transformation council to infuse a mind-set of improved quality into his workers and those at suppliers, Banyan says. In concert, he kicked off a Global Quality Council with the top 10 suppliers for all of Lockheed Martin Aeronautics' suppliers.

Banyan notes that the company is sharpening its focus not only on qual-

ity itself, but also on its cost.

Mahr says the program office is updating its memorandum of agreement with DCMA to clarify oversight responsibilities for the F-35.

Quality assurance has become more complicated for the fleet as it grows. Early on, aircraft were only being delivered to Eglin AFB, Fla., for training, but more bases are now receiving operational aircraft. The goal is to reduce squadron acceptance to weeks; it has taken months in the past, notes Mahr.

The IG's audit, while in-depth, is far from comprehensive and does not lead to a guarantee that aircraft will perform as required.

A high-cycle fatigue problem that came to light with the low-pressure turbine during engine testing in 2007-08 was technically not a quality problem, Mahr says. In that case, Pratt & Whit-

ney's equipment conformed with the specification, but the spec was found to be wrong. Ultimately, officials had to change the quality-acceptance criteria.

Likewise, the audit would not have caught the delivery of Martin Baker ejection seats with parachutes loaded backwards, as that supplier was not in the review. The seats made it to the operational fleet, so aircraft were grounded while the seats were sent back to Martin Baker for parachute reinstallation.

Finally, the auditors did not look into software work, which F-35 Program Executive Officer USAF Lt. Gen. Christopher Bogdan has said is the riskiest area for this program. 

Read the inspector general's full report at: ow.ly/pqTXt

Cost Target

Pentagon locks in lower prices for latest F-35 production lots

Amy Butler Washington

The Pentagon's newly signed deals for two lots of F-35s codifies for the first time that it will cost the U.S. Air Force less than \$100 million per airframe for the single-engine, stealthy aircraft. The cost for all the aircraft in low-rate initial-production (LRIP) Lots 6 and 7 will be \$8.4 billion. Prime contractor Lockheed Martin has delivered the first two of 32 aircraft in LRIP 5.

The per-unit airframe price for LRIP 6 is an average of 2.5% lower than LRIP 5;

Projected F-35 LRIP 6 and 7 Costs (U.S. \$millions)

Variant and Lot Size	Target Airframe Cost	Estimated Retrofit Cost	Estimated Engine Cost	Total Estimated Aircraft Cost
F-35A				
LRIP 5 (22)	\$105	\$10	\$14	\$124
LRIP 6 (23)	103	7.4	14	120.7
LRIP 7 (24)	98	7.4	14	115.7
F-35B				
LRIP 5 (3)	113	10	38	156
LRIP 6 (6)	109	7.4	38	150.7
LRIP 7 (7)	104	7.4	38	145.7
F-35C				
LRIP 5 (7)	125	10	14	144
LRIP 6 (7)	120	7.4	14	137.7
LRIP 7 (4)	116	7.4	14	133.7

Engine costs reflect last known data. Retrofit costs are split equally between Pentagon and Lockheed Martin so the Total Estimated Aircraft Cost figures include half of the estimated retrofit cost. Sources: U.S. Defense Department and Lockheed Martin

LRIP 7 prices are about 6% lower than LRIP 5. Lockheed Martin's pricing excludes the cost of the Pratt & Whitney F135 engine, which is handled under a separate contract.

Thus far, the Pentagon has awarded \$3.7 billion for LRIP 6 of the total \$4.4 billion contract. Funds will be awarded incrementally as aircraft reach specific milestones in the production process. LRIP 7 is valued at \$3.9 billion.

This is the first deal in which Lockheed Martin assumes all responsibility for overruns of target cost. The government and contractor shared at varying levels for overruns in the first five lots.

The target F-35A airframe price in LRIP 7 is \$98 million. Neither the F-35 Joint Program Office nor Pratt & Whitney have released the target cost of the engine in each successive lot, though Pratt officials say the price has decreased 16% over the last three engine lots. "Disclosing publicly the price of our military engines would put us at a competitive disadvantage in the commercial engine market, so as a company policy we consider this as proprietary information," says company spokesman Matthew Bates.

Based on the last known engine pricing, the LRIP 7 F-35As are expected to cost roughly \$115.7 million (a figure that also includes the projected cost of retrofitting those aircraft).

The contracts call for Lockheed Martin to assume more responsibility for so-called concurrency costs associated with the aircraft in LRIPs 6 and 7. This refers to the price of retrofitting aircraft in these lots with fixes that are discovered in the development program as it continues through fiscal 2016. LRIPs 6 and 7 include aircraft for the U.K., Norway, Australia and Italy, as well.

Deliveries of LRIP 6 aircraft will begin in the second quarter of 2014, with LRIP 7 aircraft following a year later.

Lockheed Martin officials are "extremely pleased" with the deals. They are a "significant milestone for the F-35 program and its path to enhanced affordability," a company statement says.

Rear Adm. Randolph Mahr, F-35 deputy program manager, says the program office hopes to nail down terms for LRIP 8 early next year. ☛

A400M Reports For Duty

All eyes are on France as it puts the Airbus A400M into service.

Tony Osborne **Seville, Spain, and Orleans, France**

With its first Airbus A400M Atlas handed over, attention is now being focused on how the French air force will put the new European airlifter through its paces.

The handover on Sept. 30, some 10 years after Airbus Military was contracted to build the airlifter for Europe's air arms, and almost four years since the maiden flight, marks the beginning of what will be the real test of the aircraft. As the keys to France's first A400M—MSN7—were transferred during ceremonies in Seville, Spain, and later at Orleans AB, France, foreign air force officials have turned their focus toward France as to how it will integrate the new airlifter into daily operations.

A smooth entry into service is not only needed for France as the A400M Atlas begins to replace the country's aging fleet of C-160 Transalls, but also for Airbus Military, which believes it can capture 50% of the market share for large transport aircraft over the next 30 years. It estimates exports of 300-400 aircraft worldwide.

"France, along with the U.K., is one of a few European countries that have a lot of credibility because of how they use their aircraft, so other countries will be watching what they do with interest," says one company executive.

Opportunities for A400M will no doubt be boosted by the announced closure of the Boeing C-17 line in 2015. Although some insist that the C-17 was not a competitor to the A400M, the U.S. aircraft has been a thorn in the side of the European program,

with several customer nations examining a buy of the C-17 Globemaster to offset delays in the A400M program. Indeed, the U.K. was one of those nations that leased and later bought its fleet outright to gain the airlift capability it needed.

While it is unlikely that the C-17 line could have been sustained on the small number of exports once all the U.S. Air Force aircraft had been delivered, the C-17 could have still been a threat to A400M sales, particularly in markets in the Middle East or Asia. It seems likely that the remaining "white-tailed" 13 C-17s will be snapped up by unnamed customers or sold as top-up orders from existing operators.

The formal handover comes eight weeks after MSN7 arrived at Orleans. France's second aircraft, MSN8, which made its first flight in June, is also expected to be handed over within the next two weeks. Technical issues with the aircraft, understood to be a series of leaks, has held up the transfer, while France's third aircraft, which had been due to be delivered by the end of the year, is now expected in early January. The French defense procurement agency, DGA, states that it is only expecting to take delivery of one more aircraft before the end of the year.

Turkey's first aircraft, MSN9, is also scheduled for delivery in three weeks. The Seville-based San Pablo factory is now a hive of activity following the delivery of A400M components destined for the second U.K. Royal Air Force





AIRBUS MILITARY

aircraft, MSN17. The U.K.'s first aircraft will be MSN16 and is due to be delivered in September 2014.

France is working to minimize the risk of the type's introduction into service. The A400M Multinational Entry into Service Team (MEST), also based at Orleans, is run by a group of French personnel who have so far identified close to 1,500 different tasks that need to be carried out for the type's safe operation, both in terms of deployment and troubleshooting. The team is helping to develop procedures for towing, engine and propeller changes, removal and installation of major components, and many other

The first French A400M, MSN7, will be joined by the second in a matter of weeks.

day-to-day and further-out procedures. The MEST team is also putting a paperless system through its paces. It will ultimately be used by maintenance departments.

The U.K. is partnering with the MEST with four RAF personnel, including one engineer, one logistics specialist and two technicians embedded into the MEST at Orleans. A British pilot and a loadmaster are expected to join the group shortly. Senior French air force personnel were

part of an exchange program in the U.K., where they flew the C-130J to gain experience with the glass cockpit in large military airlifters.

The French air force's first 10 pilots, four co-pilots, eight loadmasters and 71 technicians have been trained by Airbus Military in Toulouse and Seville, but in the future, this experience will be gained in new facilities being built at Orleans. The site will be shared with the German air force, following the inking of a joint agreement during the ceremonies at Orleans.

Maintenance technicians and logistical mission personnel from both countries will be trained at Wunstorf airbase in Germany beginning in summer 2015, while crew training for tactical missions will take place at the newly constructed Orleans facility. French air force crews begin their sessions in 2014; their German colleagues will start in 2018. Germany's first aircraft, MSN18, is due to be delivered in November 2014. Commanders say they are open to the idea of more nations joining the partnership.

Meanwhile, test pilots from the French air force's military air experimentation center (CEAM) will be validating the Standard Operating Clearances (SOC) as they are released by Airbus Military. France's first two aircraft, along with Turkey's first A400M, are delivered in an Initial Operational Clearance (IOC) configuration, but the French air forces' third aircraft will be delivered with SOC1.



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An SOC1.5 capability, which will enable elements of tactical flying—including the basic ability to conduct airdrops and aerial refueling—will come toward the end of 2014.

CEAM will test the aircraft into 2018 when SOC3—A400M's full-operational capability—comes online. France wants to achieve the low-level tactical flying using onboard automatic terrain, along with system and inflight refueling for both combat aircraft and helicopters, along with many other capabilities.

The A400M program represents a major stride in trying to standardize Europe's wide-ranging military requirements. Airbus Military CEO Domingo Urena-Raso noted during the handover that the introduction of the aircraft celebrated, among other things, "what Europe can achieve when it gets its act together."

But industry officials say that more work needs to be done. EADS CEO Tom Enders says he was determined not to repeat the errors made during development of the A400M, and he calls on Europe's defense ministers to push for greater levels of integration to develop a unified military certification body and to do for the military what the European Aviation Safety Agency has done for civil aviation.

"The A400M saga is rich in lessons for future multinational defense co-operation," says Enders.

He notes that the program had faced "unrealistic schedules," and that discrete requirements from some nations (he did not name them) had "gone beyond physics." He hopes the issues will be "picked up in the upcoming European Union defense summit."

Airbus Military's current program calls for delivery of 174 A400Ms to eight customers, but several partner nations are trying to reduce their orders. Spain, in particular, seeks to cut its buy by more than half, while France's military program act calls for 15 A400Ms in the 2014-19 timeframe, and a white paper report called for a fleet of 50 transport aircraft, including C-130s and CN235s, which could also result in a reduced complement of A400Ms procured. But Airbus Military says no procurement reduction discussions have taken place. Indeed the only country to have formally reduced its A400M order is the U.K., which signed for 22 aircraft rather than the 25 it initially planned. ☒



The venerable Vickers VC10 provided nearly a half-century of service to the Royal Air Force.

TONY OSBORNE/AW&ST

End of an Era

As VC10 retires, Voyager takes up RAF refueling role

Tony Osborne London

The U.K. Royal Air Force has retired the last of its vintage Vickers VC10 aerial refueling tankers, which opens an unlikely capability gap.

For almost 50 years, the VC10 provided strategic transport, airlift and an aeromedical capacity. In the 1980s, with the arrival of several secondhand ex-airline VC10s, the role was extended to provide air-to-air refueling, a capability for which the type became best-known. Of the 54 VC10s produced by Vickers, the RAF operated 28, in four different versions.

Now the mantle of aerial refueling has been taken up by the last six remaining Lockheed L-1011 Tristars, due to exit service in May 2014, and by the expanding fleet of Airbus A330-200 multirole tanker transports, known in RAF service as Voyagers, and operated by the AirTanker consortium under the Future Strategic Transport Aircraft contract.

However, the Voyager will not be fulfilling a once-secretive mission carried out by the VC10—that of air sampling. The VC10 inherited the mission following the retirement of the Avro Vulcan in the 1980s. The missions, part of international nuclear-verification efforts, were often flown in conjunction with the U.S. Air Force's Boeing WC-135B "Constant Phoenix" in the aftermath of nuclear tests, such as those carried out by North Korea in 2006 and 2009 and follow-

ing India and Pakistan's nuclear trials in 1998. The aircraft used a specially designed particulate-filter collection pod fitted in place of the under-wing hose-drogue unit (HDU), allowing the aircraft to slip by undetected.

The final VC10 aerial refueling operations took place Sept. 20 with the last two K3 variants, ZA147 and ZA150. They took to the air and performed flybys over sentimental locations around the U.K. as part of the farewell. Days later, the aircraft made one-way flights to Dunsford, Surrey, and Bruntingthorpe, Leicestershire, to join museums and collections. AirTanker is now building up Voyager capability, and, on Aug. 11, was officially cleared to refuel the Eurofighter Typhoon.

The next major milestone for AirTanker and the RAF will be to clear the center-line HDU fitted to three-point Voyagers, allowing the aircraft to transfer fuel to larger receivers such as the C-130J Hercules and the Boeing E-3D Sentry. Trials with the two types are expected this year. This month, the company is due to take over the airbridge between the U.K. and the Falkland Islands, replacing civilian charter operators. A defensive aids suite upgrade is anticipated to allow the Voyager to begin flying between the U.K. and Camp Bastion, Afghanistan, before year-end. ☒

Two Steps Ahead

In another strategy shift, JetBlue introduces premium cabin for transcontinental services

Jason Rabinowitz New York

The airline world has become used to low-cost carriers offering more and more perks. Even some form of premium cabin is no longer uncommon. But JetBlue is taking that concept one step further. Or rather, two.

The airline last week revealed its plans for a new business-class cabin to be used on transcontinental routes. Dubbed Mint, the cabin will comprise 16 lie-flat seats, some of which include a movable partition to become a “mini-suite,” on a dedicated subfleet of Airbus A321s, compared to the Airbus A320 currently in use for transcontinental routes.

This is JetBlue’s first foray into the premium-product market, signaling a dramatic shift from its signature single-class concept. Mint is also another iteration of the JetBlue business model. For the first time, the airline will be marketing two distinct products, an economy- and a business-class-type cabin.

In some way, it is also consequent. Even when JetBlue only offered an economy cabin, it gave its passengers more space than even most legacy carriers and essentially all of its domestic competitors. The airline never opted for maximum-asset use by putting as many seats into its aircraft as possible. The carrier was still at a product disadvantage when it came to coast-to-coast flying, where space and comfort matter most in the domestic market, because it did not offer lie-flat seats.

The decision is moving JetBlue even deeper into the legacy and premium field. The airline is betting it can generate more revenue per square inch with fewer passengers paying a higher fare than it would using its economy product. Per-seat costs are also going to rise significantly on its transcontinental routes, due to the investment needed and the less-economical use of space.

The new cabin will be offered on a dedicated fleet of A321s. Delivery of the first aircraft assigned to the Mint product role is set for February 2014. JetBlue has 30 orders for the A321, 11 of which will be assigned to the premium transcontinental role. The current A321 has some range limitations on winter west-bound flights, but JetBlue expects this to be resolved with the

introduction of sharklets, Airbus’s marketing name for winglets. All JetBlue A321s will have the devices.

CEO David Barger noted that although his airline has not yet ordered the A321neo, he “would not be surprised” if an order was placed, adding, “We haven’t ordered the 321neo yet . . . I think we will.”

Mint will be sold as a distinct product from the traditional economy offering, and upgrade via mileage or points will not be an option. Potential passengers will now be presented with the usual “lowest” and “refundable” economy fares, with two new choices, “Mint lowest” and “Mint refundable.” The Mint lowest prices will start out initially at \$599 one-way after a three-day \$499 special, which represents a one-third to one-half discount over the competition.

The decision to offer a premium cabin was made 5-7 years ago, says Barger, but work actually began two years ago. “We found that on the transcontinental markets—specifically into LAX [Los Angeles International Airport] and San Francisco International—there were really two reasons passengers were [not] booking our company. They told us: ‘You don’t have a premium offering, and by the way, I’ll pay [for that], and you don’t have WiFi,’ so we had a choice to make,” he explains.

The Mint cabin, along with the long-awaited K_a-band WiFi connectivity, should put JetBlue back on the map for frequent transcontinental passengers, but it will take some time to take effect. Service with the premium A321 product is scheduled to start in June 2014 from New York John F. Kennedy International Airport to LAX, but the new Mint-cabin-equipped aircraft will not make its way to San Francisco until fourth-quarter 2014, when JetBlue has taken delivery of enough A321s to make constant service possible.

In New York, JetBlue will not attempt to compete with the legacy carriers for corporate contract passengers—some of the most frequent business-class passengers on the transcontinental routes. “We’re not going to try to out-compete those guys in a place like New York because that’s not our business,” says Barger. “There are places, like Boston, where we’re very relevant to the corporate customer, because of our flight schedule offering.” However, JetBlue does not currently have any plans to expand Mint service to include the Boston market; it will focus on getting the initial routes solidified first.

JetBlue is targeting the “high-end leisure traveler” and “small business owner.” Barger adds that these types of customers typically pay full fare for a premium-cabin experience, which should allow the airline to see higher returns from a premium offering than their competitors. ☼

JetBlue is scheduled to add Airbus A321s to its large existing fleet of A320s next year.



Vueling is expanding its Airbus A320 fleet before taking on the first of its A320neos.



Blending the Model

Vueling is betting on Barcelona connections and foreign bases

Jens Flottau **Cologne, Germany**

Spanish low-cost airline Vueling is the International Airlines Group's only unit that manages to generate solid returns on intra-European routes. And having just placed a huge order for up to 120 Airbus A320s and A320neos, Vueling is working on refining its model further.

IAG, the parent of Iberia and British Airways (BA), took full control of Vueling earlier this year to complete its portfolio with an asset that is successful where others, including Iberia and BA, have failed: making money in Europe. But Vueling is outgrowing its home market, Spain, as well as its hub, Barcelona, so is weighing its options.

One possibility is developing foreign bases in Paris, Rome and Amsterdam, and that is where 80-90% of the planning is focused, CEO Alex Cruz tells Aviation Week. Vueling is increasingly putting its sights on becoming a pan-European airline. Cruz believes that if the brand is not attached to a specific country, growth will be more easily attained. "The wider brand gives us some freedom," he says. In 2014, the airline plans to open more bases outside of Spain and increase capacity at its existing international bases. Vueling has allocated three aircraft to its Paris operation and is placing one in Rome and one in Amsterdam.

The CEO sees the airline's network extending to Russia, primarily to cater to Russian outbound leisure traffic, and into Africa. He is working to obtain traffic rights to Senegal, and Dakar is on his wish list. But Cruz also sees significant

opportunities in Central Africa, thanks to the geographic location of Barcelona. In that part of the market, Vueling would compete mostly with TAP Portugal, which has developed African destinations via its Lisbon hub.

But in spite of the hub-and-spoke operation in Barcelona and its affiliation with sister companies Iberia and British Airways within IAG, Vueling has no plans to join the Oneworld alliance, although talks have taken place. "But alliances have to understand they cannot impose the same kind of requirements" on hybrid airlines such as Vueling. "[These] add too much cost," Cruz says.

As part of a broader IAG aircraft order, Vueling will gain access to a large fleet of more A320s and A320neos. Of the 62 aircraft on firm order, 58 are options. The Boeing 737 MAX and the Bombardier CSeries were also in the running. Cruz says that ultimately the assessment of risk in taking on a newly developed aircraft model kept it from ordering the CSeries. "It was very close; Bombardier did a fantastic job. But you have to add in some risk cost in the calculation, and we made our own predictions," Cruz explains. If it had selected the CSeries, it would have opted for the 160-seat version of the CS300 and would also have ordered either the A320neo or the 737 MAX. A CSeries order would have made a parallel Airbus commitment more likely than a MAX order, because Vueling would have otherwise had to integrate two new fleet types instead of one.

Separately, Vueling is working on

refinements at Barcelona. Minimum connecting times are being reduced to 35 min. from 55, which doubles the possible connections there.

The move is part of a broader initiative to grow the airline's share of connecting traffic. Currently, 18.5% of its passengers are in the connecting category. Cruz expects that share to rise to around 20% by year-end, and grow up to 25% in 2014.

The airline began experimenting with the concept in 2009. Cruz believes there is a "natural limit" to the amount of connecting traffic, simply because of Vueling's fare structure. Connecting fares are essentially what would be the two local fares combined, plus a connection fee that can be up to €20 (\$27.20). That makes its connections, in many cases, more expensive than its competitors', but it ensures that the airline can recover the additional cost. "We can't afford to dilute revenue," says Cruz.

The system also protects the airline from overly aggressive expansion based on low yields, and the network is still designed based on local demand. Cruz observes that a lot of last-minute bookings are made for the connecting flights, indicating that passengers chose those itineraries when competing airlines are already fully booked.

Extensive studies were conducted before the 35-min. connecting time procedure was implemented. This change requires more manpower on the ground for the accelerated process. Early figures indicate the investment is paying off through significantly higher revenues. The reduced minimum connecting time applies to all flights within the Schengen Agreement area, which covers countries that do not involve additional passport/security checks.

Vueling plans to invest more in information technology and in targeting a few Spanish coastal cities for direct services to European destinations. ☐

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Austrian is exploring alternatives for replacing its Fokker 100 fleet soon.



Austrian Revival

Deep cost-cutting means the airline may return to profitability this year

Austrian Airlines at a Glance

	First Half	
	2013	2012
Revenues	€977 million	€1.03 billion
Operating Loss	€35 million	€55 million
Passengers	5.28 million	5.44 million
Load factor	75.7%	74%
No. of aircraft	77	77

Source: Austrian Airlines

€1=\$1.36

Jens Flottau Vienna

A little more than a year ago, Austrian Airlines was closer to shutdown than survival, but after some deep and very contentious cuts, it is en route to an operating profit this year.

"We think the worst is behind us," says CEO Jaan Albrecht, the man behind the turnaround, who led the Star Alliance for 10 years before joining taking the helm at Austrian. When he arrived in Vienna in November 2011, he quickly realized that things

were much worse at the airline than expected.

The previous management had just prepared a budget proposal projecting a €206 million (\$280 million) loss in 2012. Albrecht recommended that the board of directors reject the plan—and they did. Then, he took a deep dive into the figures and structures, working on alternatives. Someone pulled out an old idea that had been overlooked because it seemed too daring: transferring aircraft and crews to regional subsidiary Tyrolean Airways, while shaving some legacy

costs built up over decades as a state-owned company.

The transfer to Tyrolean, implemented in the summer of 2012, is the main reason Austrian is now in a much improved state. The airline reduced its surplus of senior pilots—close to 120 (most of them captains) left the airline with an opulent package of up to €580,000 each. More than 200 cabin crew also departed. For a relatively small airline, that translated into significant cost savings.

At the same time, Albrecht negotiated concessions from key suppliers,

Slots Scuffle

Japan Airlines protests ANA's larger slice of new Haneda capacity

Adrian Schofield

The latest round in the fight for coveted slots at Tokyo's Haneda Airport shows that despite Japan Airlines' (JAL) financial recovery, it is still being haunted by its journey through bankruptcy protection.

JAL is criticizing Japanese regulators for awarding a greater share of new slots at Haneda to rival All Nippon Airways (ANA) and calling for an explanation of the criteria used by the government. Whatever the official rationale, it appears that ANA has won support for its argument that slot awards should be used to help offset the advantage gained by JAL through its government-backed bailout in 2010.

Of the 16 international slots awarded by the land, infrastructure and transport ministry (MLIT), 11 have been granted to ANA and just five to JAL. The additional Haneda slots are enabled by runway and facility expansion at the airport, and they can be used in the fiscal year that begins in April.

Slots at Haneda have been a contentious topic among Japa-

nese and foreign carriers since the airport began to reintroduce a limited number of international flights there in recent years. Haneda slots are valued by airlines because the airport is closer to downtown Tokyo than Narita International Airport.

ANA lobbied the Japanese government for several months regarding the slots, insisting publicly that it deserves a greater share because the help given to JAL during its emergence from bankruptcy protection unfairly altered the competitive playing field. There have been signals that the government was leaning toward giving ANA more slots.

JAL says it "cannot accept" the explanation given by the MLIT regarding its allocation criteria, which involved the establishment of new routes. JAL states that it will "proceed to formally seek from MLIT a rational explanation and a correction of the content of this allocation."

JAL also argues that "decisions regarding the allocation of national assets such as departure and arrival slots were not made from the standpoint of maximization of passenger convenience and the national interest. . . . Additionally, no rational reason was given by MLIT as to how the current allocation would bring about such benefits."

The carrier further complains that regulators have not "specifically explained why new criteria have been abruptly established, why it is that routes established at [Haneda] are to be regarded as 'new,' or how they might impede or distort an appropriate competitive environment."

such as Vienna International Airport, informing them that Austrian owner Lufthansa would not fund further losses. Eventually, Austrian reported a €10 million operating loss for 2012—not the initially projected €206 million.

The transfer to Tyrolean has since been legally challenged, and Austrian's works council, which represents its unions, has won a court ruling. However, the two have been negotiating an out-of-court settlement for weeks, and Albrecht says, "I believe we will come to an agreement" that the council will drop the lawsuit in return for something that does not threaten the turnaround plan. Lufthansa ultimately supported the restructuring with another €160 million.

Now that the fundamental cost structure seems to be much better, Austrian must address two interconnected crucial issues, the business model and the fleet.

Forty percent of Austrian's long-haul traffic connects through Vienna; including short-haul passengers, the figure rises to 55%. While Albrecht does not want to reduce capacity, he is aware that Austrian needs to strengthen regional traffic to decrease dependency on expensive, lower-yield, one-stop flying. But it is not clear that this model will work, even if costs are

low enough and Austrian has a good share of short-haul connections, as it operates out of a small hub in Europe against much bigger competitors.

This is where the fleet comes in. Austrian would like to retire its 24 Fokker 100/70s, since expensive heavy-maintenance checks are due in 2016 and 2017. It acquired parked ex-American Airlines Fokker 100s more than 10 years ago and has used them predominantly on niche routes from Vienna to Eastern Europe and Central Asia, one of Austrian's specialties. If it buys a larger model, it could only continue to fly routes with sufficient demand and might have to pull out of smaller markets.

Austrian sees three scenarios: quit the segment altogether and focus on traditional narrowbodies, introduce a new 100-seater while keeping its Bombardier Q400 as a smaller alternative for thinner routes, or discontinue operating aircraft with fewer than 100 seats. "It is not an easy question," Albrecht says.

Aiming to simplify its fleet as part of its deep restructuring, Austrian retired its last Boeing 737 last year. It may opt for aircraft such as the Embraer 190 or 195 for the Central European flying. Given that the Fokkers will be retired in the next 3-4 years, the

airline is under some time pressure.

Next in the line for replacement are six Boeing 767-300ERs that Austrian inherited from Lauda Air. They have just been refurbished with improved business-class seats, and the airline used part of the €160 million gift from Lufthansa to invest in a new premium cabin. The business case for the new cabin was based on an eight-year planning cycle according to which 767 operations are to continue until around 2020, when they will be well over 20 years old. Austrian plans to continue 777-200ER operations until 2025. It operates four of the type and is taking a fifth next summer to further expand long-haul capacity.

Austrian's future long-haul fleet will likely be a single type, either the Airbus A350-900 or Boeing 777-9X. Lufthansa has just placed a large order for both types and plans for its subsidiary to take some of the options in the contract.

Albrecht says Austrian would like to catch up on missed opportunities in the long-haul arena. "In the past, Austrian went from crisis to crisis and did not have the resources to look at long-haul expansion," he explains. It is beginning to do this with the relaunch in May of Vienna-Chicago services for which the airline says it is pleased with the initial bookings. ☺

JAL says it argued for an even split of the Haneda slots available to Japanese carriers. This would be of the greatest benefit to customers and the national interest, it argues, by maximizing the value of a limited amount of slots, promoting connections between international and domestic flights and helping maintain a competitive balance between the two airlines and their alliances.

ANA is understandably more positive about the slot allocation.

"This will help close the competitive gap between ANA and [JAL] created by the extensive state financial support given to JAL after its bankruptcy," says ANA CEO Shinichiro Ito.

In addition to the international slots awarded to Japanese airlines, about the same number will be allocated to overseas carriers. U.S. airlines, which have long complained about lack of access to slots at Tokyo's airports, have already signaled they will compete fiercely for any quota granted to them. ☺

All Nippon Airways plans to add new international routes from Tokyo Haneda Airport.



Against the Grain

Delta forgoes iPad for Microsoft EFB

John Croft **Washington**

Delta Air Lines is breaking ranks with its three major U.S. airline rivals, selecting Microsoft as

its electronic flight bag provider over Apple. The airline announced Sept. 30 that it will purchase 11,000 Microsoft



DELTA AIR LINES

Surface 2 tablets for its pilots as part of a move to increase productivity and situational awareness, as well as to cut costs by replacing paper manuals and charts.

American Airlines and United Airlines have already equipped all of their pilots with iPads to be used as portable electronic flight bags (EFB), and Southwest Airlines plans to roll out iPads to its entire fleet by the end of 2014, pending the conclusion of a beta test underway with approximately 700 pilots. Southwest pilots will be giving up the portable Panasonic Toughbook tablet they use for performance calculations and electronic manuals as the airline transitions to iPads, which include electronic charts and weather applications.

Delta says it will begin the rollout of the Microsoft 10.6-in. touchscreen tablets in its Boeing 757 and 767 fleets later this year, followed by integration into the entire mainline fleet by the end of 2014. As off-the-shelf components, the devices do not require FAA certification, but rather an authorization in the operations specification by the air-

A Delta Air Lines' pilot views airport maps on the carrier's new Microsoft Surface 2 electronic flight bag.

Upping On-Time

Aerospace industry group asks FAA to lift ban on portables below 10,000 ft.

John Croft **Washington**

A government and industry panel has recommended that the FAA loosen its ban on using e-readers, tablets, smartphones and other electronic devices in the passenger cabin below 10,000 ft. Though the specifics have not been made public, the recommendations broadly call for allowing the use of personal electronic devices (PED) at all altitudes, except for heavy PEDs, like laptops, that could become projectiles during a rapid acceleration or deceleration. Smartphones, when not in "flight mode," would continue to be banned inflight, as the transmissions to the ground networks are controlled by the Federal Communications

Commission, but Wi-Fi connections to onboard systems could be used at all altitudes.

How the FAA will respond to the recommendations is unclear, though comments received from airlines and industry groups to the agency's August 2012 open request for solutions reveal safety tradeoffs the FAA will consider. Comments indicate an "extremely remote" chance of interference with aircraft systems based on in-service experience.

The 10,000-ft. ban on all devices, and requirements that cell phones only be used in "flight mode" at any altitude, are largely in place today to prevent PEDs—particularly ones that trans-

mit radio-frequency (RF) energy over Wi-Fi, Bluetooth and other cellular modes—from producing RF signals that could interfere with cockpit display systems, and to keep unshielded or extensive wire cables from running through the aircraft. Avionics-maker Honeywell's position is that the effects from PEDs could vary based on whether the aircraft is built of metal or composites. "Threat levels have increased with composite aircraft due to lower shield attenuation of aircraft skin requiring increased electromagnetic compatibility protection in avionics equipment," the company states.

Airlines have the ultimate say on use of PEDs onboard, though the FAA requires testing and analysis to prove the usage is problem-free, an increasingly difficult task given the variety of PEDs and aircraft systems to consider.

"Traditionally, airlines have used onboard testing to confirm inflight Wi-Fi systems, and ground usage of cell phones have not interfered with

line's FAA principal operations inspector. In Delta's case the authorization to use the EFB in all phases of flight will include rapid decompression testing of the tablet, along with altitude and electromagnetic interference testing to ensure the device will not disrupt installed equipment.

Delta will initially use Jeppesen software for electronic charts and documents, but expects to roll out advanced applications, including weather, electronic dispatch, pilot training, operational information and communications, with aircraft technicians starting 12-18 months after the fleet is equipped.

"We've been studying EFBs for over a decade," says Steve Dickson, Delta's senior vice president for flight operations. "We did have a brief period in 2007 when we looked at Boeing 777LRs that could have come provisioned with Boeing Class 3 EFBs, but decided not to go down that path."

A Class 3 EFB is considered installed avionics, and is generally more comprehensive and expensive compared to Class 1 (portable) or Class 2 (semi-attached) EFBs. Delta's Surface 2 tablet, running Windows 8.1, is considered a Class 1 EFB with "Type B" software, meaning the device can display electronic charts as well as documents. One downside of a Class 1

EFB is that it cannot show "own-ship" position on the ground or in flight.

"There was nothing out there that appealed to us as an enterprise solution. That's why we were interested in Microsoft," says Dickson. "We were looking at this as a work tool for a mobile workforce." In August, the carrier provided its 19,000 mainline and regional carrier flight attendants with Microsoft Windows-based Nokia Lumia 820 smartphones to use for on-board purchases.

Dickson says Delta briefly tested iPads in cruise flight with pilots using their personal devices, but found the Apple operating system to be too limiting. "Our choice of the Surface 2 was driven by it being very scalable and flexible," he explains. "It's a tool for us to stay in touch with a mobile workforce."

The airline estimates it will save 1.2 million gal. of fuel per year alone by eliminating each of the 38-lb. flight bags that pilots currently carry. When combined with other efficiency factors, including wireless updates to charts and documents, Delta states that the EFBs will result in \$13 million per year in savings.

Dickson says Delta is testing some of the EFBs now, while the airline's supply chain group completes the deal with Microsoft. It will begin a trial

phase on 757s and 767s later this year, where crews will carry paper charts along with the Surface 2 tablets for six months before going paperless. In parallel, Delta will be working with the FAA and its principal operations inspector on the authorization process for all of Delta's aircraft types, a task Dickson expects to be completed by year-end. Other aircraft types will follow, with the fleet crossover to electronic charts complete by the end of 2014.

Like most other carriers, Delta will position its tablets in rigid mounting arms that attach, using dual suction cups, to the side windows in the cockpit. Dickson says each aircraft will have a spare mounting arm. There are no wired or powered connections to aircraft systems.

The basic Surface 2 has a 10-hr. battery life, but each tablet will have a spare battery integrated into the unit to provide another 5-10 hr. Dickson notes that the tablets will have Wi-Fi, but no cellular capability, with crews during the initial deployment using Wi-Fi on the ground "to ensure we have updated content prior to flight." Once Delta develops more advanced applications, he says, Wi-Fi will be enabled in flight. "Initially, with charting and manuals and basic EFB functions, it won't be necessary." ☼

E-readers could be allowed to be powered up below 10,000 ft., if the FAA accepts the recommendations of an advisory group.

aircraft systems," says Kirk Thornburg, managing director of aviation safety assurance for Delta Air Lines. "However, continued reliance on testing of every PED against every potential aircraft system is an untenable task." Thornburg was chairman of the PED aviation rulemaking committee (ARC), launched by the FAA in January that comprised 28 government and industry representatives. The ARC presented its final report to the FAA Sept. 30. Thornburg, in his comments, suggested using a safety management system approach to the problem, which would recognize that interference is unlikely, but would provide pilots procedures to deal with any avionics issues that crop up.

The growing call to allow some PEDs to remain on below 10,000 ft. is that there is little to no empirical data



JOHN CROFT/AW&ST

that show interference problems.

Delta says a review of its maintenance defect and pilot Aviation Safety Action Program (ASAP) reports, culled from 2.3 million flights from January 2010 to October 2012, yielded 24 maintenance-defect reports and three ASAP reports where pilots cited PEDs as a potential source of an observed

flight equipment discrepancy. Mechanics mentioned the possibility of PED interference when resolving avionics system problem reports, but in every case, there was no conclusive evidence.

Airbus says it has run tests transmitting PEDs (T-PED) on more than 100 aircraft, with no adverse results. "Experience shows that T-PED signals may only influence electronic parts in close vicinity to the signal source," the airframer wrote in response to the FAA August 2012 call for solutions. "The number of active T-PEDs can be neglected; the one T-PED nearby is the highest threat. Taking this into account, an expanding use of PED does not change the situation we experience today." ☼

Tighter Tolerance

Exactitude in manufacturing should drive down MRJ costs

Bradley Perrett Nagoya, Japan

The card that every new commercial aircraft should get to play is a decisive rise in operating efficiency. Being new, the airliner should offer fresh technology that lets it transport passengers for less expense. For a mature rival program, a card to play in reply is low manufacturing cost. Having slid well down the learning curve, it can, if necessary, be priced more cheaply than the fancy new competitor.

It is not working out quite like that in the regional jet market, however. Because of more than three years of development delays and a vigorous technological response by an established competitor, Mitsubishi Aircraft's forthcoming MRJ may quickly lose much of its efficiency advantage. First delivery for the MRJ program is now due in mid 2017, but by 2020 a heavily updated version of the most closely comparable Embraer E Jet should go into service. The Embraer 175-E2, as it is called, will reply not only by adopting the MRJ's engine; but it will also have improved avionics and, most notably, a new wing (AW&ST Sept. 23, p. 18).

But it turns out that Mitsubishi Aircraft has another card up its sleeve. The company says the MRJ has been designed to very high levels of precision, with the aim of easing assembly and thereby cutting production costs from the very beginning of the manufacturing program. No cost figures are available, but evidence of high-quality manufacturing was apparent when Aviation Week last month saw fuselage major assemblies of the first prototype, built by airframe contractor Mitsubishi Heavy Industries. Other cost savers will be a moving assembly line and oven-cured composite parts.

MRJ development costs, meanwhile, are rising by about ¥20 billion (\$200 million) in engineering salaries for each year of delay, says Mitsubishi Aircraft President Teruaki Kawai. Since the original budget for a five-year, nine-month program with entry into service at the end of 2013 was ¥150 billion, development now looks like it will cost ¥220 billion, though Kawai says that

can be easily absorbed in a program with decades of production life.

Production engineers at MHI are making use of the extra time by driving more risk out of fabrication and assembly processes—probably not a small benefit for a manufacturer that is not skilled in making all parts of commercial aircraft. The program can hardly afford manufacturing foul-ups after suffering the development delays, which were mostly caused by Mitsubishi Aircraft's lack of experience in airworthiness certification (AW&ST Sept. 9, p. 50). Three customers are awaiting delivery of 165 aircraft from the program, which so far is developing the MRJ70 of 76 seats and MRJ90 of 92 seats, the latter attracting the most demand.

From the outset, the program envisaged high costs for design and early fabrication of detail parts in return for permanent savings in assembly. The idea is simply to design and build the aircraft with tighter tolerances than are normal in commercial aircraft so that parts fit together better, greatly reducing the time taken by adjustment, such as shimming. The tolerances of detail parts in the MRJ are typically only half of those normally used in other manufacturers' programs, says Hiroyuki Tatsuoka, deputy director of MRJ manufacturing assembly at MHI, declining to give details.

As production proceeds, the cost of fabricating highly precise parts will quickly fall to normal levels, says Kawai; making them does not take more machining time than less-exact components do. Rather, the main cost has been the greater engineering effort in designing the aircraft for higher precision. But that is a once-only burden on the program, whereas quick and easy assembly will be a cost saver until the last MRJ or MRJ derivative is

built. The benefits are not just in final assembly, usually thought to account for about 5% of commercial aircraft costs, but also in making the major assemblies, such as fuselage modules, and also subassemblies.

Each of the fuselage modules of the first prototype took about half as much



BRADLEY PERRETT/AW&ST

Mitsubishi Aircraft is manufacturing the MRJ with skin finish within 10 microns. Double curvature sections at the nose and tail have presented considerable challenges.

time to put together as might have been expected with normal fabrication precision, Tatsuoka says. Thanks partly to prior practice on engineering prototypes, no major problems arose, and almost no adjustment was needed to make parts fit. Making shims—insets that fill unintended gaps between parts—is a seriously time-consuming process in assembly, because measurements must be made for each one, which is then customized for its joint.

Normally, about 10% of holes will re-

quire reaming to get a fit when pieces are joined for riveting, laying one hole over another, Tatsuoka says, without specifying which parts of the aircraft that ratio applies to. For the MRJ the fraction was much less, “a very small number.” The tolerance of drilled holes is normal, however, because MHI is us-

Aviation Week’s visit to the Tobishima factory in southern Nagoya.

“The assemblies look very clean for early articles,” says an experienced production engineer from another manufacturer, examining photographs of the prototype. “There are no apparent tool marks [and] the fasteners are

cially Toyota Motor; it is not surprising that MHI is applying the technique to MRJ production. The company has hired the Japanese consultant who advised Boeing on the process, says Kawai. MHI instituted its first moving line at Nagoya and then applied the process to production at its factory in Hanoi, where it makes flaps for Boeing 737s.

Although the MRJ is largely built of conventional aerospace aluminum, carbon-fiber reinforced plastic will be used for the moveable surfaces and for the tail. For the latter, MHI is using a process called A-Vartm—a variation of vacuum-assisted resin transfer molding. In this process, carbon fibers are infused with resin partly by suction, so the cost of an autoclave is unnecessary. MHI and material supplier Toray developed the A-Vartm variation.

Two other cost savers for MRJ production are the adoption of a circular body cross section, which has simplified tool design, and the use of conventional aerospace aluminum, that is cheaper than so-called advanced aluminums and aluminum-lithium alloy. Those newer metals offer weight savings that Mitsubishi Aircraft judged unjustified for a regional aircraft. A 2009 decision to build the wing of aluminum, instead of carbon-fiber composite, also saved money, though the main aim was reducing weight for the MRJ70.

Of MHI’s plants around Nagoya, the one at Oye is making detail parts and the tail surface assemblies while Tobishima is building the major assemblies, including the outer wings and the fuselage modules, which it is also joining to create the whole fuselage, incorporating a wing center box. This includes fitting onboard equipment. The Komaki South plant, also at Nagoya, will perform final assembly, checking out and flight testing. MHI is building six MRJ airframes, five for flight-test aircraft and one for static ground testing. Pratt & Whitney will supply PW1217G engines.

In September, the fuselage sections of the first prototype were lined up but not connected. The outer wings were still being made, so a manufacturing prototype of the left outer wing was placed alongside them to show the final appearance. MHI also displayed a completed left winglet. The machinery for series production was employed in making the parts for the prototype.

Approaching an aircraft manufacturing program, production engineers first address the processes and parts



Assembling fuselage modules for the first MRJ was unusually easy, say program engineers. Almost everything fitted.

ing standard rivets, says Akihiko Ishikawa, general manager of MHI’s MRJ manufacturing program.

Availability of precise manufacturing machinery appears to have been a key enabler for this design and production strategy. MHI, Mitsubishi Aircraft’s majority owner, needed only to buy few machines to build the MRJ’s structure; its fabrication equipment could already achieve the necessary tolerances. In earlier programs, the precision capability had not been fully used, says Kawai. That may seem surprising, but he adds: “Almost all the machines in Japan are precise.”

Tight tolerances should also pay off in MRJ operation. Carefully manufactured skins with a surface finish within 10 microns (0.4/1000 in.) are mounted on precisely built frames, minimizing drag. The smoothness of the skin of the first MRJ prototype, the tight alignment of its panel joins and the regularity of its riveting were readily apparent during

all the same size and in a consistent pattern, so it does not appear that there’s been workmanship problems or even rework caused by an engineering issue or change.”

Visible fasteners on the MRJ prototype all appear to be seated properly, meaning there are no gaps underneath the head or collar. Accurate drilling has evidently kept them perpendicular to the surface, as they should be. From the outside, at least, sealing between panels looks like high-quality work.

A consultant production engineer who has also examined close-up photographs agrees that MHI has done a good job on the prototype.

The global aerospace industry is increasingly adopting moving assembly lines, in which the product continuously edges through the factory, creating a production beat and reducing wasted time and inventories. Since this is part of the lean manufacturing philosophy, largely learned from Japan and espe-

where they see the greatest risks. For the MRJ, MHI engineers focused particularly on the wing, where the challenge to precision was the length of spars and skins, and the nose and tail fuselage sections, which presented the difficulties of double curvatures. Those end sections also typically use

thicker skins, adding to the challenge in achieving required tolerances for length, width, curvature and so on.

The nose, especially, was seen as a risk, because MHI had no experience in making that part of a jet transport, says Tatsuoka. "We had to make it very tight, but for us, it was new," he says.

"We tried many methods to do that, starting with windscreen," around which the rest of the nose was built. "There were several different ways to do that." The outer wing boxes, too, required repeated attempts.

Development delays have given the production engineers time to progres-

Better Burn

Testing is underway on second package of Trent 900 fuel-cut upgrades for A380

Guy Norris **Derby, England**

Rolls-Royce's campaign to step up fuel-burn savings and reliability across its big fan engine family is reaching a key phase with tests starting of a second round of upgrades to the Trent 900 for the Airbus A380 and for design audits beginning on improvements to the A330's Trent 700, and delivery of the first updated Trent 800EP for the Boeing 777.

The upgrade programs are designed in most cases for retrofit, but in each instance, will also provide the production standard for new-build engines in the future. Collectively, they form a vital element of Rolls' competitive battle against the General Electric-Pratt & Whitney Engine Alliance GP7200 over the A380, and the engine options provided by both U.S. manufacturers for the A330.

The battle is particularly intense over the A380 market. The Trent 900-powered version has been in service six years and now powers 58 aircraft with six operators. Since 2012, all Trent 900s have been delivered to EP (enhanced performance) Block 1 standard to improve reliability and fuel burn. "We have the best reliability in the A380 fleet, and based on last month's numbers, we reckon we are ahead," says Peter Johnston, head of customer marketing for civil large engines. Following the introduction of the EP Block 1 package, Airbus has changed its official fuel-burn specification (or "Orange Book" listing) for the Trent 900. "The EP has been better than we said it would be," says Johnston. "It's around 0.3 percent better than we claimed it to be based on results of Airbus production flight tests,

so with around a one percent improvement, that is a better starting point for EP2."

Block 1, like the other upgrade packages, is based primarily around the introduction of elliptical leading edges in the compressor. Other changes include tighter low-pressure (LP) turbine tip clearances and a new hard coating for the high-pressure (HP) compressor drum. Reliability-driven upgrades include changes to the HP and intermediate-pressure (IP) turbine disc and blades, IP nozzle guide vanes, seal segments, turbine case cooling, an LP location-bearing package, an IP turbine shaft coupling nut and a software upgrade to the electronic engine controller.

"We have now moved into the test phase for the follow-on EP2," says Johnston. Designed to provide up to a 0.8% fuel-burn improvement, Rolls says that together with the better-than-expected outcome of the production EP1 engines, the overall improvement could net more than 1%. Five EP2 test engines are involved in the evaluation with the third unit currently moving on to core certification testing at Rolls' 57-bed ground-test facility in Derby, England. A fourth engine, built to production standards, will be used for back-to-back testing.

The three other engines in the program include a structural test engine that is viewed using a powerful X-ray device to assess dynamic movement and clearances of parts. Another functional test engine is used for detailed air and oil systems evaluation, assessment of the bearing loads and confirmation of overall functional behavior.



A fifth engine, built to production representative standard with all the EP2 core modifications fitted, is currently in assembly and will be used for cyclic endurance tests.

The EP2 configuration includes optimization of the fan blade tip clearance using technology features derived from the Trent XWB now in flight test on the A350, as well as from the Trent 1000 on the Boeing 787. It also incorporates a tighter turbine case cooling control system and better sealing of the LP turbine, both of which are mainly derived from the XWB. Other elements include air system changes, aerodynamic improvements to the IP compressor and lower-drag 'A-frame' engine section stators with elliptical leading edges between the core and fan duct.

A group of engineering auditors is meanwhile completing a review of a second package of planned improvements to the Trent 700, which are designed to provide a further 1% fuel savings to A330 operators worth

sively address smaller risks. Tatsuoka gives the example of drilling vertical holes in the upper chord of the center wing box, where that part protrudes for joining with the skin of the outer wing boxes. It is a classic problem area in commercial transport aircraft, because of the constricted space beneath the fu-

selage. Tatsuoka says the team has now worked out how to drill the holes there properly. It was an issue that would have been worked out much later in the manufacturing development schedule had the aircraft made its first flight in late 2011, as initially planned.

Mitsubishi Aircraft says that, with

two big delays caused by its unfamiliarity with airworthiness certification now behind the MRJ, design development should proceed normally. If the production engineers have used the unexpected time well, the manufacturing side of the program may turn out to be smoother than normal. ☺



MARK WAGNER/AVIATION-IMAGES.COM

\$200,000 per year from 2015 onward. "We want to make sure we're happy with it before we launch into detailed

design and development later this year," says Johnston, adding that the focus this time is primarily on LP turbine system changes to maximize propulsion efficiency. "The LP turbine is a big improvement because it results in almost a one-to-one benefit, rather than core improvements, which tend to be more diluted."

Specific changes for the EP2 pack-

Five engines will be used in the Trent 900EP certification effort, the third being this unit in the company's 57-bed test site.

age, which is timed to coincide with the introduction of the heavier-weight 242-ton A330 in 2015, include the debut of a lower-drag version of the anti-flutter bridge in the LP turbine. Similar in concept to a clapper or snubber on a fan blade, the bridge is located mid-span on the turbine nozzle guide vanes. The revised design introduces a thinner profile that is reduced in thickness to 1 mm from 1.5 mm. Together with improved nozzle guide vane sealing, as well as build improvements and

the introduction of three-dimensional stators in the intermediate- and high-pressure compressors, Rolls estimates the EP2 will generate typical specific fuel consumption reductions of 1%.

The upgrade work is seen as a valuable investment in what has become a successful engine-airframe franchise for Rolls. Since first entering service with Cathay Pacific in 1995, the Trent 700-powered A330 is now in service with 58 operators with approximately 533 aircraft in service. Earlier this year, this became the largest in-service fleet for Rolls, finally overtaking the RB211-535-powered 757.

In other EP developments, Rolls says the first upgraded Trent 800 with refitted elliptical leading-edge blades has been completed for an undisclosed customer. The 800EP should provide between 0.5-0.7% fuel-burn benefit, worth around \$200,000 per aircraft per year. However, the concrete determination of how much benefit has accrued is yet to be determined. "We need to build and test at least 20 engines before we're sure, but so far everything indicates it is going well," says Johnston. ☺

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Dreamers welcome
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Jetman Yves Rossy, with his experimental wings, frames AirVenture 2013 at Oshkosh, ground zero for avionics innovation from the grass roots up.

John Croft Oshkosh, Wis.

Largely free from FAA certification rules, the experimental and light-sport aircraft markets are home to big ideas at low prices. Builders and owners equipping with non-certified avionics can have all the features of the most modern business jet or airliner—at a fraction of the cost. While many of the technologies ultimately fail or stay experimental, others are picked up by established avionics companies to be incorporated into new or upgraded products for the certified market. The annual week-long Experimental Aircraft Association's AirVenture general aviation show in July is often the site of the "pickups." At this year's show, Aviation Week focused on five small companies—Levil Technology, Vertical Power, DepotStar, World Aircraft Co. and Aerocross—that are developing innovative products for the experimental and light-sport aircraft market, often with a longer-term goal of reaching into the certified market.

"We primarily go because there is some real innovation happening there at the grassroots level," says Paul DeHerrera, chief operating officer with Universal Avionics, a supplier to the business jet and airliner market. "We take the [vice president] of engineering, software development people and chief scientist. There's always a lot to learn, mostly in the halls."

It was in those halls in 1997 that Universal first met Don Moore, founder

of a small Colorado-based company called NavRadio that had developed a very small digital radio for aviation. The companies linked up, and Universal now incorporates Moore's radio design in its UniLink communications management unit.

More recently, Dynon Avionics was looking for ideas for a new synthetic-vision-based integrated avionics system. At AirVenture, the company came across Tom Schnell, a University

of Iowa human factors researcher who had developed a synthetic vision system with funding from NASA. Dynon ended up buying a non-exclusive license from the university for the intellectual property. "It gave us a head start on the [SkyView] project," says Mike Schofield, marketing manager for Dynon.

Schofield describes the experimental sector as "very permissive" at its core. While the aircraft has to meet basic operational requirements—for example, having airspeed, altitude, oil pressure and other indications—Schofield notes that "nowhere is there any requirement for those avionics or instruments to be certified." There are certain exceptions where certified equipment is required, he says, including transponders and GPS units for instrument-flight-rules operations. The FAA verifies the basic functionality using an inspection by an FAA-designated airworthiness representative.

"The entire home-built industry is framed around the notion that these things really are experimental," Schofield says. "There aren't very many regulations that restrict the aircraft or the avionics."

He says the light-sport market, where aircraft are built to ASTM consensus-based standards, is "somewhere in the

middle" between experimental and certified aircraft. Dynon is the market leader for integrated cockpits for light-sport aircraft. While no standards today exist for light-sport avionics, Schofield says ASTM committees are in the process of developing equipment standards that would cover avionics.

Will those standards be one step closer to regulation? Schofield doesn't think so. "It's about finding a balance between a good product definition and helping the consumer know they're buying a competent product," he explains.

Laminar Research's Austin Meyer, who developed the X-Plane simulator and Xavion, a cockpit safety aid that runs on Apple portables, believes a new product should be "locked down" first for the experimental market before attempting a certification effort.

"As soon as certification starts, a lot of the creativity stops," he says. Meyer emphasizes this by noting that in one weekend, he developed and tested an automatic descent mode for an experimental avionics package for a Lanceair Evolution single-engine turboprop. "If it depressurizes, the aircraft automatically comes down to a lower altitude, maintaining separation from terrain," he adds.

The certification process for all aircraft is purposefully slow in many cases to ensure product safety and durability. However, the FAA is studying moving to consensus standards for light aircraft (Part 23) structures and systems, a nod to bringing low-cost innovation back to the sector. ☼

Finding Focus

Texas company readies 'augmented reality' for general aviation cockpits

John Croft **Oshkosh**

Texas startup Aerocross Systems is confident it can succeed where others have failed in building a low-cost head-up display for the light aircraft market.

The company says it will be ready by late 2014 to begin selling a \$2,000, near-to-eye, head-mounted display that puts flight information in front of the pilot, enabling the pilot to keep looking outside for traffic or maneuvering the aircraft for takeoff or landing.

Previous attempts at low-cost, wearable head-up displays, also known as head-mounted displays (HMD), have resulted in failure either because the device was too expensive or bulky, the image was not collimated (focused at infinity) or the display did not have enough luminance to clearly present the information in bright sunlight. In the case of MicroVision, which went to market with a \$12,000 head-mounted, laser-based retinal raster scan display for light aircraft in 2002, the monochrome red image was focused at infinity but the bulky system did not sell and was discontinued.

Seeing Google and other companies racing to market with relatively low-cost "augmented reality," full-color,



AEROCROSS

While Aerocross employed eye-glasses for its first prototype of its near-to-eye display, the second iteration will likely feature a strap arrangement for more stability.

normal-sized glasses in the very near future, however, changed the dynamic for Aerocross President Tam Pho.

Pho became interested in low-cost head-up displays for general aviation after he and his Aerocross partner, Henry Wysong, developed an unmanned aircraft called the Echo Hawk for a U.S. Air Force program to extend airborne



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communications at test ranges. In addition to the aircraft, Aerocross had to develop the means to fly the vehicle remotely. The solution was a synthetic display that overlaid real-time video taken from nose and tail cameras. After taxi tests, the project ran out of money in 2010 and Pho was not able to test the

A vendor whom Aerocross would not identify did agree to collaborate, and a first prototype was delivered in February. About the same time, the EAA announced it would offer free booth space in its Innovations Pavilion for companies “with something new to demonstrate” at AirVenture. “We applied and

type, optimized for mass production and including an image processor that accepts data through a wireless link to portable sensors or devices. What the pilot sees through the screen could be generated by a commercially available iPad application that takes input from a portable attitude and heading reference system (AHRS) with GPS and Automatic Dependent Surveillance-Broadcast (ADS-B) for attitude, position, traffic and weather. The pilot could select how much information to display.

Pilots using the near-to-eye display initially will see basic “six-pack” information, with traffic, weather, terrain and other features to come later.

Pho says he plans to launch initially with the traditional six-pack of information—altitude, heading, airspeed, vertical speed, horizontal direction and a magnetic compass. Brilliant Eyes “works in full sun,” he explains, but could benefit from additional brightness through changes to the backlighting for the LCD. He is projecting an 8-hr. battery life for the device.

Making the data presentation conformal to the pilot’s head position during flight remains an ongoing research area. Pho says he is testing an off-the-shelf AHRS, as well as an on-chip sensor for tracking the movements of the HMD. The pilot would have to calibrate the glasses at the start of the flight to align the device’s AHRS with

the aircraft attitude, after which certain functions—such as the horizon line—would remain in the correct location as the pilot’s head moves.

“The calibration doesn’t have to be that precise,” notes Pho. “It

is only intended to be an aid and doesn’t have to be spot-on.” As a situational awareness aid, Pho says the HMD will not require FAA certification.

Once calibrated though, Brilliant Eyes must stay in place for the calibration to remain valid, which may require the use of an elastic head band rather than glasses or a headset mount, at least in the near term. “We think there’s room in the future to build the entire system on a pair of Oakleys,” says Pho. ☛



AEROCROSS

display in flight. “They transitioned the project to the Army and we never heard back from them,” he says.

The project whetted Pho’s appetite for developing a head-up display for general aviation, though. At the Experimental Aircraft Association’s AirVenture show in Oshkosh in July, he unveiled the Brilliant Eyes HMD.

“The biggest challenge we couldn’t overcome was the optics. Everything has to be significantly cheaper than what the government is paying,” says Pho, referring to the bulky helmet-mounted monocular displays used by Apache helicopter pilots for targeting.

But the monocular concept, in small, lighter and cheaper form, is the approach Pho and Wysong selected.

With Google and competitors developing glasses with a small LCD screen and close-in focus for under \$500, Aerocross began looking for an optics vendor who could instead collimate the light but keep the costs down.

“Focus at infinity turned out not to be a big deal; it’s just not something the other people had thought they needed,” notes Pho, describing the process in the optics as being similar to adjusting the focus of binoculars. “More of a challenge was finding somebody who would work with us on that.” He says Google was not interested.

won a spot,” says Pho. “It motivated us to get going on the prototype.”

The prototype featured a micro-LCD with LED backlighting (similar to a flat-screen TV) housed on the right side of the glasses as the image source. Light from the image travels through an optical module that focuses the light at infinity and injects it into an optical wave guide built into the glass or polycarbonate right lens of the glasses.

“We think there’s room in the future to build the entire system on a pair of Oakleys”

Pho says about 2,000 people tried the glasses at AirVenture, with “younger folks” having no problem seeing the display and older people “taking longer.” He says “four or five” could not see the image at all. As with any product that interfaces with vision, he estimates there will be a portion of the pilot population that will not be able to adjust to the near-to-eye display or will become nauseated from eye fatigue.

Work is underway on a new proto-

Beyond the Six-Pack

More cockpits being fitted with non-certified avionics operating off-the-shelf software

John Croft **Oshkosh**

Low-cost wireless avionics and tablets are changing the face of flight decks in the experimental aircraft market as builders seek to maximize capabilities and avoid obsolescence of installed equipment. The trend has caught the attention of established avionics makers that build equipment for the certified aircraft.

For an experimental aircraft, which does not require FAA-certified avionics, a builder can replace the traditional “six-pack” instruments—for airspeed, altitude, attitude, heading, compass and vertical speed—and many other features with a single, battery-powered electronics unit not much bigger than a deck of cards.

“Some builders want two iPads on the panel,” says Ruben Leon, president of Levil Technology Corp., which builds attitude indicators for the certified and experimental aircraft markets. “Others say they’re going to put three iPads on the panel. Another will want two Androids.”

Levil’s latest product for the experimental market, the iLevil Plus, provides an attitude and heading reference system (AHRS) using micro-electromechanical system (MEMS) gyros, single-band (978 MHz) Automatic Dependent Surveillance-Broadcast (ADS-B) “in” with wide area augmentation system (WAAS)

GPS for traffic and weather, airspeed via a connection to the pitot and static ports and integrated engine data.

All of the information is transmitted over Wi-Fi to an iPad or Android tablet that uses an off-the-shelf software application to interpret and display it. Given that the iLevil Plus can be mounted in a cradle under the windshield, the device is also covered on its front face with solar cells to help with battery life.

Though an aircraft will likely need radios and a transponder and perhaps an autopilot, systems that Levil does not

build, the bulk of a very capable cockpit can be had for the \$2,000 cost of the iLevil Plus, in addition to the price of a tablet and software. The iLevil Plus is compatible with iPad and iPhone applications from nine vendors, including Bendix King’s MyWingMan navigator. “We try to work with as many software packages as possible,” says Leon.

Leon notes he has not heard of interference problems in any of the 300 iLevil units now in operation. “Surprisingly, there’s been no interference on the Wi-Fi link,” he says. “We haven’t seen any problems on iPads on all the aircraft we’ve tested.” Leon says the Wi-Fi link can be password protected, but no one has asked for that.

Levil also builds MEMS-based AHRS for the certified market through gyro-maker RC Allen Instruments. “We built the AHRS [for RC Allen], starting with certified instruments first,” says Leon. “Then we decided to market [our own

Levil Technology’s iLevil provides all the basic sensor functions, plus WAAS GPS, ADS-B and solar-cell charging, in a compact portable with Wi-Fi connectivity.

AHRS] that communicates with the iPad.” He says Levil has about 3,000 AHRS installed in RC Allen products to date.

Competitor Appareo is selling a similar unit, called Stratus, starting at \$900. Stratus is equipped with dual-band (978 MHz and 1090 MHz) ADS-B, WAAS GPS and AHRS, connecting exclusively to Apple devices over a Wi-Fi link. Stratus does not integrate air data or engine instrumentation, and it works exclusively with ForeFlight’s navigator application for the iPad and iPhone.

Though requiring the operator to use Apple products or ForeFlight might seem limiting, Appareo communications coordinator, John Pedersen, says the opposite is true. “It’s extremely beneficial for us. Our ideologies and vision of the future match together really well,” he notes. “We can do things in terms of quality and control and test-

Along with navigation and surveillance functions, the iLevil can also bring engine data in through a serial interface and out via Wi-Fi to a tablet.



LEVIL PHOTOS

ing that competitors aren't able to do."

For example, he says pilots can update Stratus's firmware or software through ForeFlight, as well as control brightness of Stratus's LED lights, reducing control interfaces. Like Levil, much of Appareo's Stratus business is from the experimental market, though the systems can be used in certified aircraft as a situational awareness aid without FAA approval.

Despite the trend toward portable

sensors and iPads as displays, not all avionics makers in the sector believe Wi-Fi and tablets are the only way forward.

"At its core, [the iPad] is not a piece of avionics," says Mike Schofield, marketing manager for Dynon Avionics, the market leader for integrated cockpits in factory-built light sport aircraft. "It's good as a backup tool, but once you have the right stuff in your panel, you don't really need it too much."

With the exception of transponders, light sport aircraft do not require FAA-certified avionics.

"We look at the iPad area with some fascination," Schofield says. "There's no doubt that tablets and other non-panel devices are becoming an increasing part of people's tool bag, but people are finding they're not really suitable for panel-mounted." Key to that incompatibility, he notes, is that iPads can overheat and shut down. He says

Vertical Progress

Emergency help for experimental aircraft starts with electronic circuit breakers

John Croft Oshkosh

By modernizing a component as rudimentary as a mechanical circuit breaker, Albuquerque, N.M.-based Vertical Power has opened the door to a wealth of new applications and safety features for the experimental market, including an automatic landing system that flies to the threshold. The offering is similar to new systems being developed for high-end business jets, but at a much lower cost.

Marc Ausman, a former product support manager at Eclipse Aviation, launched Vertical Power in 2006 to build electronic circuit breakers for small certified aircraft (Part 23), but he began with the experimental and light sport sectors, where avionics do not have to be approved by the FAA. The company today remains primarily in those sectors, having sold 1,000 VP-X electronic circuit-breaker systems, and more recently, the VP-400 backup electronic flight instrument system (EFIS).

With the VP-X, Ausman has the ability to integrate the electronic circuit-breaker unit with electrical utilities on the aircraft, allowing the operator to augment how those devices are controlled and to minimize costs and wiring as part of the avionics design process. "We can look at the airspeed on the EFIS and say, above that airspeed we are going to run the trim speed more slowly," says Ausman. "Or we can look at fuel pressure and

say, if the fuel pressure drops to zero or dangerously low, we can turn on the boost pump automatically. We can flash the landing lights while you're in the air but make them steady when you're on the ground.

"Because we have an intelligent pow-



Vertical Power's VP-400 split-screen display provides a backup EFIS at the top and a choice of runways within gliding distance at the bottom.



Tap the icon in the digital edition of *AW&ST* for a video with details on the runway-seeker technology built into Vertical Power's

VP-400 for the experimental aircraft market, as well as John Croft's flight evaluation of the core software application, called Xavion, or go to AviationWeek.com/civilvideo

er distribution system, we can now determine what phase of flight an aircraft is in and turn things on and off automatically," Ausman continues. "We can check to see if the aircraft is configured correctly—trim and flaps in the right position, the right devices on or off for that phase of flight. We also have a system that automates the handling of emergency procedures."

On one customer's Lancair Evolution, a 300-kt., single-engine turboprop experimental aircraft, the VP-X powers the avionics, lights, landing gear, climate control, pressurization and deice system.

That customer is Austin Meyer, creator of the X-Plane simulator and owner of Laminar Research. Meyer teamed with Ausman to develop the VP-400.

By coupling Meyer's flight simulation platform with Vertical's electronic circuit breakers with an independent wide area augmentation system (WAAS) GPS and an attitude, heading and reference system, the two created a backup EFIS that, along with attitude and electrical system diagnostics, provides synthetic vision guidance to a destination or to the most suitable runway within gliding distance.

When engaged, the VP-400 will command the autopilot to fly the aircraft to the best-fit runway based on Meyer's Xavion algorithms, assuming a runway is within gliding distance.

Meyer bought the Evolution about

Dynon may be interested in “doing some flight planning” on tablets in the future, but at present, it does not have “interconnectivity” with the devices.

Schofield says Dynon continues to use the “sneaker net” process—plugging a memory stick into the avionics—to update SkyView databases as often as every 28 days. Tablets, in contrast, can receive updates wirelessly anywhere with a Wi-Fi connection.

Aspen Avionics, a builder of certi-

fied avionics for the fixed-wing and helicopter markets, is taking the middle ground, with limited interconnectivity with iPhones and iPads. Aspen’s Connected Panel technology allows for pilots to transfer flight plans and other information to the installed avionics through the company’s CG100 “connected gateway,” priced at \$2,499. The caveat is that the aircraft, to be fully compatible, must be equipped with Aspen primary flight and multifunc-

tion displays and Garmin GNS400 and GNS500 navigation systems.

With the proper kit, however, Aspen says there is no limit to the clever applications that could exploit the links. The company has applications for transferring flight plans from the iPad to the installed avionics and for handling radio-tuning from the iPad. Safety applications include using the iPad GPS function as a backup position reference if the installed systems fail. ☛

three years ago. “It was an amazing aircraft but with steam gauges, mechanical circuit breakers and no automatic landing capability,” he says.

Meyer’s software—also for sale as a stand-alone product for the iPad, iPod and iPhone—uses a synthetic vision display with terrain and obstacles as well as highway-in-the-sky guidance. The software continuously simulates the glide range of the aircraft to all runways within reach based on the glide ratio with the propeller in flat pitch or feathered position. The system computes the most favorable airport for landing based on runway dimensions, aircraft glide characteristics and forecasted winds at altitude and on the ground.

Meyer’s software and the VP electronic circuit breakers are essential ingredients of the VP-400’s “runway-seeker” mode. Engaged by a red button on the panel, the runway-finder mode assumes the engine has failed or is at idle and it commands the autopilot to fly the aircraft to a runway using Meyer’s software, modulating the elevator and flaps to control total energy and configuring the landing gear and other systems. Included on VP-400’s 5 X 7.5-in. touchscreen display is the top-down view of the path to the airport and an energy meter that shows the combined kinetic and potential energy needed to reach the runway selected by the automation or alternatively, to a runway or runway end selected by the pilot.

Above the 2D view is a 3D synthetic vision system that includes speed and altitude tapes, a flight-path marker and highway-in-the-sky guidance that keeps the aircraft at least 1,200 ft. above obstacles. The automation, in theory, will give the pilot time to talk to controllers or debug problems described in the VP-400, which shows



Vertical Power’s VP-X electronic circuit-breaker system, mounted below the floor boards, creates a smart power distribution system for experimental and light sport aircraft.

a schematic of the electrical system and allows for breaker resets.

Aviation Week evaluated the Xavion software system for the iPad in flight on Sept. 22 (see accompanying video). We found the application to be valuable for situational awareness and engine failures, particularly for night flying, though the software does not currently inform the pilot which airports have turf runways or are unlit, features that could be key in choosing a runway if several are available.

The VP-400 software is programmed to return the aircraft to the correct pitch-and-roll attitudes and airspeed from any initial condition, including upsets, thereafter limiting bank angles to 25 deg., if “there are no pitch or roll limitations upon activation,” Ausman

says. “But it is not guaranteed because each experimental aircraft responds differently, and we have not tested it under all conditions with each type of aircraft with each autopilot.”

Meyer says the WAAS GPS altitude and Xavion airport database are not accurate enough to allow for automatic landings. Instead, the VP-400 is designed for a pilot to take back control at 200-400 ft. above the runway. If the system is left engaged, however, it will put the aircraft into slow flight with full flaps and landing gear extended at a GPS speed that is 20% above the aircraft’s stall speed. “We expect, based on thousands of simulations, for the aircraft to belly onto the runway,” says Meyer. “It might take out the landing gear and do some damage, but it will probably be survivable. It works 95 to 98 percent of the time.”

Ausman says he has sold more than a dozen VP-400s to date, but only three aircraft with them are already flying, including Ausman’s Vans RV-7. Meyer says he has tested the VP-400 in his Evolution once and is in the process of fine-tuning the software. He says the roll angle oscillated ± 20 deg., and pitch oscillated ± 10 deg. during the first flight. “We’re refining it,” he says, adding that within a year, his Evolution will be the “ultimate demonstrator” for the VP-400.

Most VP-400 sales have been for new aircraft, Ausman says, but he is beginning to see interest from owners of older aircraft as they ponder panel refreshes. “If you’re going from steam gauge to a modern EFIS, you have to gut the entire panel, so that’s a perfect opportunity to install electronic circuit breakers,” he says. The VP-X is the six-employee company’s best-selling product, with the VP-400 more of a “technology demonstrator” at this stage, according to Ausman. ☛

Opening the Drawer

Household metal becomes a maintainer's dream

John Croft **Oshkosh**

A light bulb went off in Dan Miller's head several years ago as he struggled to complete the avionics behind the panel of his company's newest light sport aircraft, the Spirit Grand Edition. Miller, sales manager for World Aircraft Co., based in Paris, Texas, had an idea that was so obvious it seemed silly that no one had thought of it before.

Miller's problem was all too familiar with anyone who has the need to debug problems, make wiring changes or install or replace avionics behind an aircraft's panel. You must either remove the entire panel via myriad screws and plate, or put something soft and clean on the aircraft floor and then snake your body onto the floor, face up, contorting to put your head under the panel while keeping your arms free to reach up and work on the wires and equipment. Do

not forget to bring a bright light.

Miller had had enough of it. "It was a pain in the butt for us to wire this thing, because every time we'd think we'd gotten it done, or wanted to add another wire or run something differently, we'd be pulling the panel out," he says. "Why don't we just do a pull-out drawer?" Others liked the idea, so Miller says he went to a hardware store, bought some cabinet slides and installed them in the Grand Edition.

The drawer can hold up to 140 lb. of equipment, 70 lb. on each side, and snaps into place using six knobs. Wires that connect to the aircraft were extended by 18 in. to account for the drawer opening and closing, and quick disconnects were added for removing the drawer. Miller says there is no issue with pinching wires when the drawer is opened or closed. The

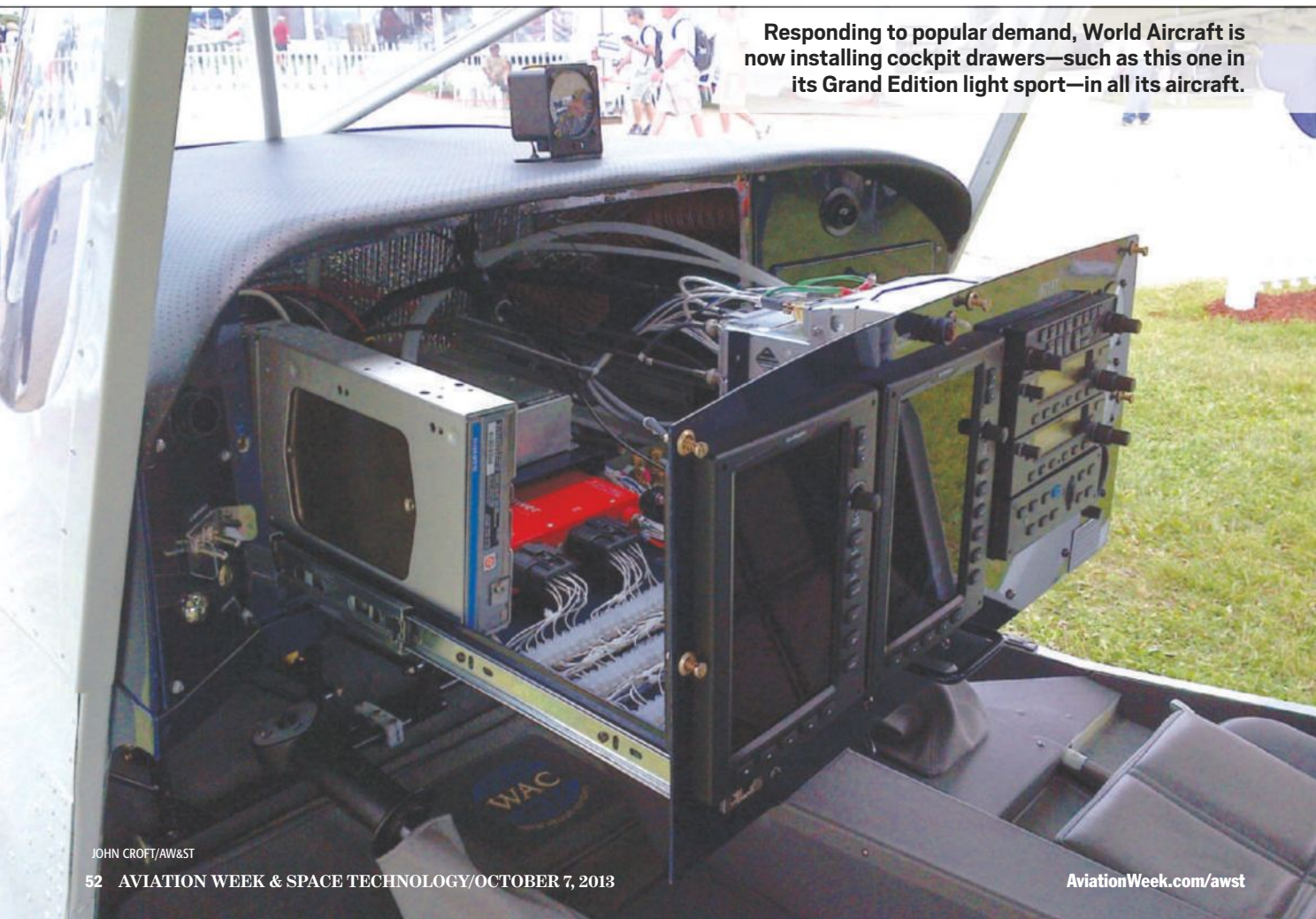
company is now engineering a more permanent drawer that will be 2-3 lb. lighter but will hold the same or more weight, he notes.

World Aircraft had intended to put the drawer in the Grand Edition only, leaving the more basic Vision Sport Edition with a fixed panel to save costs. The 10-year-old company works in partnership with aircraft designer Max Tedesco, based in Colombia. "Max designs the airplanes for us and we build them in Paris," says Miller.

However, response to the drawer at the Experimental Aircraft Association's AirVenture show in Oshkosh in July and the Fifth Annual Midwest Light Sport Aircraft (LSA) expo in Illinois early last month changed the company's position. "We're going to put a drawer in all our aircraft now," Miller says.

The company will not be pursuing a patent on the idea, and he is not sure whether it could be approved by the FAA for a certified aircraft, he notes. "The certified market would take 10 years to do this," Miller adds. "In the LSA market, because we're the manufacturer, we can do what we want." ☛

Responding to popular demand, World Aircraft is now installing cockpit drawers—such as this one in its Grand Edition light sport—in all its aircraft.



Angled Ambition

A small company with innovative designs gains traction in light of AOA safety findings

John Croft **Oshkosh**

Mark Korin's small business in Ramsey, Minn., has been building angle-of-attack indicators for the experimental and light aircraft market in relative anonymity for nearly 18 years.

That is no longer the case, thanks to the findings of an FAA and industry committee that studied light aircraft loss-of-control (LOC) accidents. In a final report issued in September 2012, the government/industry General Aviation Joint Steering Committee ranked installation of angle-of-attack (AOA) indicators at the top of its list of 23 safety enhancements that could help cut the problematic general aviation (GA) fatal accident rate. "AOA systems are not in wide use in GA,"

Minnesota-based DepotStar offers several display options for its angle-of-attack systems for small aircraft, including a "donut" indicator for the optimum approach angle.

the committee concluded. "The GA community should embrace to the fullest extent the stall margin awareness benefits of these systems."

The safety spotlight, combined with only a few companies who sell AOA systems, has quadrupled Korin's business and has led to a new joint venture with a Honeywell subsidiary.

The steering committee's action was not a surprise to Korin, a firm believer that the legacy method of teaching general aviation pilots to avoid stalls based on airspeed alone is flawed. Whereas airspeed is an indirect and approximate measure of the lifting capability of a wing, an AOA indicator provides a direct measure of margin with respect to the critical angle of attack, the angle where the wing will stall regardless of weight, configuration or air density.

Korin's company, DepotStar, builds a line of AOA systems that typically includes a probe (separate from the pitot tube) mounted in place of an inspection plate under the wing, a computer unit and a lighted indicator in the cockpit.

The indicator is mounted where the pilot can see the colored lights (green is good, red is bad) through peripheral vision while maintaining a focus outside. Along with alerting pilots of dangerous AOA angles, the system also identifies the optimum AOA for landing with a lighted circle, a marker the military calls the "donut." Military pilots, particularly in the U.S. Navy, are taught to "pitch to the donut" on approaches, says Korin.

not build a dedicated display for AOA, it does have an audible annunciation. "The time when you're going to use it the most is on short final, when you're trying to minimize your workload," says Mike Schofield, marketing manager for Dynon. "As the AOA increases, you get something that sounds like a Geiger counter mixed with the stall horn—the frequency [of the beeps] increases as the AOA increases."

This summer, Honeywell, through its light-aircraft avionics arm, Bendix King, partnered with Korin to build a new product called the Bendix King KLR10 "lift reserve indicator," an AOA system initially for the experimental market but with an eye on the FAA-certified Part 23 light aircraft sector.

Korin is the "technology partner" for the program, which includes his



JOHN CROFT/AW&ST

Though airliners and business jets come equipped with AOA sensors, the information is typically integrated into the primary flight display and used for automatic stall-avoidance systems, including stick shakers and stick pushers.

For general aviation, Korin says, the primary flight display (PFD) "is the wrong place you want a pilot to be focused on" unless the aircraft is flying in instrument conditions.

One of his competitors, Dynon Avionics, displays AOA on the PFD, but has audible aids to keep the pilot looking outside. A provider of avionics to the experimental and light-sport sectors, Dynon builds a pitot tube with a second hole under the front surface that senses AOA and provides the information to the avionics. While Dynon does

sensor, computer and indicator, re-designed by Bendix King to show the ideal-approach AOA, also known as the "blue meatball," as well as yellow and red AOA indications and audio alerts for the normal, caution and action-required AOA zones.

Bendix King is selling the KRL10 for \$1,600 for the experimental market, but is waiting to see how the FAA will finalize with a planned modernization to Part 23 light-aircraft certification standards before entering that market.

The FAA is considering moving to ASTM consensus standards for certain aspects of Part 23 certification, which would list an AOA installation as a minor modification to a certified aircraft, eliminating the need for a costly supplemental type certificate. ☛

From the Ground Up

Grassroots movement builds to keep Thunderbolt II in flight

Jen DiMascio **Washington**

Now that the Air Force has placed the A-10 Thunderbolt II under consideration for cuts in a worst-case budget scenario, a grassroots movement is building to keep the aircraft, flying since 1977, around longer.

The A-10 is not one of those programs, like the F-35 Joint Strike Fighter or the KC-46A tanker, that the ser-

The up-with-the-A-10 crowd was present at a recent 40th anniversary gathering of the "Fort Myer Round Table," a Wednesday night happy hour at a bar on the Virginia military base that many of the Joint Chiefs of Staff call home.

The Pentagon's former top testing and evaluation official, Tom Christie, organized the event that was attended

Coram himself recently published a column on the Project on Government Oversight's website articulating the case: "No \$160 million F-35 is going to get down in the weeds where a single bullet can take it out. A host of small arms fire hitting an A-10 can be fixed with what amounts to duct tape," Coram writes. "No F-35 can maneuver under an 800-foot ceiling with two-mile visibility as can an A-10. No F-35 has more than three combat trigger pulls before running out of ammo. The A-10 has twenty. No F-35 has the battlefield survivability of the A-10."

Whether the efforts will make a difference within the Pentagon remains to be seen as high-level budget politics on Capitol Hill and in the Obama administration are sorted out.

But lawmakers have been working to maintain the A-10 fleet, at least in the short term.

Last year the Air Force recommended carving out nearly a third of the A-10 fleet, much of it from the Air

Lawmakers are asking whether the military would face a gap in close-air support if the A-10 is scrapped.

National Guard. Congress slowed that suggestion by creating the National Commission on the Structure of the Air Force.

This year, the Senate Armed Services Committee is already looking for a definitive comparison between the F-35 and the A-10. The committee's version of the fiscal 2014 defense authorization bill calls for a report on whether retiring A-10s would lead to a gap in close-air support for troops before F-22s and F-35s can pick up that mission.

That is the same line of questioning that led Sen. Kelly Ayotte (R-N.H.) to place a hold on the nomination of Deborah Lee James to replace Michael Donley as secretary of the Air Force.

During James's confirmation hearing, Ayotte said 60 soldiers were saved in Afghanistan in July because of the close-air support provided by A-10s. She asked about an Air Combat Command slide showing the A-10 fleet would be divested by 2015.

"I am a strong supporter of the F-35," Ayotte said. "But until the F-35 is operational, we can't be giving up our important capacity that protects our troops." ☐



USAF

vice wants to protect. In fact, a chart from Air Combat Command shows the entire fleet of close-air support aircraft may be divested by 2015.

The A-10, affectionately known as the Warthog, does have a following. The lumbering aircraft was designed to loiter over the battlefield until it unleashes firepower that can shred through tanks. Originally made by Fairchild Republic, it carries a 30 mm Gatling gun that can fire up to 3,900 rounds per minute. The service's A-10s can carry all kinds of bombs, including laser-guided ones, joint direct attack munitions, and the AIM-9 Sidewinder. Ground troops love it.

They are not alone. From a Save-the-A-10 Facebook page with 2,722 likes, to the back room of a military base bar and even on Capitol Hill, the proposal to scrap the aircraft is meeting resistance.

by generations of Pentagon watchdogs, including Winslow Wheeler and Pierre Sprey. After having met for 40 years, Christie encouraged some of the younger, active-duty members of the crowd to continue working within the Pentagon to change the process of buying weapons. And he urged those currently working in the Pentagon to find "top cover" for their efforts.

Discussion at the long-running meeting centered on two topics: A book by Robert Coram, *Boyd: The Fighter Pilot Who Changed The Art of War*, that many there see as a handbook to navigating the Pentagon bureaucracy and buying less costly weapons that make more sense. The second, related topic was how to promote alternatives to the F-35 Joint Strike Fighter—namely the Navy's F-18 and the Air Force's A-10.

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Future Events

- Oct. 9**—MRO IT Europe. Amsterdam.
Oct. 29-31—MRO Asia. Singapore.
Nov. 6-8—SpeedNews' 18th Annual Regional & Business Aviation Industry Suppliers Conference. Scottsdale, Ariz.
Nov. 12-14—A&D Programs. Phoenix.
Jan. 21-22—MRO Latin America. Rio de Janeiro.
Feb. 4-6—MRO Middle East. Dubai.
Feb. 10—Air Transport World's 40th Annual Airline Industry Achievement Awards. Pan Pacific Singapore Hotel.
March 3—SpeedNews' Fourth Annual Aerospace Raw Materials & Manufacturers Supply Chain Conference. Beverly Hills, Calif.
March 3-5—SpeedNews' 28th Annual Commercial Aviation Industry Suppliers Conference. Beverly Hills, Calif.
March 4-5—Defense Technology and Affordability Requirements. Washington.
March 6—Aviation Week's Laureate Awards. Washington.

Aerospace Calendar

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- Oct. 14-21**—AUSA Annual Meeting. Washington Convention Center. See <http://ausameetings.org/annual/>
Oct. 22-24—National Business Aviation Association Convention and Exhibition. Las Vegas. See www.nbaa.org/events/name/
Oct. 22-25—24th Annual NHA Gulf Coast Fleet Fly-In. NAS Whiting Field, Milton, Fla. For more information, contact charles.m.cunningham@navy.mil
Oct. 23—Aerospace Components Manufacturers Inc. Hartford/Windsor Airport Marriott Hotel. Windsor, Conn. See www.aerospacecomponents.org/page3643.html for more information.
Oct. 23-24—JDA Aviation Technology Solutions Regulatory Affairs Training Course. Bethesda, Md. For details and registration information, see www.jdasolutions.aero/services/regulatory-training.php or contact Nina Acosta at 301-941-1460 ext. 110.
Oct. 29-31—Third Edition of the World Passenger Symposium. The Convention Center Dublin. See www.iata.org/events/passenger-symposium/Pages/index.aspx
Oct. 29-31—Seventh Annual European Flight Test Safety Workshop. Amsterdam, www.setp.org/table/european-workshop/
Nov. 5-7—National Defense Industrial Association Aircraft Survivability Symposium. U.S. Naval Postgraduate School, Monterey, Calif. U.S. personnel only. Further information will be posted at www.ndia.org/meetings/4940/Pages/default.aspx
Nov. 5-7—22nd Avsec World Conference. Hilton, Istanbul. See www.iata.org/events/Pages/avsec.aspx
Nov. 13-15—10th ALTA Airline Leaders Forum 2013. Cancun, Mexico. See www.altairlineleaders.com
Nov. 17-21—Dubai Airshow. See www.dubaiairshow.aero/

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Seizing the Lead, Literally



Zsolt Rummy is founder, CEO and chairman of Zoltek Companies Inc., which recently entered into an agreement to be acquired by Toray Industries.

Small business has been the great incubator of technological innovation throughout most of U.S. industry. But not in the defense industry. One reason is the normal rules of commercial contracts do not apply to defense contracting. The federal government can “take”—i.e. seize—whatever technology it wants from a U.S. company, including patented technology, and it can hide behind the excuse of military secrecy in refusing to provide constitutionally guaranteed “just compensation” for the public use of private property.

I know about this problem firsthand, as the founder and largest shareholder of a company denied monetary compensation for a significant contribution to the success of two second-generation stealth aircraft—the B-2 bomber and F-22 fighter.

Our patent (issued in 1988 and reissued in 1993) relates to the production of specifically designed carbon fibers as radar-absorbing material (RAM),

“The government can take whatever technology it wants from a U.S. company and hide behind military secrecy in refusing just compensation.”

one of the key developments that made it possible to build large aircraft that are almost invisible to radar.

The now-retired F-117 Nighthawk—which entered service in 1983 as the first operational stealth aircraft—was a compact mass of jutting angles designed to deflect radar. The F-117 also employed a radar-absorbing material, but its RAM, made from a nonhomogenous mixture of glass and carbon fibers, was only minimally effective. Our patented technology made the F-117 RAM technology obsolete.

Through a novel method of manufacturing, using only carbonized material (no glass fibers), we demonstrated the ability to produce carbon fiber sheets of controlled, uniform surface resistivity—within a wide range of desired values measured in ohms/square centimeter for different parts of the aircraft. With that, it became possible to make radar signals disappear by converting a significant portion of their electromagnetic energy into heat.

This was a true breakthrough, and Northrop—the prime contractor for the B-2—recognized it as such.

In August 1987, George Rodgers, a top engineer at Northrop, sent us a letter that explicitly stated: “[Your] product was unique . . . Northrop purchased four different levels of resistivity ranging from 24 to 3,000 ohms/square. At the time the order was placed, Northrop Materials & Processes had never seen a material of this type before and was not aware of any other company that could supply material in this form with varying electrical properties.”

The B-2 flew in 1989 and entered service in 1997. The F-22 flew in 1997 and entered service in 2005. It also uses carbonized RAM with zero glass. How to make that is spelled out in our patent.

To date, the government has spent well over \$100 billion on the two programs. But it has not paid a dime to Zoltek over and above the few thousand dollars that we received from Northrop for test samples.

After more than 11 years of litigation, the government first invoked what is known as the “secrecy privilege” in 2007 to block Zoltek’s discovery of conduct infringing our patent in building the B-2 bomber. Then, earlier this year, it invoked the privilege again in the case of the F-22. In effect, the government is using—and abusing—the privilege as a Catch-22, telling us: “For you to prove your case in a court of law, we would have to divulge information to you, and we won’t do that. We won’t answer any of your questions.”

And just what is this privilege? It dates back 60 years. In 1953, the U.S. Supreme Court recognized the state-secret privilege in *U.S. v. Reynolds*. Pointing to the Fifth Amendment, which states that “private property (cannot) be taken for public use without just compensation,” the court warned that state secrecy is “not to be lightly invoked.” Nevertheless, at this critical stage of the Cold War, the court accepted on faith the government’s assertion of need for secrecy in refusing to release an accident report on a deadly airplane crash.

Almost 50 years later, in 2000, the truth came out. Relatives of people killed in the crash found a copy of the original accident report. There were no state secrets in the report. But there was clear evidence of negligence on the part of the Air Force. It, however, was too late for relatives to sue the government.

But it is not too late for our justice system to recognize—and correct—abuse of the secrecy privilege as a means of strong-arming smaller companies that do not have large lobbying organizations in Washington. The government itself will benefit from vigorous development of new technologies if it is prepared to treat smaller, entrepreneurial companies with the respect that they deserve in being compensated for use of game-changing technology. ☛

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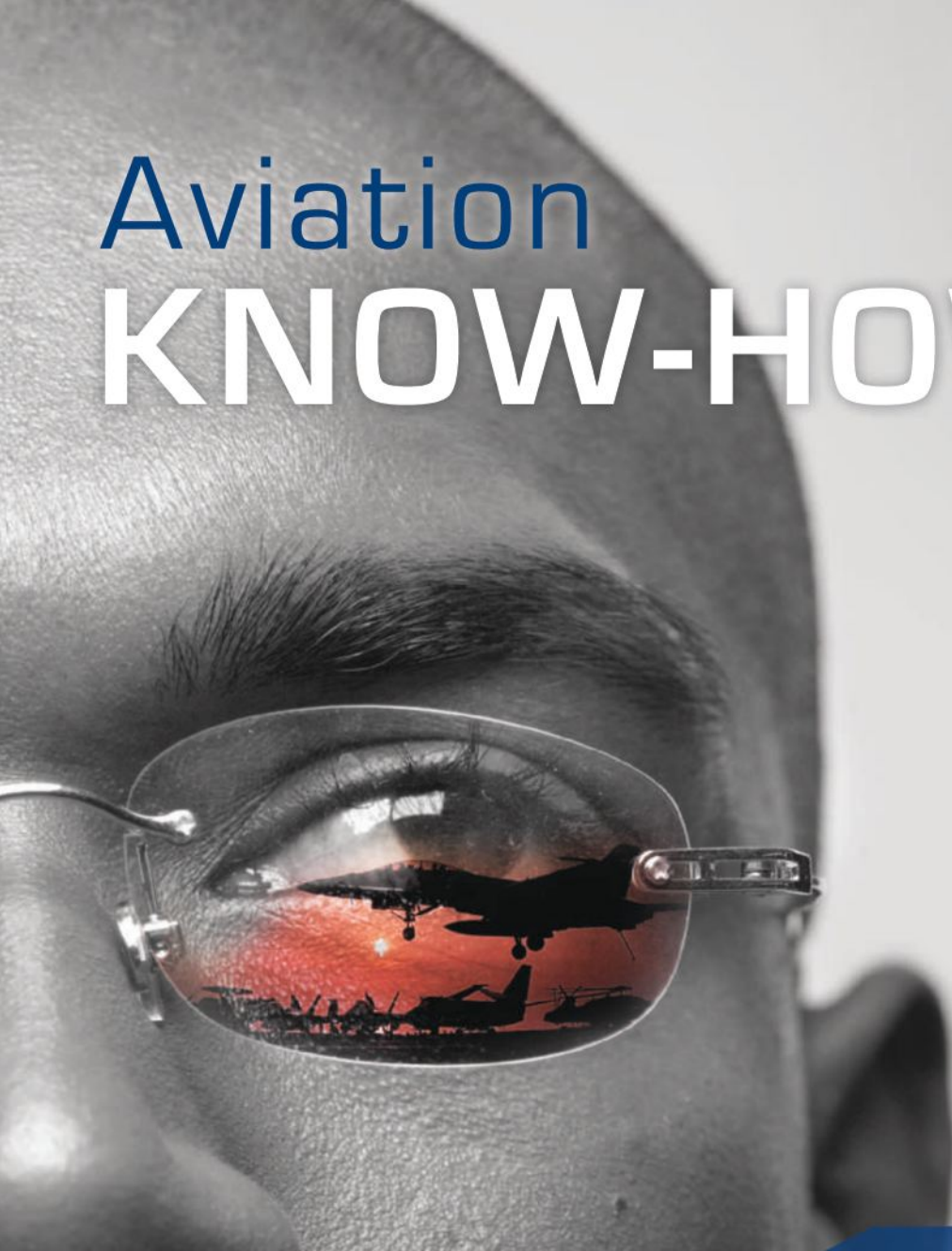
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