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Fire trucks wait on a runway at Takamatsu, Japan, after an All Nippon Airways Boeing 787 made an emergency landing following an inflight incident with an apparently overheated lithium-ion battery. Passengers evacuated via the deployed emergency chutes.



REUTERS/KYODO/ANDOV

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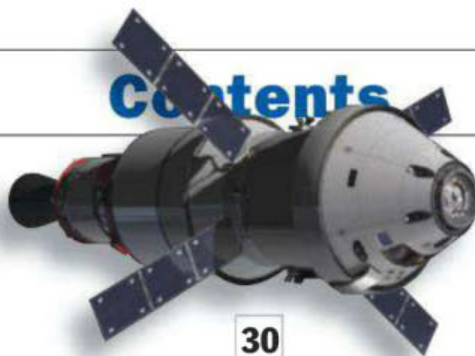
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Week On The Web

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

Web readers weighed in on the **problems facing Boeing** after all eight 787 operators grounded their fleets following a battery fire in Boston and emergency landing in Japan (p. 22). Keep up with the latest 787 developments on our **commercial news channel** ow.ly/gUg8K

AIR DEFENSE TEST

The Kuwaiti air defense brigade has been testing MBDA's Aspide 2000 surface-to-air missile. ow.ly/gUivb



F-35 DEBATE

The debate about F-35 sustainment has taken a new turn, with the focus now shifting to costs per flying hour. **Readers debated the numbers on our Ares blog.** Will this be a key issue to watch in 2013? ow.ly/gRiwC

READER COMMENT

On Angela Merkel being named as Aviation Week's Person of the Year: DWG wrote: "I think my eyebrows climbed past their altitude ceiling when I read the announcement on Twitter." ow.ly/gRj2S



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The image is a vertical split-screen composition. The top half shows the front of a large commercial airplane flying towards the viewer. The left side of the image (daytime) shows the plane against a blue sky with white clouds, flying over a green, hilly landscape. The right side of the image (nighttime) shows the same plane against a dark, starry sky, flying over a brightly lit city skyline at night. The text is overlaid on the top half of the image.

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CALL FOR A CRASH TEST

In "Electric Shock" (AW&ST Jan. 14, p. 19) about Japan Airlines' Boeing 787's lithium-ion auxiliary power unit (APU) battery explosion incident at Boston Logan International Airport, there appears this comment: "The fire caused 'severe fire damage' to the aft electrical/electronics bay in which the battery—one of two on the 787—is located, states the NTSB."

However, consider that when fire broke out inflight in the rear electronics bay of a flight-test 787 in 2010, it triggered loss of some aircraft system functions.

And last fall, 787s flying for United Airlines, LAN and Qatar Airways all experienced inflight problems with

consequences related to composite flexibility and toxicity.

The NTSB should purchase Boeing's retired ZY 997 prototype 787 airframe to conduct a remote-controlled test crash to ascertain the airframe's breakup sequence and severity as well as flammability repercussions.

Airbus's A350, with an equivalent amount of composites, is hard on Boeing's heels. These new-generation aircraft should be more vigorously crash-tested now, before it is too late. *Lee Gaillard*

SARANAC LAKE, N.Y.

(Boeing states it has conducted extensive tests that indicate composite fuselage structures do not sustain combustion or propagate fire, nor do they radiate heat to the same degree as aluminum structures—Ed.)

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at McDonnell Douglas, just before Boeing acquired it in 1997. The F/A-18E/F is available off-the-shelf and presents a smaller transition training leap for pilots and ground crews.

● The RCAF also needs to rebuild capability in maritime/Arctic patrol, reconnaissance and electronic warfare.

On Feb. 20, 2008, the 50th anniversary of the cancellation of the Avro CF-105 Arrow by the Conservative government of John Diefenbaker, I gave a lecture in Ottawa on what would have happened if we had continued with the Arrow. In short, we would have earned billions in foreign currency and would still be a major aerospace power. We would doubtless still be building our own fighters and most likely fielding an RCAF with at least 30 (front-line and reserve) combat-capable fighter squadrons. National security cannot be procured on the cheap, a fact totally lost on the Tories of 1959, 1990 and 2013.

Dan Perley
COSTA MESA, CALIF.

HEED THE PAST

Your editorial "Don't Misinterpret Entrants' Slow Pace" (AW&ST Nov. 19, 2012, p. 58) should be posted in the office of every U.S. aerospace company.

Twenty years ago, when I worked in the automotive industry, a highly respected trade publication published a similar editorial warning about the appearance of new competition from South Korea and the need for the "Big Three" U.S. automakers to take the threat seriously. None of them did and we all know the results. That apathy—especially knowing that we had already been bested by Japan in that realm—has always amazed me.

In the end, it comes down to complacency on our part. The fact that the South Koreans were new to the industry was not a weakness, but a strength. They were starting with clean sheets and engineers and designers who were free to imagine entirely new vehicles

Continued on page 10



their power-distribution panels.

In this all-new aircraft you have brand-new engines; highly computerized flight-control and aircraft system management programs; huge electric power-generation increases and pioneering use of lithium-ion batteries prone to bursting into flame when overcharged; and an all-composite fuselage contributing to a total composite usage larger than on any previous commercial aircraft.

It took Logan airport's firefighters 40 min. to subdue that battery explosion and fire; it took a Laredo, Texas, ground crew to extinguish the power control panel fire in 2010. What if both aircraft had been flying at 35,000 ft.?

Keep in mind that all-composite fuselages have never been tested under crash conditions and there are dire

CANADA NEEDS THE JSF

The latest F-35 Joint Strike Fighter debate is surely raising the ire of Royal Canadian Air Force pilots from the era when it was still a world-class service. However, if we expect to remain a huge land mass controlled by a puny middle power with a relatively tiny population, we need a large and capable air force. Unfortunately, our politicians are out of touch with this and the following facts.

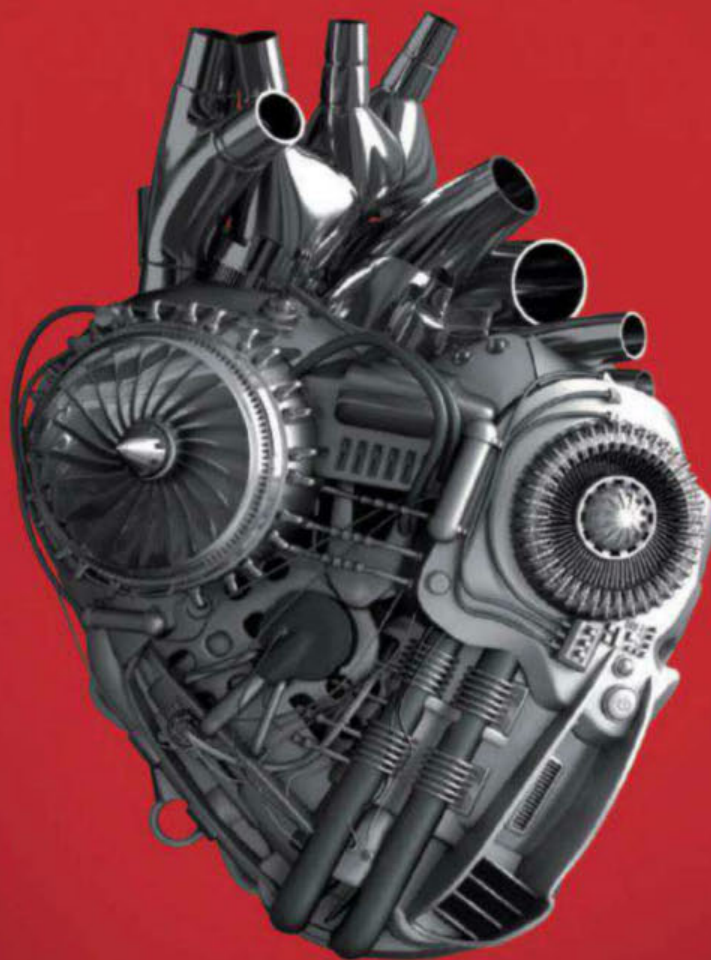
● During the first Persian Gulf war the Tory Cabinet promised the U.S. five squadrons of CF-18s, even though this was physically impossible. Fifty years of cost-cutting and neglect almost decimated the RCAF, and reverting back to its old name won't fix the problem.

● Making—and keeping—the peace now requires suppression of tin-pot dictators and terrorists, none of whom have good air forces, and on whom we can most efficiently use crushing (not token) airpower to control. Canada hasn't contributed its fair share of Western aerial might since the 1960s.

● Canada was an industrial member of the Lockheed Martin F-35 program, with a large investment, long before we ordered the production aircraft. Stay the course. Yes, it is a troubled program so the answer is to slow down and phase in our aircraft buy over more years while the program slowly matures.

● In the meantime, admit that the CF-18A/B Hornet is ready for museum duty and replace them with the (much less costly) Boeing F/A-18E/F Super Hornet. This well-managed program came in under budget/ahead of schedule

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Jeff Fegan (see photo), CEO of *Dallas/Fort Worth International Airport*, plans to retire Sept. 1. He has worked at DFW for 28 years, the last 19 years as its CEO.

Michael McCann will become CEO of U.K.-based *GKN Aerostructures*. He has been senior VP-business development and strategy, a role that will be filled by **Charles Paterson**. Paterson was general manager at the company's facilities in Filton, England.

Jean-Bernard Levy has been elected chairman and CEO of Neilly-sur-Seine, France-based *Thales*, succeeding **Luc Vigneron**, who has resigned.

Michael Kurth (see photos) has been named VP and general manager of *Boeing's Unmanned Airborne Systems Programs*, based in St. Louis. He is currently managing director of Boeing Defense U.K. Ltd. **David Pitchforth**, managing director of U.K. Rotorcraft Support, a division of Boeing Global Services & Support, will succeed Kurth.

Stephen Young has been appointed CEO of U.K.-based aerospace compa-

ny *Meggitt*, succeeding **Terry Twigger**, who plans to retire. Young has been finance director since 2004.

Richard Hildenbrand has been promoted to president from executive VP of Burbank, Calif.-based *Avjet Corp.*, succeeding **Mark Lefever**, who has become chief operating officer.

John Turner (see photo) has been appointed director of engineering at Denton, Texas-based *Odyssey Aerospace Components*. He has worked for NASA, American Airlines, Associated Air Center and Weber Aircraft.

Gareth Hall (see photo) has been promoted to president and managing director of Chatsworth, Calif.-based BBA Aviation's *Ontic* subsidiary. He was managing director of *Ontic U.K.*

Joan Pompa has been named interior refurbishment sales manager for *West Star Aviation's Grand Junction*, Colo., facility. Pompa has a 13-year career in interior, paint, design and other maintenance operations.

HONORS AND ELECTIONS

Steven Udvar-Hazy, chairman

and CEO of *Air Lease Corp.* and former head of the *International Lease Finance Corp.*, has been named the recipient of the 2012 *Howard Hughes Memorial Award*, presented by the Los Angeles-based *Aero Club of Southern California*. The award honors an aerospace leader whose accomplishments over a long career have contributed significantly to the advancement of aviation or space technology.

USAF Lt. Gen. **Larry D. James**, deputy chief of staff for intelligence, surveillance and reconnaissance, and **Douglas L. Loverro**, executive director, Space and Missile Systems Center, Air Force Space Command, have been named to receive the *Stellar Award for Government Service*, presented by the New York-based *Society of Satellite Professionals International (SSPI)*. The two leaders are being honored for "their dedication to unifying the requirements and capabilities of the commercial and military space ventures," SSPI says. ☺

Feedback

Continued from page 8

beyond the confines of legacy products. Hungry to enter the market, they worked night and day to be successful. Our domestic industry was too focused on short-term profits to meet the Asian challenge. Was every Asian model successful? No. There were initial quality issues and some designs simply did not appeal to the public.

However, free-market forces pruned the failures and the Asians learned lessons from each failure.

Customers benefitted from more choices. As the competitive bar was raised in every way, we were forced to improve our products as well.

Commercial aircraft are arguably more important to the U.S. than automobiles—not just in absolute dollars—but for the technology demanded

by each new generation. That leap of engineering and scientific prowess has far greater impact across our entire economy than that of their surface-bound counterparts.

Imagine what commercial aircraft we would have today if Douglas, Convair, Lockheed and Martin had been willing and/or able to independently stay in the commercial airframe business. Although loved by Wall Street, the problem with mergers and consolidations is that the various creative forces of separate organizations are funneled under fewer and fewer umbrellas. Competition is a good thing, but Boeing had better be prepared for rain.

Joseph Davis
PEORIA, ARIZ.

FAR-SIGHTED LEGACY

In 1970s, then-Swissair moved its pilot training from the U.K. to Vero Beach,

Fla. I remember Al Ueltschi being keen to sign up the airline as a customer since his ancestors came from Switzerland! When we made the transition from the U.K. (CAE) to the U.S., I enjoyed a few years of working closely with the flight-instructor group of *FlightSafety International*, under the leadership of his son Jim. I also admired Al's acumen in helping to treat blindness around the globe. Your tribute was well-deserved (*AW&ST* Oct. 29, 2012, p. 20).

Werner Naef

WAIKANAE BEACH, NEW ZEALAND

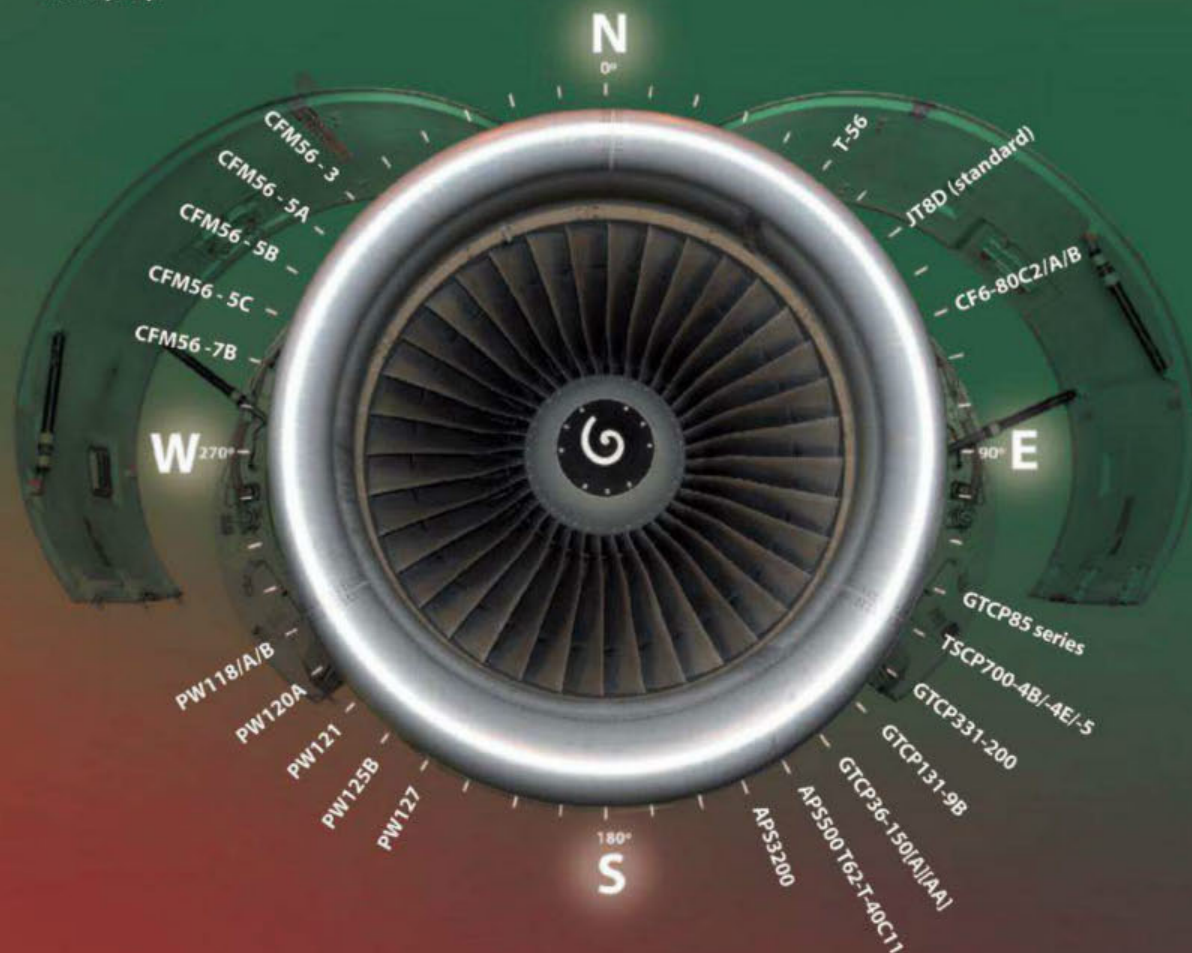
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DEFENSE

Indian Antiship Missiles

India plans to buy medium-range, anti-ship missiles for its navy, and is polling industry on its options. The defense ministry has issued a request for information for the missiles, which must have a range of at least 120 km (75 mi.). Once prospective vendors respond, they will have to be cleared by a technical evaluation committee. Selected systems will then undergo field trials on a no-cost/no-commitment basis. The navy already has inducted a version of the BrahMos supersonic cruise missile into service, along with the nuclear-capable Dhanush ballistic missile.

Ford Radar Concerns

The U.S. Navy needs to reinvestigate testing plans at its Wallops Island, Va., site for its proposed radar system for the new CVN-78 Gerald R. Ford aircraft carrier, according to the latest annual report from the Pentagon's director of operational test and evaluation (DOT&E). The Navy has proposed a dual-band radar that replaces five legacy radars used on current carriers. Last year, DOT&E cited concerns about the Navy's plans to curtail testing at Wallops for a similar radar system then proposed for the DDG-1000 Zumwalt-class destroyer.

Horner AESA Questioned

While the active, electronically scanned array (AESA) radar offers improve-

ments for F/A-18 aircraft operations, the DOT&E is questioning the degree of improvement over the legacy system. "The APG-79 AESA radar demonstrated marginal improvements since the previous DOT&E (follow-on operational test and evaluation) period and provides improved performance relative to the legacy APG-73 radar," DOT&E notes in its latest annual review. "However, operational testing does not demonstrate a statistically significant difference in mission accomplishment between F/A-18E/F aircraft equipped with AESA and those equipped with the legacy radar."

Green Light for Gripen E

The Swedish government has given the country's armed forces the go-ahead to procure the next-generation version of the Gripen fighter aircraft. Defense minister Karin Enstrom said on Jan. 17 that the armed forces would buy 60 Saab JAS-39E Gripens for an as-yet undisclosed price. The first aircraft would be delivered in 2018 with the full complement by 2027.

New T-X Team

Alenia North America and General Dynamics are teaming to vie for a U.S. Air Force contract to build 350 T-38 fast-jet trainer replacements, rounding out the likely field of would-be competitors for T-X work. Alenia North America will provide the Alenia Aermacchi M-346—dubbed the T-100 for the U.S. sales campaign—while General Dynamics C4 Systems will handle prime contractor

responsibilities, including subcontractor management and systems integration, based on a letter signed by both companies. The team is likely to compete against the Northrop Grumman/BAE venture offering the Hawk, a Lockheed Martin/Korea Aerospace Industries team proposing the T-50 and a clean-sheet design being developed by Boeing.

SPACE

Space Agency Chief Resigns

Steve MacLean, president of the Canadian Space Agency (CSA), will step down Feb. 1 to take a private position in research physics. Selected in 1983 as one of the first eight Canadian astronauts, MacLean was program manager on the Advanced Space Vision System used to guide Canadian-built robotic arms on the space shuttle and International Space Station. He tested the system in space as a payload specialist on STS-52 in 1992, and later used it to operate the station's Canadarm2 on the STS-115 assembly mission in 2006. He was appointed head of the CSA in 2008, to a term that was set to end in September.

Russian Moon Probe

Reuters reports that Russia will resume a long-dormant quest to explore the Moon by sending an unmanned probe there in 2015. The craft, called Luna-Glob, or Moon-Globe, will be carried by the first rocket to launch from a new facility that Russia is building in its far eastern Amur region. Prime Minister Dmitry Medvedev

Speea, Boeing Continue to Parry

A sweetened pay proposal from Boeing was met with a counterproposal from the Society of Professional Engineering Employees in Aerospace (Speea) as the two resume talks—halted in December—on a contract through 2016, which takes the manufacturer past all of the production rate increases it currently plans.

Boeing Commercial Airplanes Vice President Mike Delaney outlined a revised two-tier wage proposal, but says the company is leaving intact health and retirement plans proposed earlier for the 23,000 engineers and technical staff that Speea represents at BCA factories in Washington, Oregon, California and Utah.

Delaney, BCA's chief engineer, is deeply involved in the FAA's investigation of 787

flight-safety issues (see p. 22). Citing that crisis, Speea responded with a "best and final offer" that it called "unprecedented" that retains elements of the current contract. Without such a move, the two sides are likely to face "protracted and increasingly contentious negotiations that appear headed for a strike," Speea states.

Without specifying, the union appears to want to leave in place current elements of defined pensions and health care that Boeing has fought for more than a decade to change. The company wants to increase employee payments in health care and shift new hires away from defined pensions toward an employee-directed and company-backed 401(k) investment plan. The manufacturer's engineers' and machinists' unions have managed to fend off these attempts. The company's tiered-wage proposal also

is a sticking point for Speea, which insists it wants bigger raises equally applied for engineers and technical workers.

The engineering pay pool averages 5% for 2013-14 and 4% for 2015-16. For the average engineer, who earns \$110,000 now, the raise would bring an additional \$85,600 over the life of the agreement, Delaney says.

The pay pool for technicians would increase 4% over the full four-year contract, with a 1% lump sum payment in 2013 and 2014. The company says the average gain in direct pay and incentives for tech workers will be \$61,200 over the life of the contract.

Delaney says the proposals are "market-leading by every definition," but Speea's position is that the whole package—wages and benefits—is inadequate given the company's solid 4,000-aircraft backlog, earnings and double-digit pay raises for executives.

approved a plan in December to spend the equivalent of \$70 billion on space industry development through 2020.

Indian Mars Mission

India is on track to launch its first Mars orbiter in November, says a senior scientist in charge of the mission. The unmanned satellite, named Maangalyaan, will be expected to aid a study of the thin Martian atmosphere to determine the existence and sustainability of life, and focus on climate, geology, origin and evolution of the planet, the scientist at the Indian Space Research Organization said earlier this month. The spacecraft will be boosted by a Polar Satellite Launch Vehicle that was used for the Chandrayaan-1 Moon mission.

ROTORCRAFT

Helo Crash Prompts Review

U.K. officials are calling for a review of helicopter operations over London following the fatal crash of an Agusta A109 on Jan. 16. Two people, including the pilot, died when the aircraft struck a crane in poor weather. Kate Hoey, member of Parliament for the area of London where the helicopter crashed, called for an examination of "where and how and why helicopters fly through our city," particularly with London's rising skyline.

AW159's Turn in Korea

AgustaWestland has secured its first export order for the AW159 Wildcat with a sale of eight to South Korea. The deal, which also includes a support and training package, is worth \$560 million. AgustaWestland's share is worth \$360 million. The Wildcat was selected over the Sikorsky MH-60R Seahawk, which had beaten the Wildcat to a nine-aircraft order in Denmark in November. The Wildcats will be used for anti-submarine and anti-ship warfare, maritime security, and search and rescue.

Huey Turnaround

Bell Helicopter has delivered its 100th of 349 H-1s to the U.S. Marine Corps—80 ahead of schedule—after earlier challenges in producing the upgraded UH-1Ys and AH-1Zs, says Maj. Gen. John Croley, assistant deputy Marine commandant for aviation. The service and Bell have negotiated the terms of a second multiyear procurement, worth roughly \$1 billion, he adds. And, the



NASA Funds Trials Of Inflatable Habitat

NASA will pay Bigelow Aerospace \$17.8 million to test this subscale inflatable habitat module at the International Space Station, using instruments and station crewmembers to study whether the technology will allow the housing of astronauts and their gear on their way to Mars.

Under the two-year contract, the Las Vegas-based company is expected to deliver a Bigelow Expandable Activity Module (BEAM) in a folded configuration that can be attached to an unmanned

SpaceX Dragon capsule bound for the ISS with a load of cargo in a mission now scheduled for 2015. Once the Dragon is berthed at the station, crewmembers there will use the Canadarm2 to transfer it to a port on the Tranquility node, where it will be inflated into a 13 X 10-ft. cylinder, using air it brings along.

The hatch between the inflatable module and the rest of the station normally will be sealed, although station crewmembers will enter the inflatable module periodically to collect data. Instruments there will be expected to measure temperature, radiation levels and the module's ability to maintain pressure even if its multilayer skin is penetrated by orbital debris or a micrometeoroid too small to track from the ground and avoid.

Founded by real estate entrepreneur Robert Bigelow, the company already has two small free-flying inflatable testbeds in orbit, and has been in discussions with NASA for at least two years about additional testing at the ISS (AW&ST March 7, 2011, p. 26). "Using the station's resources, we'll learn how humans can work effectively with this technology in space, as we continue to advance our understanding in all aspects for long-duration spaceflight aboard the orbiting laboratory," says William Gerstenmaier, associate NASA administrator for the human exploration and operations mission directorate, which is funding the experiment.

Corps is expected to save roughly that much in cost avoidance by signing up to a five-year deal.

AIR TRANSPORT

EFB Upgrade

Boeing is upgrading software for electronic flight bags to make it less costly and easier for airlines to standardize systems across their fleets without expensive hardware upgrades. The first application will become operational in the second quarter on Air France's 747-400 fleet. The upgrade applies only to software and focuses on third-party Class 2 installations, which Air France uses extensively. Air France's head of flight operations engineering, Jacques Verrier, says by allowing its EFB software to work on multiple EFB platforms, Boeing is helping the carrier meet cost and operational efficiency needs. Previously, Boeing's EFB offerings tied hardware to software. But customer feedback underscored how much pressure airlines face to respond to changes in technology on limited budgets.

OBITUARY: D. Brainerd Holmes, who led NASA's human spaceflight effort in the early 1960s, died Jan. 11 in Memphis, Tenn., of pneumonia. He was 91.

An experienced executive who was trained as an electrical engineer at Cornell University, Holmes was project manager at RCA for the Ballistic Missile Early Warning System. He became NASA's director of manned spaceflight in October 1961, after President John F. Kennedy set a goal of landing men on the Moon by the end of the decade. Holmes was named deputy associate administrator for manned spaceflight centers in October 1962, but resigned in June 1963, reportedly because of policy conflicts with Administrator James Webb over the scope of his authority to manage the Apollo program. During his tenure at the U.S. space agency, Holmes flew four orbital Mercury missions, beginning with John Glenn's historic Friendship 7 flight, and started work on the large launch vehicle and orbital rendezvous techniques that enabled the lunar landings.

After leaving NASA, Holmes joined the Raytheon Corp., retiring in 1986 as its president. He later was chairman of what was then Raytheon's Beech Aircraft unit.



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DAVID B. GLEASON

COMMENTARY

Exports No Cure For Budget Woes

Slow growth seen for foreign military sales

Ask a top U.S. aerospace and defense (A&D) contractor how it plans to offset potentially deep cuts in Pentagon budgets and you will hear a common refrain: exports. **Lockheed Martin** is aiming to raise non-U.S. sales to 20% of its total, up from 17% today. "International" sales already account for a quarter of **Raytheon's** business, and the company intends to drive that even higher. "We see a lot of growth in the Middle East and Asia-Pacific," says Marillyn Hewson, Lockheed Martin's new CEO.

But a new report by Deloitte Touche Tohmatsu cautions that such sales will remain too low for the foreseeable future to offset cuts in the U.S. defense budget, despite increased military spending in Asia, the Middle East and Latin America.

The reason is the sheer size of the U.S. military spending. Though Deloitte expects the defense budget to decline \$24-50 billion annually—depending on how the budget debate in Washington

shakes out—it will remain 5-6 times larger than that of the nearest peer country. And that second-place peer happens to be China, which is mainly off limits to any defense contractor that wants to sell to the Pentagon.

"There are important weapons sales in India, the United Arab Emirates, Saudi Arabia, Taiwan, [South] Korea and Japan," says Tom Captain, Deloitte's global A&D sector leader. "But there isn't enough work to

make up for the reduced U.S. defense budget."

U.S. defense giants also face a lot of competition in the new markets they are targeting. European contractors are even more desperate to offset tight military budgets at home. Brazil and India have become more active in seeking defense exports, and China will likely become a much bigger player in the near future. "It's tough. Everyone is looking at the same set of market opportunities," says Byron Callan, an A&D analyst for Washington-based investment firm Capital Alpha Partners. "I would be leery of any claim that international sales would offset U.S. budget cuts."

The reality is that offsetting the coming declines in Pentagon spending will require a multi-faceted approach. In addition to pursuing export opportunities, contractors should target high-growth "adjacent" markets in which their skills, expertise and products can be applied. The health care industry, for example, which accounts for 18% of U.S. GDP, presents significant opportunities for A&D companies equipped to expand into health care information technology. The booming oil and gas industries are buying lots of commercial helicopters—helping to offset declining demand for military rotorcraft—and are an attractive market for companies that manufacture high-pressure pumps.

Captain also foresees established A&D contractors generating richer yields through investments in "new-reality technologies," such as directed energy and laser weapons, unmanned aircraft, and intelligence, reconnaissance and surveillance. "These technologies will help bridge the gap," he says. ☼

AW&ST/S&P Market Indices as of 1/16/2013



Source of data: Standard & Poor's and Capital IQ Inc. (a Division of Standard & Poor's).

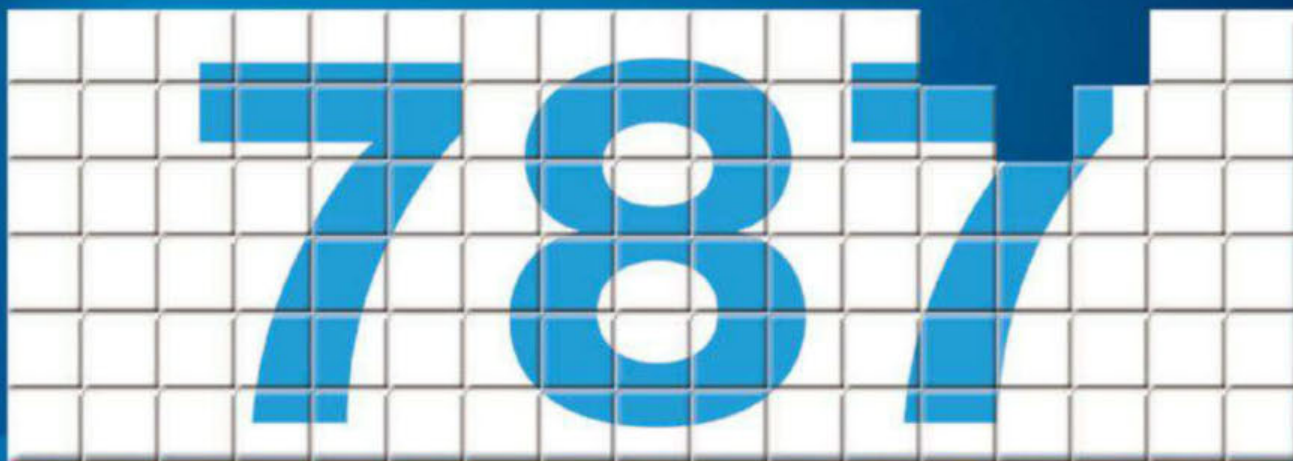
Platts Jet Fuel Prices as of 1/16/2013



All data, except for Asia/Pacific, represent latest spot price data as of Wednesday. Asia/Pacific data represent latest spot price data as of Thursday. Source: Platts. Subsequent use of these data in index-format or in derived financial instruments requires a licensing agreement with Platts. For related questions contact Gerald_Bueschel@platts.com



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COMMENTARY

Paying Attention?

Are you up on production and manufacturing innovations, acquisition lore and 2012's budget and policy debates? How about early innovation? Score 8 and you pass, get 11 or better and you're management material. (No fair outsourcing your answers to the Web. Answers are on page 34.)

First, some easy scores for history buffs.

1. Boeing's first monoplane aircraft designed from the ground up had its debut flight on May 6, 1930.

What was it designed for?

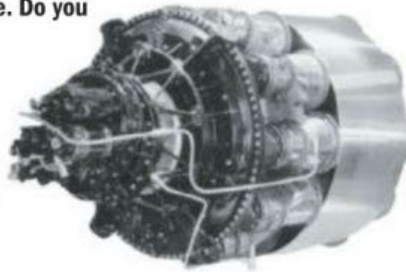
- a) passengers
- b) aerial pursuit
- c) reconnaissance
- d) mail

2. The PT6 program put Pratt & Whitney Canada on the map as a turboshaft manufacturer. What was its first aircraft production customer?

- a) Hiller UH-12
- b) Beech 18
- c) DHC-2 Mk.3 Turbo Beaver
- d) Lockheed XH-51

3. The World War II era brought a race to develop the first turbojet engine, with the lead taken by RAF engineering officer Frank Whittle and Heinkel engineer Hans von Ohain (obviously working separately). The U.S. was also in the picture. Do you recognize this effort?

- a) Pratt & Whitney J42
- b) Heinkel HeS 3
- c) GE I-A
- d) The Whittle Unit



4. The Soviet Union's launch of Sputnik made reform of weapons development a priority at the Pentagon. In 1959, a thorough vetting was ordered for the Air Force's management process. When the Weapon System Management Study Group sought an example of a quick, efficient development, which of these earned an "A"?

- a) Thor Intermediate Range Ballistic Missile
- b) Snark subsonic intercontinental missile
- c) B-58 bomber
- d) B-52 bomber

Let's move on to programs, budgets and processes.

5. Export restrictions have long been viewed as a roadblock to the competitiveness of the U.S. aerospace industry. The 2013 National Defense Authorization Act returns authority to the White House to determine appropriate control requirements in one key area. What industrial sector benefits?

- a) Five-axis CNC milling machines

- b) Commercial transport navigation controls
- c) Commercial satellites
- d) Composite aircraft lightning protection

6. Which region of the U.S. will suffer most if by-the-book sequestration budget cuts mandated by the Budget Control Act of 2011 are adopted?

- a) The Northeast
- b) Texas and the South
- c) The Pacific states, Alaska and Hawaii
- d) The Midwest

7. What political party is overwhelmingly represented in question 6's winning region (and will react accordingly)?

- a) Republicans
- b) Democrats

8. United Technologies' \$18.4 billion acquisition of Goodrich brings a landing gear, brake and nacelle specialist into UTC's fold. What skill sets does the sale expect to bring to Goodrich?

- a) A single IT platform
- b) A proprietary operating system called ACE
- c) Uniform standards and practices
- d) all of the above

9. True or false, the Defense Department's recognition of cybertheft as a "very serious problem" means contractors have been given permission to charge anti-cybertheft expenses to acquisition programs?

10. Everyone knows age and high fuel use are quick tickets to storage yards for aircraft. Match the following percentages of stored fleets with the appropriate aircraft type:

- | | |
|----------|----------------|
| a) 6.4% | 1) 747-400 |
| b) 13.1% | 2) MD-11F/C/FC |
| c) 7.8% | 3) A300 series |
| d) 19.1% | 4) 737-300 |
| e) 2.4% | 5) MD-90-30 |

11. Airbus will begin building a \$600 million A320 factory in Mobile, Ala., this summer. True or false, it expects lower U.S. wage rates to save it money.

12. Given the budget pressures U.S. defense acquisition programs are under, most A&D observers could identify the F-35 Joint Strike Fighter as the one with the longest tail of spending needed to reach completion (\$256 billion). What ranks second among aircraft programs?

- a) V-22 Osprey
- b) BAMS UAS
- c) P-8A Poseidon
- d) Reaper
- e) CH-53K



Challenge yourself with the full quiz—check out the digital edition of AW&ST on leading tablets and smartphones, or go to AviationWeek.com/itquiz

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COMMENTARY

Right Design, Wrong Target

Darken the sky, after all?

When design work began on the Eclipse, the original very light jet, the key to keeping its purchase price low—it was originally advertised at around \$750,000, if you recall—was to build them in high volume. And, as the original backers saw it, the only way to get production numbers high and fast was to put them into service as high-cycle air taxis.

It later came as a surprise to many that most of the aircraft counted in the original company's much-touted 2,400-unit backlog were actually destined for DayJet, an untested, Internet-based air taxi start-up. Once in operation, the concept proved unworkable, causing DayJet to fail, and Eclipse along with it.

The rise, promotion, success and collapse of Eclipse is now the stuff of bad business legend, but the controversial enterprise did produce a certificated jet that now, purchased from bankruptcy by Eclipse Aerospace and upgraded, continues as the Eclipse 550.

After a production halt of nearly four years, the Albuquerque, N.M., line is cranking to life once again, and the first \$2.695 million EA550 is expected to be delivered in July. The new company hopes to reach a rate of 2-2.5 aircraft per month by year-end, essentially producing on a build-to-order schedule. A good little business.

But here's the thing. The U.S. Air Force is now considering what to do about its T-1A Jayhawks. Essentially Beechjet 400s used in the service's Specialized Undergraduate Pilot Training (SUPT) for future transport crews, those aircraft are now two decades old, thirsty, expensive to maintain and equipped with vintage instrumentation. So, the Air Force



ECLIPSE AEROSPACE

has invited alternative suggestions to overhauling and upgrading them.

Eclipse believes it has just the thing: an off-the-shelf twinjet with a state-of-the-art cockpit, capable of flying a 3-hr. training sortie with a minimum 30 min. of reserve fuel, reaching an altitude of 41,000 ft., and meeting or exceeding all of the service's other performance parameters. And, notes Mason Holland, chairman and CEO, since the aircraft was designed for heavy daily commercial use and light overnight maintenance, 100 of them could do the job of 178 Jayhawks—and save the service 13 million gal. of fuel annually.

"My guess would be we could save the Air Force one-third of the training costs and throw the airplanes in for free," he says. "The numbers get that silly. We're in that range of magnitude."

Regardless of the outcome of the request for information, those kinds

of savings in a time of tight military budgets have Holland projecting big thoughts about his little jet.

"The U.S. Air Force is one branch of one military of one country," he says. "There are lots of others that need to conduct training missions, too."

If need be, he believes his company can build more than 100 aircraft per year. That would be a kind of redemption of the VLJ concept, albeit for an altogether different kind of service than first imagined. ☛

UP FOR ADOPTION?

For owners of Hawker Beechcraft jets, the company's bankruptcy and its decision to abandon jet manufacturing altogether is surely unsettling. After all, where will they get parts to keep flying? But that very question also has a lot of others calculating.

It's estimated that there are 1,600-1,800 Hawker 125 series jets in operation. Also, there are approximately 300 Premier/Hawker 200s, 600 or so Beechjet/Hawker 400s and a handful of Hawker 400s. That's quite a fleet in continuing need of parts and service.

By way of reference, in 1983, when a group of investors purchased the defunct Sabreliner Div. from Rockwell International, 600 Sabres of various



SABRELINER CORP.

models and T-39s were in operation. Three decades later, 270 of those are operating and being serviced. Meanwhile, the private company has expanded into supporting a variety of other aircraft, including the Lockheed P-3, Boeing KC-135 and Sikorsky Black Hawk helicopter. It employs 400 people to handle the work at three different locations in Missouri.

Asked if his company might consider servicing the Hawker fleet, Steven Sperry, Sabreliner vice president, business development, says, "We obviously would have an interest, if the economics were right," but adds, "as does every other MRO." ☛



By Leithen Francis

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COMMENTARY

Opportunity In Adversity

Asia's secondary airports are perfect hubs for business travelers

Congestion in major Asia-Pacific cities is reaching the point where passengers now find there is a lot of time wasted, in both road and air traffic delays. Anyone who has tried to reach Jakarta Soekarno Hatta International Airport, Bangkok Suvarnabhumi International Airport and Kuala Lumpur International Airport from the city centers will tell you that getting there can be cumbersome. The airports are many miles from downtown, and often the roads are clogged with traffic. Once you get to the airport, there can be lengthy queues at the check-in, immigration and security sections.

In addition, many Asia-Pacific capital city airports have failed to keep pace with the growth in air traffic, meaning flights are often delayed as aircraft are queued up waiting for clearance for takeoff. Even Singapore Changi Airport, which is touted as one of the world's best, is now grappling with flight delays.

Airlines, meanwhile, continue to try to woo premium passengers by highlighting their inflight services and airport lounges. But is that sufficient product differentiation to capture the premium market? At the end of the day, what is important to business travelers is time. But they are subject to the same delays as economy passengers, because the two classes still use the same airports and board the same aircraft.

Bombardier Commercial Aircraft's vice president for Asia-Pacific sales, Torbjorn Karlsson, makes an interesting point, however, when he says airlines—when catering to business travelers—should consider the whole journey. That means not just the onboard passenger experience, but the time it takes to get to the airport, onto the aircraft and to the final destination. If an airline can reduce the time it takes to complete the entire journey, then it is not only good for the passenger, it



allows a carrier to clearly differentiate its service offering and command a premium fare, he says.

Karlsson suggests there is a market in Singapore for a premium airline that caters to business travelers by offering a more convenient service to Asia's major business centers. Singapore is the natural place to base such a carrier because it is Southeast Asia's main business center. Many of the major international banks, financial institutions and fast-moving consumer goods companies have their Asia-Pacific headquarters in Singapore.

Rather than locate the operation at Changi Airport, Karlsson suggests using Seletar Airport, a secondary facility in Singapore, on the northern side of the island. Seletar is farther away from the city center than Changi, but because Seletar is smaller and less crowded,

once you get there, it is quicker to pass through customs and immigration.

The terminal at Seletar is old, but the director general of the Civil Aviation Authority of Singapore, Yap Ong Heng, says his agency is looking into building a fixed-base operation at Seletar to better serve business passengers. Yap says the runway is too short to support fully loaded Boeing 737s. That means smaller aircraft are more suited to Seletar's short runway, namely the ATR 72-600, Bombardier Q400, Bombardier CSeries and CRJs, and Embraer regional jets.

If a regional-aircraft operator emerges in Singapore, it could fly turboprops or regional jets from Seletar to Jakarta Halim Perdanakusuma Airport, Kuala Lumpur Subang Airport, Ho Chi Minh City Tan Son Nhat International Airport and Bangkok Don Mueang Airport.

Halim, Subang and Don Mueang are secondary airports already open for commercial operations. They are closer to the city centers and thus easier to reach than the larger international airports. If the new scheduled carrier were to operate regional jets, their faster

Who says a turboprop such as an ATR 72 VIP can't be as comfortable as an executive jet?

speeds and greater ranges could make reaching these Southeast Asia destinations easy from Singapore. But the new airline would need special approval to serve Subang, as this airport currently only allows scheduled turboprop operations and charter jet services, not scheduled jet services.

The turboprop offers lower fuel burn and operating costs. But propeller aircraft are slower, and the general consensus is that they work best on routes of less than 2 hr. It may be impractical to operate a turboprop from Singapore to as far away as Bangkok, which is a 2.5-hr. flight by jet. Jakarta is 1 hr. and 7 min. away, and Kuala Lumpur can be reached in 55 min.

If the airline can ensure it takes less than 30 min. to get to the airport, and passengers can check in as late as 15 min. before departure, there could be a market for such a premium service, especially as Asia-Pacific's full-service carriers are grappling with congestion and flight delays at the big airports. ☛



By Frank Moring, Jr.

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COMMENTARY

Hot Fire!

Saturn engine components tested for SLS

Engineers at NASA's Marshall Space Flight Center have test-fired a gas generator built from parts originally manufactured for the F-1 first-stage engine that sent men to the Moon on the Saturn V. One reason for the tests is to learn if the old technology can help the planned Space Launch System (SLS) heavy lifter get off the pad for missions beyond low Earth orbit. Some of the engineers on the test series had not been born when the 40-year-old hardware was machined by North American Aviation's Rocketdyne Div. for the Apollo program, and NASA wants to know if the modern manufacturing techniques with which the new generation has grown up, can be used to make building the old designs more affordable.

While NASA is testing the gas generator in-house at Marshall in part to give its young engineers experience with the old technology, a commercial team that includes Dynetics and Pratt & Whitney Rocketdyne has a \$73.3 million contract to study whether it will be possible and practical to use a pair of modernized F-1 engines to drive advanced kerosene-fueled strap-on boosters for the 130-metric-ton version of the SLS, and perhaps for other launcher applications (*AW&ST* Oct. 29, 2012, p. 40). The gas generator tested during the past two weeks at Marshall could go into a breadboard engine the commercial team plans to build using old turbomachinery stored at Rocketdyne and perhaps a new combustion chamber.

Hardware for the gas generator tests came from two other F-1s, one of them a flight article built for the Apollo 18 mission that never flew and was eventually warehoused by the Smithsonian Institution. Using test facilities that also ran injector tests for the developmental J-2X engine derived from the Saturn V upper-stage engines (see photo), Marshall engineers planned 11 hot-fire tests of the F-1 gas generator, which uses some of the engine's



propellant to spin the turbomachinery that feeds the engine's main combustion chamber. Tests were intended to examine different fuel-mixture ratios and their effect on soot production that can degrade performance. Also on tap at the end of the series were two combustion-stability tests.

"That's where we ignite a very small bomb that causes an acoustic signature in the combustion chamber; and then we see how well the combustion process damps out the pressure wave," says Ralph Coates, lead discipline engineer on SLS advanced development at Marshall.

Coates and Chris Calfee, NASA project manager on the Dynetics contract, say the engine components were in surprisingly good shape after four decades, although some needed cleaning because of corrosion caused by water seepage. One objective of the broader effort will be to use white-light

scanning and other optical techniques to produce digital images of the old hardware for conversion into computer-aided design (CAD) files.

The CAD data in turn will be compatible with many of the analytical tools that weren't available when another generation of engineers at NASA and Rocketdyne designed the parts with pencil and paper on drafting boards. They may also be used to drive additive manufacturing equipment in a test that could have reverse-engineering implications far beyond the NASA rocket work.

"There will be what we call fabrication demos, where they will take the existing design and build it a different way, with this additive manufacturing, with the selective laser sintering, or selective laser melting, where they essentially build it up with a laser, and they will start from 3-D models," says Coates. "So you can use your advanced measurement system to scan it in, and then you've got to work with it analytically a little bit to get it where it will manufacture it the way you want."

In February the Dynetics team is scheduled to take over testing aimed at a breadboard engine. Under its contract, one of the team's goals will be to determine if advanced techniques such as optical scanning and additive manufacturing can bring down the cost of development and fabrication on engines, which are typically the most expensive component of a space launch vehicle.

"It's all about affordability," says Calfee. "We're trying to build an affordable advanced booster, so what we hope to get back from Dynetics is to confirm the assumptions they're making on affordability, on how they can redesign and manufacture the parts on this F-1A engine."

NASA is also funding work on advanced solid-fuel boosters and composite propellant tanks that could play in the SLS advanced booster, with ATK and Northrop Grumman, respectively, performing that work. Like everything the agency is doing these days, cost is a major factor.

"The reason we started with the old hardware is it exists," Coates says. "We don't have to go out and procure it. We own it." ☛



By Jen DiMascio

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COMMENTARY

Under the Gun

Will hawks maintain opposition to sequestration?

When the president begins his second term, he will be dealing with a new Congress. In the last Congress, Republicans on the armed services committees provided a nearly united front against sequestration, but that opposition to across-the-board reductions to defense could be wavering.

The Wall Street Journal quotes House Speaker John Boehner (R-Ohio) as saying that even defense hawks will support letting sequestration take effect. Rep. Bill Young (R-Fla.), the powerful chairman

of the House Appropriations defense subcommittee, downplayed the comment. Yet in a vote that

nearly handed down another blind 1.6% cut to government spending—including \$10 billion in Pentagon dollars—44% of Republicans on the House Armed Services Committee voted “yes.”

Committee Chairman Rep. Buck McKeon (R-Calif.) was not one of them. But in response to a letter from the Joint Chiefs of Staff stating that the indiscriminate cuts to defense would hollow the force, McKeon says the details are arriving late. “I only wish the service chiefs’ warning had come sooner,” McKeon says. “Now, as we approach the midnight hour, DoD is just beginning to offer specifics.” ☼

POWER VS. MONEY

Sen. Barbara Boxer (D-Calif.), a senior member of the Senate Commerce, Science and Transportation Committee, will renew an old fight with cargo behemoths FedEx and UPS. Expect Boxer to bring back legislation that would require uniform fatigue standards for all pilots. Reps. Michael Grimm (R-N.Y.) and Timothy Bishop (D-N.Y.) have already introduced companion legislation, the Safe Skies Act, on the House side.

Cargo pilots are exempt from FAA



EPA/LANDOV FILE PHOTO

‘As we approach the midnight hour, DoD is just beginning to offer specifics.’

REP. BUCK MCKEON

flight and duty time limits and minimum rest periods due to take effect in 2014. FedEx and UPS argue that cargo pilots have greater opportunities to rest, since they fly far fewer hours than their passenger aircraft brethren. The companies have well-heeled lobbying operations: they spent \$9 million and \$3.6 million, respectively, to promote their views on Capitol Hill in 2012, including opposition to the rest rules. ☼

SPACE SHOWDOWN

The looming 2014 retirement of Sen. Jay Rockefeller (D-W.Va.) as chairman of the Senate Commerce, Science and Transportation Committee sets up a potential showdown among Democrats over space policy. Sen. John Kerry (D-Mass.) is likely to be approved as the next secretary of state. If he leaves, next in line to lead the committee that presides over space matters would be Sen. Barbara Boxer of California, a hotbed of commercial-spaceflight activity.

Whether she opts to lead the committee or hand off the baton to the next-in-line Sen. Bill Nelson (D-Fla.), a NASA specialist, the pair may be in a tussle over where to spend space dollars. Nelson has been trying to preserve government jobs for his Florida constituents by pushing hard to fund NASA’s in-house heavy-lift Space Launch System, the Orion multipurpose crew vehicle and the modifications at Kennedy Space Center that would be needed to launch them. ☼

HAGEL REVERSAL

Former Sen. Chuck Hagel (R-Neb.) may have picked up Democratic supporters in his quest to be confirmed as the next defense secretary, but he has lost a leading Republican.

Sen. Jim Inhofe (Okla.), now the top Republican on the Senate Armed Services Committee (SASC) that will first review Hagel’s nomination to replace Leon Panetta, says he will vote “no.” “We are simply too philosophically opposed on the issues for me to support his nomination,” Inhofe says. “One of my biggest concerns is avoiding . . . sequestration that, as Secretary Panetta has said, would be devastating to our military. However, Senator Hagel’s comments have not demonstrated that same level of concern about the pending defense cuts.”

Inhofe also pointed to Hagel’s support for nuclear-weapons reductions and his positions on Iran and Israel. Inhofe’s statement came on the heels of pledges of support for Hagel by Sens. Chuck Schumer (D-N.Y.) and Barbara Boxer (D-Calif.), who represent states with large Jewish populations. Neither serves on the SASC, but both will be important votes if the nomination reaches the full Senate. Hagel pointed out in a Jan. 14 letter that he has “always been supportive of a strong U.S.-Israel strategic relationship and always supported Israel’s right to defend itself against attack.” That statement, along with Hagel’s response to questions about Iran and gays and lesbians in the military won Boxer’s support. “His answers were reassuring and show a sensitivity and understanding of these issues,” Boxer says. Hagel’s confirmation hearing is set to begin at 9:30 a.m. Jan. 31. ☼

Caged Li-ion

Controlling powerful battery's volatility poses urgent design challenge for Boeing

Guy Norris **Los Angeles**

While the full fallout from the grounding of the Boeing 787 fleet following two separate battery failures remains as yet unknown, there is at least one aspect over which there can be little argument.

The basic physics of the lithium-ion battery at the center of the 787 investigation cannot be changed, and the focus of the investigation has already shifted rapidly from whether the safety precautions in Boeing's design were sufficiently adequate, to more urgent questions over how quickly they can be modified.

Spurred on by the U.S. airworthiness authority's emergency directive, the NTSB probe and the broader FAA-led report will determine with Boeing what modifications are required to the battery-related aspects of the electrical system as well as whether the fire containment or protection system

can—and should be—augmented. In the most extreme scenario for Boeing, this could conceivably lead to a change to alternate batteries, a new test effort, certification and modification program.

Until now, Boeing has remained unequivocal over the question of adopting or even studying different battery technology, saying simply: "We have no such plans at this time." Outwardly, at least, the company remains confident in its choice of technology, which was driven by the lithium-ion battery's high power and energy density and its low maintenance requirements and low installed weight.

Eight crew and 129 passengers evacuated by escape slides following the Jan. 16 ANA 787 diversion to Takamatsu in western Japan.

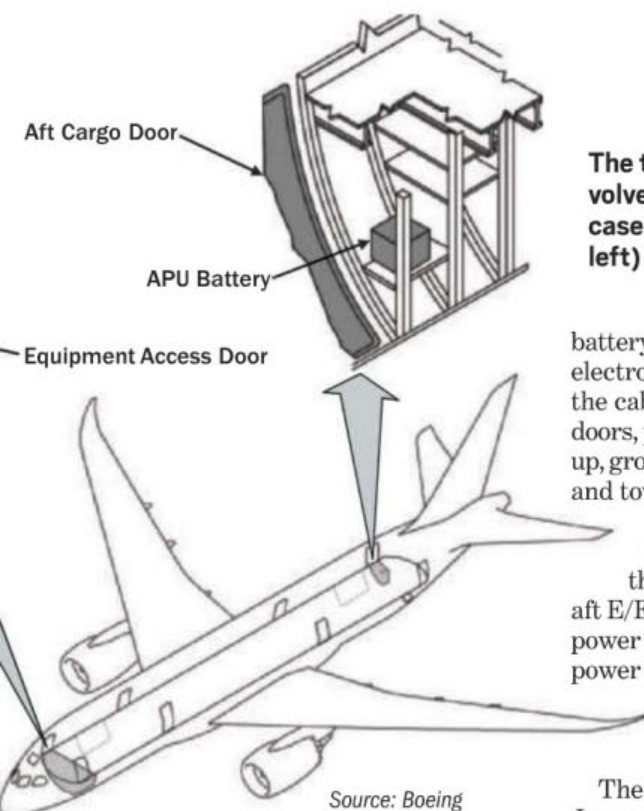


Boeing 787 Lithium-Ion Battery Locations

Yet the worldwide groundings, combined with NTSB images of the charred remains of the battery from the Boston incident, add to a growing litany of industry and public unease over the use of lithium-ion technology in aircraft. Even carrying lithium batteries as air cargo has proved lethal and prompted the International Civil Aviation Organization (ICAO) to issue stringent new rules governing their carriage as recently as Jan. 1. Fires erupting in this type of battery, carried as cargo, were prime suspects in separate accidents involving two Boeing 747 freighters and a DC-8.

According to FAA figures, not counting the recent events, lithium batteries make up almost 80% of the 33 instances in which batteries have ignited on aircraft since 2009. Cessna,





Source: Boeing

The two battery incidents involved the aft unit (left) in the case of JAL, and forward unit (far left) in the case of ANA.

battery, located forward in the electric/electronic (E/E) equipment bay below the cabin floor by the front passenger doors, provides power for aircraft start-up, ground operations such as refueling and towing, and acts as backup power for the electrically actuated brake system. It can also assist the second battery, located in the aft E/E bay, in starting up the auxiliary power unit (APU) and, in the event of a power failure, energizes essential flight instruments in the flight deck until the drop-down ram air turbine spools up.

The battery that caught fire on the Japan Airlines 787 in Boston was the second main battery. This unit's primary purpose is to electrically start the APU when neither of the engines is running and the aircraft is not connected to external ground power. In this case, the battery energizes the right-hand of the two starter/generators connected to the APU. The aft battery also provides another minor role, namely to power navigation lights during battery-only towing operations.

The unit in the second incident, which forced an ANA 787 to make an emergency landing in Japan on Jan. 16, involved the main battery in the forward E/E bay. In this case, there was less damage, though spilled electrolytes, fumes and minor thermal damage indicated signs of overheating.

Mike Sinnett, 787 vice president and chief project engineer, says the lithium-ion battery has "the right chemistry it takes to have a large amount of energy in a short time to do the APU start, and allows us to recharge that in a short amount of time." These qualities, added to the low weight, were sufficient to swing Boeing in favor of the technology in 2005, when it awarded the battery contract to Japan-based battery manufacturer, GS Yuasa, as part of the Thales-supplied electrical power conversion system.

The 787 contract marked the first commercial aviation application of lith-

PLAN C

Jens Flottau Toulouse

The temporary grounding of the Boeing 787 fleet is causing major disruptions particularly for the aircraft's largest operator, All Nippon Airways (ANA). Others flying smaller 787 fleets are likely able to mitigate the impact better.

The FAA last week grounded the 787 fleet operated by U.S. carriers, effectively only United Airlines, until safe use of the lithium-ion battery can be ensured. That decision was quickly followed by authorities abroad. ANA and Japan Airlines (JAL), the two carriers directly affected by the battery defects, decided to temporarily ground their 787 fleets even before the FAA-initiated ban. Their 24 aircraft combined did not fly on Jan. 16. ANA operates 17 units, followed by JAL with seven, and United and Air India with six each.

Unlike the Japanese carriers, the aircraft's

787 Deliveries

Air India	6
All Nippon Airways ...	17
Ethiopian Airlines	4
Japan Airlines	7
LAN Airlines	3
LOT Polish Airlines	2
Qatar Airways	5
United Airlines	6

Source: Aviation Week Intelligence Network

other operators initially decided to continue flying. LOT Polish Airlines, which has two aircraft, even decided not to cancel its inaugural 787 long-haul flight from Warsaw to Chicago. That aircraft is now stranded at O'Hare International Airport. The ban also hit Qatar Airways on the day of its inaugural 787 service

from Doha to Zurich. ANA and JAL had to cancel dozens of flights. Where possible, carriers are replacing 787s with other aircraft, as Ethiopian Airlines has with Boeing 767s on some routes.

While this is a worst-case scenario for Boeing, it also comes in the midst of a steep production ramp-up. Following the long-delayed entry into service, Boeing has delivered 50 787s through Jan. 3, decreasing the large parked and completed fleet of the type. A prolonged grounding is expected to have a huge impact on deliveries—even before the FAA decision, Qatar Airways allegedly threatened to suspend further deliveries. An airline official was unavailable for comment at press time.

Further delivery delays will also hamstring growth plans for Qatar Airways and could jeopardize the fundamentals of business models such as that of Qantas's low-fare long-haul unit Jetstar. ☹



REUTERS/KYODO/LANDOV

ium-ion technology and was selected over contemporary nickel-cadmium because it provided 100% greater energy storage capacity and double the energy from the same-sized unit.

"Lithium-ion wasn't the only choice, but it was the right choice for us at the time," says Sinnett.

However, Boeing knew the outstanding performance of lithium-ion technology comes at a cost, namely development of an elaborate series of safeguards to prevent the battery from catching fire.

The GS Yuasa unit and its charging system is designed to modulate and control the energy flow so that overcharging, one of the identified causes of lithium-ion battery fires, cannot occur. Similarly, Boeing developed safeguards both inside and outside the battery to prevent it from over-discharging, or over-heating, both triggers for fires. However, in the worst-case scenario, which is known as a thermal runaway, once the reaction begins, there is very little to be done. As Sinnett comments, "fire suppressants just won't work. It's very difficult to put out with suppress-

sants and you just have to assume its going to go."

The problem lies with the lithium at the heart of the battery. Although this has twice the electrochemical potential of other materials, it also melts at a much lower temperature than other battery fuels, such as nickel. Energy experts in contact with Aviation Week say lithium melts at 357F—versus

Analysis of the burned main APU battery from the JAL incident continues by the NTSB.



Get detailed data on ANA's and JAL's incident aircraft in the digital edition of *AW&ST* on leading tablets, or go to

AviationWeek.com/787battery

2,800F for nickel—and acts "like molten sodium" in the process.

The other issue associated with the battery design is that the unit is made up of a stack of tightly packed cells to generate the high energy density. Each cell consists of a layer of lithium, acting as the cathode, separated from an oxidizer, or anode, by a thin layer of ion-conductive polymer. If a short occurs, and the lithium melts, the lithium reacts first with the electrolyte and then the oxidizer before propagating to other cells. This process, which does not occur with nickel-cadmium or nickel-metal hydride batteries, is the "thermal runaway" circumstance cited by Boeing.

If the chain reaction starts, as is believed to have occurred in the Boston event, the current procedure in flight is to vent smoke overboard from the E/E bay. The energy release from the lithium, however, cannot be stopped and will only cease once the material has been consumed by the reaction. The initial NTSB investigation found that although the APU battery had been severely damaged by the fire, the thermal damage to the surrounding structure and components was "confined to the area immediately near the APU battery rack (within 20 in.) in the aft electronics bay."

However, while this would appear to be good news in terms of containment, an update from the NTSB released on Jan. 14 indicates that Boston firefighters had been "able to contain the fire using a clean agent (Halotron)," suggesting that without their efforts the damage would almost certainly have been far worse. Halon fire suppression is provided in the cargo hold but not the E/E bay.

The NTSB investigative team includes subject-matter experts such as the U.S. Naval Surface Warfare Center's Carderock Div. in West Bethesda, Md. The Navy has bitter experience with the technology, having lost a prototype mini-submarine known as the Advanced SEAL Delivery System in 2008 because of a lithium-ion battery fire. ☐

AIRBUS ON ALERT

Jens Flottau **Toulouse**

Airbus would face a "very serious decision" and possibly "months in delays" in the A350 program, if the manufacturer were forced to replace the aircraft's lithium-ion batteries, Executive Vice President for Programs Tom Williams tells Aviation Week.

The real impact on Airbus is still unclear and the company is closely watching the outcome of the investigation into the Boeing 787 incidents. Airbus has selected a different supplier, Saft, for the batteries, and the A350 also is a less-electric aircraft than the 787. Systems such as brakes and functions like deicing are still performed in the conventional way, using hydraulics and bleed air, respectively.

Williams also points out that Airbus is relying on more cells than Boeing in functions such as start-up of the auxiliary power unit, where lithium-ion batteries are used, which requires less power per battery. "But that does not mean that we may not be facing the same issues as Boeing," he notes.

According to Williams, Airbus has put design features in place that are intended to make the battery operation particularly safe, including mechanical relief vents made of titanium. "The critical issue is to get failure management right," Williams says.

Airbus could return to more traditional nickel-cadmium batteries, but that would require a huge effort and cause a significant weight and space penalty. Also, nickel-cadmium batteries are prone to the memory effect and cannot be recharged fully after a certain amount of cycles. Environmentally, the cadmium content would be a serious issue, too.

Airbus CEO Fabrice Bregier says that "Airbus went through discussions with the U.S. Federal Aviation Administration and the European Aviation Safety Agency about the electric architecture of the aircraft, and they seemed very happy at the time." According to Bregier, Airbus will "carefully study" any recommendations from the current Boeing 787 investigation and see whether they also apply to the A350. ☐

A Load Shed

FAA on path of lesser resistance on 787 review

John Croft **Washington**

The FAA's "comprehensive review" of the design, production and quality assurance of the Boeing 787 departs, at least in name, from legacy processes that are in place for cases when a certified aircraft exhibits significant safety problems.

Under FAA type certification regulations (Transportation Department Order 8110.4C), a Special Certification Review (SCR) is the only remedy listed for "post-certification evaluations" of a design.

Though FAA officials contend that an SCR would not be broad enough to cover all of the 787 areas of concern, the rules reveal flexibility that allows the agency to delve into "complex, controversial or potentially unsafe" designs or components post-certification.

And while a thorough review is certainly the FAA's goal, avoiding the SCR stigma could be a plus for Boeing.

SCRs have been used sparingly in the FAA's 50-plus years as an agency, but are often perceived as a "black eye" to the aircraft and manufacturer involved. SCR rules direct officials to "thoroughly explore every significant aspect and ramification of the potential safety problem in question," which would appear to include the production and quality assurance areas.

Earlier SCR include an investigation of the McDonnell-Douglas DC-10 after a fatal engine-breakaway crash in Chicago in 1989, a review of the MD-11 after an inflight upset killed several passengers in 1993, and analysis of the ATR 72 certification after an icing-related crash in 1994.

Fatalities are not essential to trigger an SCR. The most recent notable SCR targeted the Eclipse 500 very light jet, an aircraft that pushed the boundaries for traditional Part 23 light aircraft certification standards in terms of the avionics and other innovative features.

In that case, the FAA appointed a team of "experienced technical and managerial personnel . . . with no prior involvement in the Eclipse 500 type-certification program" to perform a 30-day review to determine if the aircraft was certificated "in conformance with [regulations] in four areas—cockpit displays/screen blanking, stall speeds, trim and flaps." The SCR team followed a flow diagram that started with a review of the certification basis for the very light jet—including special conditions, policy memos and ELOS papers—and ended with an assessment of reported anomalies based on the system safety assessment prepared by Eclipse during the certification. Along with interviews, the group reviewed service difficulty reports before coming up with eight "findings" and six recommendations to improve the aircraft.

For the 787, the FAA and Boeing released few details about the specifics of their joint inquiry into the certification, production and quality control aspects of the aircraft when launching the comprehensive review of the new twinjet, prompted in large part by a series of battery problems.

FAA Administrator Michael Huerta on Jan. 11 said the emphasis would be on the widebody's electrical system, which



JOHN CROFT/ANWST

The FAA and Boeing are beginning a post-certification review to include production and quality control on 787 assembly lines, such as this one at Everett, Wash.

depends on lithium-ion batteries as its primary power storage medium, as well as the power-distribution system and interaction between various mechanical and electrical systems.

The agency added key details on Jan. 16, however when it grounded the U.S. fleet of six 787s owned by United Airlines, via an emergency airworthiness directive.

The action was prompted by an inflight emergency on an All Nippon Airways (ANA) 787 after the crew received warning lights and detected an odor. Though the incident ended in a safe landing with passengers evacuating to the runway on slides, a preliminary investigation revealed a failure of the lithium-ion battery. Dots were connected between the ANA incident and a battery failure on a Japan Airlines 787 on the ground at Boston Logan International Airport on Jan. 7. Both aircraft had battery failures that "resulted in release of flammable electrolytes, heat damage and smoke," states the FAA.

As a result, the U.S. airline safety agency is now saying the comprehensive review will also include a validation "that 787 batteries and the battery system on the aircraft are in compliance with the special condition the agency issued as part of the aircraft's certification."

The new details more tightly couple the FAA to both the problem and the solution since the agency, by regulation, must be "directly involved" in safety and compliance decisions for special conditions, meaning the work cannot be outsourced to designated engineering representatives at Boeing.

In this case, FAA had approved "special conditions" for certifying the lithium-ion batteries, a required step as legacy type-certification rules do not cover the advanced technologies. Other companies, including Airbus and Gulfstream Aerospace have received similar approvals for lithium-ion batteries for use on the A380 and G650, respectively. Airframers will generally demonstrate that proposed new technologies will have an equivalent level of safety (ELOS) to traditional systems through analyses and "issue" papers that the FAA must approve.

The FAA has not set a timeline for its 787 review to be wrapped up. "We'll see where the data take us," says Huerta.

As for the grounded 787s, the FAA states: United "must demonstrate . . . that the batteries are safe, but that the agency will "work with the manufacturer and carriers to develop a corrective action plan to allow [the] fleet to resume operations as quickly and safely as possible." ☐

Getting There?

Although making progress, F-35 flight testing is not delivering required capabilities on schedule

Guy Norris and Graham Warwick Fort Worth

A massing flight hours and test points at an accelerating pace, the F-35 Joint Strike Fighter program faces the question of whether it is completing the right tests at the right time. As it enters 2013 with a focus on high angle-of-attack and weapons testing, the program is still falling behind in clearing the capabilities its customers require.

Lockheed Martin exceeded its development flight-test goals for 2012. But a report by the Pentagon's director of operational test and evaluation (DOT&E) reveals this was helped by bringing forward test tasks from future years. Aircraft deficiencies and software delays prevented the program from achieving some test objectives set for 2012 and required to deliver capabilities to the services now beginning to train pilots on the F-35.

Lockheed says it logged 1,167 flights and 9,319 test points in 2012, against the plan of 988 flights and 8,458 points. Of the flights completed, 926 were by flight-sciences test aircraft expanding the flight envelopes of the three F-35 variants, while 241 were by the smaller number of mission-systems aircraft assigned to testing avionics and sensors.

But according to the DOT&E report, through November 2012, the program had completed only 78% of the test points planned for the year. The addi-

tion of test points to investigate new problems, for regression testing of aircraft and software fixes, and for tasks brought forward from future years pushed the test points accumulated to 35% above the total planned (see F-35 Flight Testing table).

The report says horizontal-tail scorching and delamination and higher than expected airloads on open weapons-bay doors has restricted testing of all variants. Afterburner operating restrictions and delayed aerial-refueling disconnects have affected the conventional-takeoff-and-landing (CTOL) F-35A. Testing continues on a redesigned clutch, driveshaft and doors for the short-takeoff-and-vertical-landing (Stovl) F-35B, and the tailhook is being redesigned for the F-35C carrier variant (CV).

Sustained-maneuver and transonic-acceleration performance has been reduced for all three variants based on flight-test results, the DOT&E says. And live-fire ballistic testing has confirmed vulnerabilities resulting from the 2008 decision to delete shutoff systems for the flammable avionics coolant and nozzle fuelhydraulic actuation systems to save weight, the report reveals.

"The DOT&E report offers 10 recommendations. The F-35 Joint Program Office has already taken action



U.S. NAVY

on six of the 10 recommendations," says the JSF program office, noting all of the issues highlighted in the report were known. "Of the remaining recommendations, three involve vulnerability concerns and are being reviewed."

While the program continues to evaluate fixes for problems already identified, and to test multiple blocks of mission-system software concurrently, it is pushing ahead into new areas of testing. "From a flight-test perspective, there are two priorities this year: complete weapons verification and high alpha [angle of attack]," says Tom Burbage, Lockheed Martin F-35 program integration executive vice president and general manager.

"We are using 18 aircraft to conduct the equivalent of three development flight-test programs and one mission-system program," says J.D. McFarlan, F-35 test and verification vice president. "We expect it to eventually include 8,000 flights and 60,000 test points. So far we've collected 22,000 of those, so we are around 36% through the test program."

Across the three variants, there are 12 aircraft in the flight-sciences test fleet. Another four are assigned to mission-systems testing, with two more—Stovl production aircraft BF-17 and -18—about to join and complete the flight-test stable based at Edwards AFB, Calif., and NAS Patuxent River, Md. Together they had logged 4,243 flight hours by Jan. 7, with the Stovl

F-35 Flight Testing Through November 2012, All Variants

FLIGHTS

2012 Actual	1,092	18% > planned
Cumulative Total	2,533	13% > planned

TEST POINTS

2012 Baseline	4,711	28% < planned
Added	1,720	Regression tests
Brought Forward	2,319	From future years
2012 Total	8,750	35% > planned
Cumulative Total	20,006	5% > planned

Source: Director of Operational Test & Evaluation, 2012 Annual Report



Weapons clearance has begun on the F-35A and F-35B (pictured) and will be a focus of flight testing in 2013.

aircraft logging 1,309 of those hours and conducting 381 vertical landings.

Tests to clear the F-35A "clean wing" flight envelope for the Block 2B initial combat capability—to Mach 1.6/700 kt airspeed, 9g maneuvers and 40,000-ft. altitude (see F-35 Capability Plan table)—are wrapping up. The next step will be to clear the envelope with internal weapons-bay doors open, he says. Release of the Block 2B envelope is planned for mid-2015. Expanding the flight envelope to 50,000 ft. for the Block 3F full combat capability is planned for 2016, when development testing is scheduled to finish.

The flight-sciences sortie rate is ahead of plan for the F-35B and C, but behind for the A, says the DOT&E. There are high-speed/high-altitude restrictions on all three variants caused by the tail scorching. New surface coatings have been flown unsuccessfully, so a new skin design will be tested on CTOL aircraft AF-2 early this year, according to the report.

High angle-of-attack testing is underway at Edwards AFB using aircraft AF-4 equipped with a spin-recovery parachute. Where the F-16 is limited to 26 deg. alpha by its fly-by-wire flight-control system, the F-35's limiter is set at 50 deg. and the aircraft has been flown to 73 deg. to ensure there is sufficient pitch authority. "We have to really slow down to get those pitch conditions—100 kt at 40,000 ft.," says McFarlan. "Pilots are pleased with the

ability to get the nose down from high angle of attack."

The control system is designed to prevent departure from controlled flight at high alpha. In tests now beginning, the prevention feature is turned off, the aircraft forced to depart and the system turned back on to ensure it recovers the aircraft. The ultimate goal is to demonstrate safe recovery from a flat spin, with the chute as a backup. After completing these tests, they will be repeated with the spin chute removed. High-alpha testing on the F-35B will begin this year.

Test flights to investigate transonic

roll-off, caused by slight differences in left and right wing stalls during maneuvers, have shown that control-law software changes are sufficient to mitigate the phenomenon, says Burbage. As a result, pop-up spoilers added to the larger wing of the F-35C have been removed in production aircraft.

The DOT&E report says alternative trailing-edge flap settings are being explored to improve flying qualities during the approach to the carrier. Pilot surveys show handling qualities improve with 15-deg. flap deflection, but flight tests indicate 30-deg. flaps are needed to meet the 145-kt. maximum-approach-speed requirement. Burbage says the F-35C's flight-control system uses the flaps to keep the aircraft stable on the approach glideslope, taking out the lag from the pilot's inputs.

A new tailhook for the CV will undergo its critical design review within a month and is scheduled to be installed in test aircraft at Pax River by year-end. After the F-35C had problems catching the arrestor cables, the hook point, shank and dampers were redesigned. The concept was demonstrated last August at NAS Lakehurst, N.J., when aircraft CF-3 made five successful engagements, McFarlan says.

While live-fire testing in the first F-35, aircraft AA-1, at China Lake, Calif., has confirmed the redundancies and re-configuration capabilities of the flight-critical systems, it has also shown that ballistic damage to polyalphaolephine (PAO) coolant and fuel-draulic lines can cause fires. The report says the program office may reconsider install-

F-35 Capability Plan, Block by Block

Block	1A/B	2A	2B/3i	3F
Capability	Initial training	Enhanced training	Initial warfighting	Full warfighting
Aircraft	LRIP 1-3	LRIP 4/5	LRIP 6-8	LRIP 9+
Max. altitude* (ft.)	40,000	40,000	40,000	50,000
Max. airspeed* (kt.)	450	550	700	700
Max. Mach*	0.9	0.9	1.6	1.6
Angle of attack (deg.)	18	18	50	50
Weapons	None	None	Internal AIM-120, GBU-31/32, GBU-12	Full SDD, internal and external

SDD = System development and demonstration

LRIP = Low-rate initial production

* For F-35A—F-35B and C have lower limits

Sources: Joint Program Office and Director of Operational Test & Evaluation 2012, Annual Report

ing the PAO shutoff valve, but not the fuelhydraulic fuses removed in 2008. The onboard inert-gas-generating system already is being redesigned to address deficiencies in fuel-tank inerting.

Weapons testing is underway for the limited F-35A Block 2B clearance envelope, which comprises internal carriage of the GBU-31/32 joint direct attack munitions, GBU-12 laser-guided bomb and AIM-120 air-to-air missile. "This year, we are focusing on ramping up to 15 weapons tests at both sites [Edwards and Patuxent River]," says McFarlan.

Stovl F-35Bs will return to the assault carrier USS Wasp in August for a second round of sea trials in stronger winds. "We will also bring along weapons," he says. The DOT&E, meanwhile, says weapons integration has been limited by deficiencies in the radar, electro-optical targeting system, sensor fusion and helmet-mounted display.

Ground and flights tests have demonstrated that the stealthy F-35's radar signature is meeting design requirements, says McFarlan. "We have shown that if the aircraft passes the test in the [anechoic] chamber, it will pass in flight," he says. "We are now in the mode of showing we can maintain the [low-observable] characteristics after a year in flight."

In ground durability testing, only the F-35A airframe has so far completed a full 8,000-hr. lifetime. In December, fatigue tests on the F-35B were halted for a second time after the discovery of multiple cracks in a bulkhead flange during the 7,000-hr. inspection. Previously, a crack in a carry-through bulkhead was found after 1,055 hr. of testing, and McFarlan says Stovl test aircraft at Pax River will have to go through structural upgrades beginning this year.

Recent test highlights include hovering the F-35B for 10 min. "It was record, hovering at max performance with more than 5,000 pounds of fuel before doing a vertical landing," he says. "We have done a lot of night flying to understand the helmet and DAS [distributed aperture system], and done night hovering as well." McFarlan says testing of the troubled helmet is making progress and now focusing on latency of the DAS imagery projected on the visor during night flying. ☐

—With Amy Butler and Bill Sweetman in Washington.

Capability Crunch

Graham Warwick and Bill Sweetman **Washington**

Development of the Lockheed Martin F-35's combat capability is falling behind the schedule set as recently as 2011, when the program was restructured to provide more time and resources for integration and testing.

As a result, "the program office is developing a capability management plan and review board to evaluate priorities and trades of capabilities within blocks and for deferral out of [system development and demonstration] if necessary," says the Pentagon's Director of Operational Test and Evaluation (DOT&E). This is the first official recognition that some of the F-35's combat capabilities could be pulled from the development program and fielded through later upgrades.

Mission-system testing exceeded plan in 2012, but progress was limited because software was delivered late and with limited capability, says the DOT&E. Delays in integration and testing of software Blocks 1 and 2A mean the services are taking delivery of production aircraft for training with "major variances against expected capabilities."

By November 2012, 20% of Block 1 and 50% of Block 2A remained to be integrated and delivered to flight test (see table). Block 1A/B and 2A are for training only, and include no weapons. Block 2B is the initial combat capability, intended to allow basic close air-support, interdiction and initial air-to-air missions. But while 2B is planned to include initial Link 16 and multifunction advanced data-link capability, it will not include the Rover video data link considered essential for close air-support missions.

Of the 9.4 million lines of software code on the F-35, 97% have been coded, 88% delivered for laboratory integration and 85% is in flight test, says Tom Burbage, Lockheed Martin F-35 program integration executive vice president and general manager. But the DOT&E says less than 10% of Block 2B, planned for release in mid-2015, was available for integration and testing by the end of August. "The program made virtually no progress in the development, integration and laboratory testing of any software beyond 2B," the report says.

As a result of the delays, regression testing on fixes to multiple software versions is running concurrently on Blocks 1 and 2. Since Block 3i, a rehosting of Block 2B which is scheduled to enter flight-test in mid-2013 concurrent with 2B testing, adds no new capabilities, Lockheed Martin will have a significant task ahead in integrating Block 3F, the full combat capability, which is to enter 33 months of flight testing in early 2014. ☐

DOT&E on F-35 Mission-System Software Status

Block 1 (initial training)

20% of planned capability yet to be delivered to flight test

Block 2A (advanced training)

< 50% capability delivered to production

Block 2B (limited combat)

< 10% available for testing by end of August 2012

Block 3i (re-hosted Block 2B)

Lagging in integration and laboratory testing

Block 3F (full capability)

Virtually no progress in development, integration and testing

Source: Director of Operational Test & Evaluation, 2012 Annual Report

Stretched Thin

Operations in Mali stress French military airlift

Amy Svitak **Paris** and Tony Osborne **London**

France's intervention in Mali is testing its legacy air transport fleet as the French air force supports ground forces fighting an advance by Al Qaeda-linked insurgents toward the Malian capital.

French C-160 Transalls, C-130 Hercules and Airbus A310 and A340 aircraft have been tasked with strategic transport of troops and equipment in support of the operation, which President Francois Hollande initiated Jan. 11 after an international mandate to prevent a terrorist takeover of Mali had been slow in taking shape, and because evidence from surveillance indicated a massive move toward its capital city, Bamako.

Named "Operation Serval" after an African wildcat, the French campaign began with about 200 French troops supporting Malian ground forces aided by airstrikes that targeted positions in the rebel-held north, a desert region roughly the size of France. Initially the air raids employed Gazelle helicopter gunships armed with HOT (long-range anti-tank) missiles and 20-mm cannons, and Dassault Mirage 2000Ds and Mirage F1-CR reconnaissance aircraft backed by Boeing KC-135 refueling tankers. On Jan. 13, France sent four Rafale fighters to conduct airstrikes in northeastern Mali before joining six Mirage 2000Ds and five KC-135s at France's N'Djamena air base in Chad.

After several days of bombing failed to halt the insurgent advance, Opera-

tion Serval escalated with the Jan. 15 announcement by French Defense Minister Jean-Yves Le Drian that French troop levels in the region would rise to 2,500, including 800 in Mali.

In the preceding days he said Paris had requested logistical support from allies to bolster a strategic air bridge, but only the U.K. was quick to respond, furnishing two C-17 strategic transports Jan. 13 to deliver heavy equipment and supplies to the land-locked country. Dubbed Operation Newcombe, the British aircraft are now in-theater, though one of the C-17s was grounded in France for more than a day due to an undisclosed technical issue.

Le Drian says a number of allied nations are mobilized to offer "concrete military assistance," including Belgium, Canada, Denmark, Germany, Italy, Poland, the U.K. and the U.S.

"This is necessary because airlift is an area where France must improve its capabilities for transporting troops and equipment," says Alain Dupas, an aerospace and defense consultant based in Paris. He notes that when the A400M becomes available "the situation will be significantly different."

France has ordered 50 A400Ms to be delivered starting this year and will be the first nation to receive the new strategic airlifter. Last year, Airbus Military was set to begin A400M deliveries to the French air force in November 2012, well ahead of the contractual deadline

in March, but the program was massively restructured in 2009 due to major development delays.

In September, the first two A400M deliveries were shifted to the second quarter this year related to engine issues that have since been resolved. Function and reliability trials took place in December and the aircraft is due to fly again early this year. Airbus Military is now planning four A400M deliveries in 2013, three to France, one to Turkey.

In October, when Paris began hinting at a Malian intervention, lawmakers questioned the readiness of the air force's strategic transport capability.

"Where is the A400M?" Philippe Folliot asked French armaments agency (DGA) Director Laurent Collet-Billon during testimony before the defense commission in October. "Can deliveries be accelerated, if only to avoid having extend the life of our old Transall?"

Collet-Billon said that by June the air force should begin crew training and planning for pre-operational capabilities.

"I am in favor of increasing the number of A400Ms if given the budget, which is not the case," Collet-Billon told Folliot. "It is convenient to make a trade-off between the transmission capacity logistics and intervention on the ground."

Since Hollande took office in May, the government has been reviewing defense priorities in light of the nation's fiscal crisis. A new strategy and program law are expected in the coming weeks. Already the military has faced a funding reduction of about 10% in 2011-13 that has forced delays in major programs, including procurement of new multi-role tanker transports set to replace the air force's 50-year-old tankers. The first new aircraft now is expected in 2017. ☐

The first production A400M to sport the French air force livery is at the Airbus Military final assembly facility in Seville, Spain.



Critical Element

European technology key to early development of NASA crew vehicle



Mark Carreau **Houston** and Amy Svitak **Paris**

Lacking the ability to finance costly manned space missions on its own, Europe has long had ambitions to serve as a junior partner in a collaborative campaign that would send astronauts beyond low-Earth orbit.

In January, the European Space Agency (ESA) found the right partner in NASA when the U.S. space agency announced plans to put Europe on the critical path for early development of its Orion/Multi-Purpose Crew Vehicle, a vessel designed for mission to cislunar space, near-Earth asteroids and perhaps Mars.

Under the agreement announced Jan. 16, ESA will leverage its International Space Station experience with the Automated Transfer Vehicle (ATV) into a critical-path responsibility: an ATV-derived service module for one and possibly two test flights of the Orion atop the new Space Launch System (SLS) that NASA is developing for manned exploration of the moon and beyond.

Top officials at both agencies credit their long-standing partnership in the 15-nation International Space Station (ISS) as the basis of a budding alliance that could place European astronauts aboard future U.S.-led deep-space missions. Specifically, ESA's pledge to provide five ATV cargo resupply missions to the six-person orbiting space lab between 2008-14, a barter agreement that covers Europe's share of the ISS common operating costs through 2017.

Instead of continuing ATV production, elements of the EADS-Astrium ATV will be adapted for NASA's Exploration Space Mission-1, an uncrewed 2017 test flight of the Orion capsule and an initial version of the SLS on a flight to the lunar environs, says William Gerstenmaier, NASA associate administrator for human exploration and operations. Spare service module components developed under the new agreement, if available, could be rededicated to the service module portion of Exploration Space Mission-2, a 2021 piloted test of the Orion and SLS on a similar trajectory.

The preliminaries, including hardware responsibilities and contractor roles, have been in the works for months. ESA ministers pledged a 60% commitment of their cost—about €455 million (\$600 million) in late 2012. The balance could come in mid-2014 if ESA's 20 member states commit the remaining money in a new multi-year spending plan, says Thomas Reiter, a former astronaut who heads ESA's human spaceflight and operations division.

"This is the normal process," Reiter says. "There is a clear path forward and a clear commitment on a basic programmatic ground for the time until the end of this decade."

The service module contribution has strong backing from Germany, which has shouldered 40% of Europe's spending on the space station to date. Others, notably Italy, reduced their contribution to the program through 2014, while France—

An ESA service module will propel the NASA test-flight of the Orion crew capsule in 2017.

ESA's second-largest contributor—is cautioning only provisional support for ISS through the end of the decade.

"France is ready to pursue ISS to 2020 provided we are able to master the costs," Joel Barre, head of operations for French space agency CNES, said Jan. 15 in Paris. "We also believe there should be better balance between Europe and the U.S., and hope [Orion] could redirect our operation to a more balanced relationship in the decision-making process."

Still, the two agencies expressed cautious optimism about the future course of the partnership, the first international involvement in NASA's deep-space ambitions, which are focused on a human mission to a near-Earth asteroid in 2025.

"When we talk about international cooperation, it is not talked about lightly here," Gerstenmaier says. "We probably would not have done this without the experience we had on the space station. We have learned the real meaning of cooperation is not actually counting on your partner to be there. It's actually giving up a piece of the spacecraft. That was not done lightly."

Reiter agrees: "We are looking for synergies in technical and programmatic ways. ESA has proven to be a reliable partner in the context of the ISS. Based on that, especially the ATV, this is a good choice to make for exploration—synergies that have been developed in the past that can be beneficial for reaching a common objective."

Under the terms of the agreement, NASA will furnish the Orion capsule, launch-abort system and adapters that protect the capsule's heat shield. NASA will also merge the service module to the SLS as well as jettisonable fairings.

ESA—most likely through ATV industrial prime contractor Astrium Space Transportation—will provide the actual service module structure, holding propulsion and solar-power components as well as the life-support needs of the Orion crews. The first service module will integrate spare NASA shuttle Orbital Maneuvering System components. The Europeans will also provide sustaining engineering for their hardware, which could be used for the second Orion flight in 2021. Beyond that, however, Gerstenmaier says Europe's continued participation in Orion is unknown.

"We have made sure we have kept the right intellectual property that's available to us on the NASA/U.S.-government side so that we can manufacture the follow-on service modules if we need to on our side, or if we decide it is advantageous to us to continue on those future flights with the Europeans, we can work with the Europeans to do that,"

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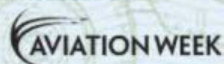


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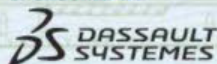
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Gerstenmaier says. "We've really made no decisions about those future flights."

In the meantime, Bernardo Patti, ESA director of operations for the ISS, says industry will operate under a tight schedule to develop and integrate the service module hardware in time for NASA's planned 2017 test flight. Although industry contracts have not been awarded, he expects the project to achieve preliminary design review (PDR) in 2013.

"We are placing industrial contracts and we are facing the very challenging schedule that will bring us to PDR by the second part of the year," Patti says. "The team is extremely excited and enthusiastic [and] looks forward to the PDR to confirm that all the expectations we are building will materialize further."

NASA has no plans to alter its \$6.6 billion agreement with Lockheed Martin, Orion/MPCV prime contractor, says Mark

Geyer, NASA's Orion project manager. Plans for a late-2014 unpiloted test flight of the Orion atop a Delta IV heavy will not be affected by the ESA agreement. That test will feature a high-speed reentry of the capsule to test the heating shielding and verify other systems prior to the capsule's planned critical design review.

ESA decided a sixth ATV would cost more than the €455 million the agency's member states owe to cover Europe's share of ISS common operating costs through 2020. Instead, NASA accepted the ATV-derived service module proposal, leaving ATV's supply role to new U.S. commercial resuppliers, SpaceX and Orbital Sciences Corp. The propellant that the ATV furnished will not be needed, as past operations show the station's propulsion needs can be handled by future Russian Progress flights, said Mike Suffredini, NASA's ISS program manager. ☛

Poor Protection

Contamination concerns could mean Curiosity rover operational impact

**Frank Morring, Jr. Washington and
Guy Norris Pasadena, Calif.**

An apparent lack of rigor in maintaining cleanliness on the Curiosity rover while it was being assembled may one day force a hiatus in its use to explore Mars, if its instruments detect the possibility that life-supporting water exists nearby.

NASA's planetary protection officer, the scientist in charge of ensuring U.S. terrestrial probes do not contaminate celestial bodies, certified Curiosity for landing only because it was targeted on an equatorial crater that is unlikely to harbor subsurface water. Had planetary scientists chosen another landing site, mishandling of the rover's wheels and drill bits on Earth might have forced a two-year slip in launching until the next planetary window.

NASA officials, including Planetary Protection Officer Catharine Conley, stress that Curiosity is "fully compliant" with international protocols dating back to the Viking missions. Those standards were designed to ensure that any life found on Mars originated there, and did not arrive on the lander that found it or an earlier robotic visitor from Earth.

However, if Curiosity turns up evidence of contemporary water or ice as it explores Gale Crater, it may be commanded to back off from the potentially life-sustaining area while astrobiologists and planetary scientists ponder whether the rover could "forward contaminate" Mars.

"We have data that suggest [Gale Crater] should be very dry," Conley says. "If somehow we discover something that means we have misinterpreted those data, before the project does anything about contacting those interesting places, they have to tell me, and I will convene my advisory committee, a

subcommittee of the NASA Advisory Council, and I may even ask the Space Studies Board [of the U.S. National Academies of Science]—that's within my mandate—and we will actually get a good scientific review of all of the information the mission has collected, and doing that review, we will decide how to go forward."

The problem is a little more acute now that the science team controlling the rover has selected an area of flat-lying rock containing a target-rich environment of fractures, veins and mineral concretions for the first use of its drill to collect subsurface samples. The drill bit is one of the items that was exposed to possible contamination during the rover's assembly, requiring Conley to accept the lower cleanliness standard.

The target area lies within a shallow depression called "Yellowknife Bay," which lies around 500 meters (1,640 ft.) to the east of the rover's landing site. It was originally identified from orbital observations of fractured ground that cooled more slowly each night than nearby terrain. To the untrained eye, it strongly resembles a dry lakebed (see photo, p. 32).

"The orbital signal drew us here, but what we found when we arrived has been a great surprise," says Mars Science

Laboratory (MSL) project scientist John Grotzinger, of the California Institute of Technology in Pasadena. "This area had a different type of wet environment than the streambed where we landed, maybe a few different types of wet environments."

To prevent contamination, the basic standard for a spacecraft like Curiosity that touches Mars in equatorial regions such as Gale is no more

than 300 bacterial spores per square meter, or 500,000 spores for the whole spacecraft (a clean terrestrial kitchen would have billions of spores). Those standards can be achieved by cleaning the spacecraft with alcohol wipes, and assaying its cleanliness by culturing samples swabbed from the hardware.

In a cold, dry equatorial region, bathed by ultraviolet light from the Sun, scientists believe that any bacteria reaching Mars would soon die. But after the Mars Phoenix lander confirmed subsurface water ice at the planet's poles, the standard was enhanced to include a requirement for heat treating the hardware to kill any spores that might thrive in highly saline underground Mars water.

**"We will interact with
unknown surface terrain
and it is the first time
we've ever done that"**

That standard was not met on the rover's drill bits and wheels, which were removed from protective containment after sterilization for more work. Nor were procedures followed when insulating blankets were installed inside the heat shield that later crashed on the planet's surface. In the latter case, which left 34 sq. meters (365.9 sq. ft.) inaccessible for assaying, the hardware was cleared by sampling "a small subset of the area through the installed blankets," according to a presentation by consultant Pericles D. Stabekis, who studied the issue for the NASA Advisory Council.

Stabekis found that planetary-protection staffing on the Curiosity program was inadequate, both at the Jet Propulsion Laboratory and at NASA headquarters. That made it difficult to keep track of the compliance paperwork, and led to discovery of the non-compliant work less than three months before launch—too late in the launch preparation for corrective action. Fortunately, by then scientists had selected Gale Crater as the landing site, and Conley was able to recategorize the landing requirement from Category IVc to the less rigorous Cat. IVa, which did not require heating.

"It was a very big, complicated project," Conley says. "There were [procedural] things that fell between the cracks."

Teflon seals within the drill assembly are another potential source of drilling-site contamination from the Mars Science Lab mission that includes Curiosity. Although not biological, NASA Jet Propulsion Laboratory MSL project manager Richard Cook acknowledges there are scientific implications.

"While it had a noticeable impact [the analysis team] thought they could work around it essentially," he says. "Teflon is a well-characterized substance, and so although it has potential [to skew a sample], that's not very likely since they know what Teflon will do."

The presence of polytetrafluoroethylene (the chemical name for Teflon) and another potential contaminant from

the drill, molybdenum disulfide, will be detected and taken into account by the Curiosity's Sample Analysis at Mars instrument, say project scientists.

At Conley's request, the chief engineer's office at NASA is including planetary-protection lessons-learned in its review of the entire MSL project. And in her recategorization, she prohibited Curiosity from entering a "Mars Special Region" that might sustain terrestrial life, including "fluid-formed features such as recurring slope linea"—seasonal bands on the surface that may be caused by flowing water below.

"Any evidence suggesting the presence of Special Regions or flowing liquid at the actual MSL landing site shall be communicated to the planetary protection officer immediately, and physical contact by the lander with such features shall be entirely avoided," Conley stated in the document authorizing the landing.

Preparations for the start of actual drilling will take another few weeks. "Drilling is the most significant engineering task we've done since landing," Cook says. "We will interact with unknown surface terrain and it is the first time we've ever done that."

Named John Klein to honor a deceased deputy project manager on the rover, the drilling site includes veins and concretions that are geological indicators of precipitation of minerals from water.

"This is why we selected it for drilling," says Grotzinger, the project scientist. "Water went through these rocks and precipitated chemicals. It is the first time in this mission we've seen something that is not just an aqueous environment but also one which results in precipitation of minerals." ☛



Scientists have selected this flat rocky area for first use of the Curiosity Mars rover drill (inset). Problems handling the drill before launch could block its use in areas that might have subsurface water, to prevent contamination with terrestrial microorganisms.



Eastern Promise

Takeover gives Enstrom new market access

Tony Osborne **London**

Enstrom Helicopter is the latest general aviation manufacturer to be taken over by Chinese investors as the country paves its way toward more open skies.

The Michigan-based manufacturer joins a long list of light aircraft companies being snapped up by China's vast industrial complex in expectation of the demand for gen-

Sales of military flight-training rotorcraft to Thailand and Japan helped Enstrom through the economic downturn.

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eral aviation likely to come from the long-awaited deregulation of China's airspace. But the Enstrom deal is more significant than it might seem at first glance.

The deal by Chongqing Helicopter Investment Co. (CQHIC), believed to be worth \$60 million, represents the first Chinese takeover of an entire helicopter manufacturer. For decades, Chinese industry has been working closely in partnership with Western helicopter firms to build knowledge and experience. While in a bid to get closer to the market, companies like Eurocopter, AgustaWestland and Bell have opened final assembly lines for select products in the country.

But many of these partnerships have formed in conjunction with, or under the watchful eye of, state-owned manufacturer Aviation Industry Corp. of China (Avic). Chongqing's purchase of Enstrom means that China now has a second helicopter manufacturer, under private ownership without the constraints and red-tape imposed by the state, albeit sitting on U.S. soil.

The buy also gives ambitious Chongqing real insight and experience in helicopter production, the general aviation industry and selling to customers outside China. Chinese airworthiness standards and certification levels are little recognized outside of the country, which makes sales of Chinese-built helicopters to those not aligned with the country simply an aspiration, at least for now.

CQHIC is no stranger to Western companies. In 2011, shortly after it was formed, the investment group signed a memorandum of understanding with AgustaWestland in the hope of producing the manufacturer's helicopters locally. But the two parties broke off discussions and the project appears to have fallen by the wayside.

For Enstrom, very little will change. The company has been owned by foreign parties for much of its 50-year history. CEO Jerry Mullins and his team did not have much to do with the takeover process, which simply saw Enstrom transferred from its previous owner, an anonymous Swiss investor.

"The first thing that everyone asks is, 'What has changed?'" says Tracy Biegler, Enstrom's marketing director. "Nothing has really changed. We still have the same management struc-

China's Aerospace Buying Spree

2009

Avic acquires Fisher Advanced Composite Components (FACC), a European aerostructures supplier.

2010

Avic purchases Epic Air, a U.S.-based general aviation kit aircraft manufacturer.

A Chinese partnership that acquired control of U.S.-based Brantley Helicopters in 1994 buys Superior Air Parts, a Texas engine and parts maker, and sends all of the Brantley tooling to China, where the company is attempting to develop an unmanned aerial vehicle.

Avic acquires U.S.-based Continental Motors, the second-largest manufacturer of piston engines.

2011

China Aviation Industry General Aircraft Co. buys U.S. general aviation manufacturer Cirrus.

2012

Bankrupt Hawker Beechcraft announces it is negotiating a sale of its non-defense businesses to Superior Aviation Beijing for \$1.79 billion. Negotiations later collapse after U.S. regulators express concerns about technology transfer.

Jilin Hanxing Group takes over Glasair Aviation, manufacturer of homebuilt aircraft.

Enstrom becomes the first helicopter manufacturer to be taken over by Chinese investors when Chongqing Helicopter Investment Co. buys it.

Sources: ICF SH&E and Aviation Week Intelligence Network

ture, the products are the same, but we don't really know what the future holds." Of course, Enstrom is hopeful that Chongqing's investment will bring more success.

"For Chongqing, this takeover isn't just about the manufacturing," Biegler says. "China already has a lot of experience in building helicopters and aircraft. A significant part of their decision is about gaining the experience and knowledge about the infrastructure of general aviation industry. That's an aspect they do not currently share with the rest of the world."

Biegler says there are no plans to move away from the U.S., but he adds that some production could take place in China and offer opportunities for the company's supply chain. More critically, Enstrom hopes the takeover will help boost sales. Chongqing would like the company to achieve a 30% share in the Chinese light helicopter market and sell 110 aircraft per year by 2015, a rate not seen by Enstrom since the 1970s.

While they have never sold in the volumes that their competitors at Robinson Helicopter Co. have, Enstrom's family of piston and turbine-engine light helicopters are seen in the industry as highly robust and cost-effective. Today, the company's product line consists of the turbine-powered 480B and the piston-engine F-28F and 280FX models. The rotorcraft have been adopted for a wide range of roles from agricultural spraying to law enforcement.

For many years, Enstrom relied on the general aviation sector for much of its business, but it was able to diversify and secure against the worst of the economic downturn when it snagged a series of lucrative contracts for training helicopters in the Far East.

Enstrom has delivered 16 rotorcraft to the Thai army and it is building the last 20 in an order for 30 helicopters for the Japanese Ground Self-Defense Forces. Enstrom officials say they are working on at least four further military training program contracts.

The company has some experience in China, too. Through established dealerships, Enstrom has a backlog of 12 helicopters destined for China. Several of its helos are already being used for agricultural spraying in the country, and the Wuhan police operate a pair of 280FXs. ☼

Answers to Quiz on Page 16

1. D.
2. B.
3. C. GE I-A. (Photo credit: GE Aviation)
4. A.
5. C.
6. B.
7. A.
8. D.
9. False.
10. A-3; B-4; C-1; D-5; E-2.
11. False.
12. C.

Garmin's Drive to Autos

Aviation fuels avionics maker's move into 'infotainment' systems

John Croft Washington

Lessons learned from building highly integrated avionics suites for aircraft could soon help Garmin gain the pole position in the emerging market for integrated "infotainment" systems for automobiles.

The avionics maker, which has made a rapid climb into the flight decks of a growing number of piston aircraft, business jets and even unmanned aircraft, revealed this month at the Consumer Electronics Show in Las Vegas that it has developed a glass cockpit for automobiles.

Called K2, the system integrates the functions that are becoming standard with today's cars—displays, voice control, infrared buttons and smartphone access—in a way that parallels information management on a flight deck.

Garmin is serious about the potential, with a "very large percentage" of its 1,000 automotive sector engineers working on the project, says Bill Stone, avionics product manager for the company. "It's a large strategic move for us at this point. One of the founding principles at Garmin is to service multiple markets and benefit from the synergy of staying in different markets with common technologies."

The engineering work is ongoing at the company's Olathe, Kan., location, where automotive engineers work in the same building with aviation and marine sector engineers. "From a profit-and-loss standpoint, the business segments stand alone, but are housed in the same building," says Stone. "We identified the need many years ago in the aviation market to have strong systems-engineering teams to understand the very disparate systems across the aircraft, even with parts we don't make. We replicated the capability within the automotive team."

Stone says Garmin is seeing a "tremendous amount of convergence" across the automotive, aviation and marine segments, with cars, aircraft and boats becoming equipped with similar and increasingly complex systems. "They are integrated within and connected to the outside world."

"Today's higher-end automobiles are typically networked vehicles," says Stone. "There are numerous processors within the vehicles, for braking, fuel and traction controls, audio and navigation functions, and the processors are available on a network, which enables a network solution to elements on the vehicle. Inside the vehicle, we're converging all those different kinds of data so the driver can manage all those systems."

Stone says what has been lacking are "very highly integrated turn-key solutions from a single supplier."

Garmin's turnkey K2 has been incubating for a decade. "We've been working with various automotive and even motorcycle [original equipment manufacturers] for 10 years now," says Stone. "We have been learning as we go along. We have had niche product wins, and our product has been evolving." Niche wins include navigation systems that were dealer-installed options rather than forward-fit, the path for K2.

Stone says human-factors design will be a key element of K2, with the company leveraging customer experience with technologies such as speech recognition, already being used by millions of customers largely in the automotive sector. "To learn from field experience just from aviation would take very long," says Stone.

Garmin has not yet announced a launch customer for K2, but Stone says the market is "primed" for the product. "We're seeing levels of integration increasing over the past 10-15 years, and we believe the market to be pretty prime to take it to the next step. There were 7-8-inch displays in the dashboard 10 years ago for only the largest luxury vehicles. Now we're seeing [those displays] in the lower end. To take this to 10-12-inch technology, consumers will react to that pretty well."

Stone says high volumes for sales in the automotive sector will be boons for the adjoining sectors, including aviation, because of Garmin's common procurement strategies and the ability to get preferential treatment from suppliers. ☛

Garmin is leveraging its glass cockpit expertise to become an integrated systems provider for autos.



Details, Details

Foreign-managed Hongkong Jet is HNA Group's launch pad for an international bizjet management operation

Bradley Perrett Hong Kong

China's HNA Group has big plans in business aviation. It also has a healthy dose of prudence. The Chinese travel conglomerate, which is an outgrowth of Hainan Airlines, is aiming at building a global business-aircraft management operation. But in deciding three years ago to do that, HNA realized that there was too much that it did not know about the industry.

The result has been an unusual instance of a Chinese company setting up an offshoot staffed entirely by costly foreigners. HNA aims to use this offshoot, Hongkong Jet, as the core of its global business aviation activities. The group's long-established bizjet operator, Deerjet, could have been tasked with international expansion but is sticking to its mission of growing in mainland China. And at some point, Hongkong Jet is supposed to transfer its expertise back to China.

HNA's challenge stems mainly from the finicky details of exquisite service. China's business aircraft management companies are proliferating, thanks to easier regulation and a growing awareness among the country's upper class and big companies that private jets are attainable and useful. But the many fine points that make up a luxury offering can escape the operators. It may be a good thing that the Chinese companies are competing mainly with each other, so they do not suffer too much pressure while learning to get the service just right.

One Western traveler recalls the service on a chartered Chinese business jet last year. When he asked for orange juice, the cabin attendant fetched a cardboard carton for him. His companion asked for coffee and was given tea. No one asked what they wanted to eat; they got what was available, and it was, at best, airline food.

Is this a big deal? In business aviation, you bet it is. When people pay thousands of dollars an hour to use a private aircraft, they expect the best service.

Hongkong Jet is based in the semi-autonomous city it is named after, but is drawing up plans to move into North America, Europe and maybe elsewhere in Asia, says Chief Executive Chris Buchholz. It will probably do so by buying existing management companies, he adds, reckoning that the group will have three or four air operator's certificates by 2016, even if 100% stakes will not be allowed in some countries, notably the U.S.

The expansion plans of Hongkong Jet are just part of the HNA Group's broad strategy of international acquisitions. The sprawling conglomerate has subsidiaries in hotels, entertainment and much more, plus just about every aspect of civil aviation that it can reach. The group states that it is undertaking a multi-year program of buying businesses abroad, noting that amid widespread economic troubles, some targets are cheap. That is as true in business aviation as anywhere. With HNA behind it, Hongkong Jet should be able to pay for any aircraft management company it sets its sights on.

Although the provincial government of Hainan is a shareholder in HNA, the group is largely private.

Hongkong Jet could set up a fifth operation, in mainland China, Buchholz says. If it does, the company will surely have to play corporate politics with care, since the mainland is Deerjet's territory. Hongkong Jet says that if it moves into mainland China it will offer a service different from Deerjet's.

HNA does eventually want the new company to help Deerjet reach international service standards, but Buchholz says that for the moment Hongkong Jet is too busy with expan-

Hongkong Jet operates mainly from Hong Kong, but the company also manages aircraft elsewhere in Asia.



HONGKONG JET PHOTOS

sion. He confirms that achieving exceptional service quality was a key reason for setting up his new company.

And it is quite a new company, having received its air operator's certificate in November 2011. By August it had 11 aircraft under management, meaning it maintains them and provides pilots and cabin attendants. Those 11 range from a Hawker 4000

to an Airbus A330. One more aircraft, owned by the company, is used for charters. The managed fleet is growing at about 10 aircraft a year.

One might have thought such growth would unnerve Hong Kong's Civil Aviation Department, but Hongkong Jet was designed to expand rapidly—another sign of its role as the kernel of a larger business. "It is a new company but it is not a new team," says Buchholz. Many of the top managers had worked for a similar Hong Kong company, Metrojet, earlier in their careers. The CEO, chief operating officer and maintenance boss are among them. In its early stages the company is deliberately overstaffed, with 73 people, including 23 maintainers. It helps, too, that some of the aircraft Hongkong Jet now manages, transferred from other operators, have come with the crews and maintainers who were already operating them.

As a subsidiary of a Chinese mainland company, Hongkong Jet is remarkable in having no mainland Chinese employees. Buchholz is Norwegian; the rest of the staff come mainly from various Western countries, Southeast Asia and Hong Kong.

Establishing subsidiaries that are managed by well-paid foreigners is hardly something that Chinese companies instinctively do, even if it is now not unusual for them to buy mature foreign businesses and leave all or most of the managers and workers in place. But the simple truth, which HNA seems to have recognized, is that attention to detail is not a common habit of managers and workers in China; it is, after all, still a developing country.

Some Chinese businesses produce excellent goods or services, but the management effort in getting to that level is usually greater than in most developed countries. Also, a company must know what counts as a good service if it is to provide one; that is not so easy when one is moving into a new business activity and when the so-



**Hongkong Jet
CEO Chris Buchholz**

cial background of managers and workers gives them little ability to judge.

In business aviation, this is showing up not just in the imperfect cabin service typical of Chinese bizjet operators. The aircraft can also be less than spotlessly clean. After a few years of service, their costly wooden cabin fittings might look ill-treated and overdue for new upholstery. The pilot may not bother with the courtesy of telling passengers about the flight plan.

Part of the problem is that the mainland companies are expanding quickly and lack experience, says Jason Liao, chief executive of consultancy China Business Aviation Group. Liao also doubts that Deerjet would have had the management time for foreign expansion.

Hong Kong aviation consultant Jeffrey Lowe, with extensive experience in the local industry, agrees that a mainland management company would have great trouble in offering acceptable service internationally. He remembers once having to explain to a cabin attendant of a mainland operator that the client's meal should be presented attractively, not slopped onto the plate as it might be in a staff cafeteria. The cabin attendant was not lazy; she just did not know. No one had told her before.

Lowe sees another great advantage in HNA setting up the Hong Kong subsidiary: It can help resolve a remarkable clash between Chinese buyers' expectations and the regulator's rules. Chinese buyers of almost any general aviation aircraft, including business jets, tend to approach the transaction as they would when ordering a new car—they want it next week. And while the buyers are unusually anxious to hop in and fly, the Civil Aviation Administration of China is unusually slow in registering their aircraft. The process can take six to eight months, says Lowe.

This creates an opportunity in first registering an aircraft outside of mainland China and flying it from a Hong Kong site until its Chinese registration is ready. Lowe's former employer, Business Aviation Asia, does that, and Hongkong Jet offers that service, too. Buchholz says its customer base is split fairly evenly among Hong Kong, mainland China and Southeast Asia, where some of the aircraft are located.

Despite the awkwardness of flying in China with private aircraft that are not registered there, some mainland customers prefer to keep their aircraft in Hong Kong indefinitely. Operators of non-mainland aircraft normally need to file flight plans two working days before taking off in China—largely eliminating the flexibility that is one of the greatest advantages of a bizjet. And after seven internal flights, the aircraft must leave China. That may not be such a problem for clients who often need to fly abroad, however. ☐



It is unusual for a Chinese company to set up an offshoot fully staffed by foreigners, as HNA has with Hongkong Jet.

Airbus delivered 30 A380s in 2012 and plans to hand over another 25 to its customers this year.



AIR TRANSPORT

Playing It Safe

In spite of strong 2012 orders, various factors have Airbus slating a modest ramp-up in 2013

Jens Flottau **Toulouse**

Airbus has far exceeded its own sales targets for 2012. Its biggest challenge may soon be to find production slots for additional orders.

The European aircraft manufacturer rang out 2012 with a surprisingly high number of orders—914. That is 40% more than its internal sales target of 650. Airbus delivered 588 aircraft last year. As positive as this news may be for the company when compared to its earlier guidance, Boeing has still taken the lead from its major rival in both orders and deliveries for the first time in many years.

While the title of the “world’s largest aircraft builder” is gone for now, Airbus is pointing to some other figures that it finds encouraging from its perspective. Chief Operating Officer for Customers John Leahy insists the A320NEO (new engine option) has held its 62% market share over the Boeing 737 MAX.

“We started earlier, we have a better product, the market has already spoken,” Leahy says. He believes Airbus will be able to remain above a 50% market share for the program. Also, the company has made progress in achieving its target of transitioning from the current A320 to the NEO as smoothly as possible. Airbus sold more than 300 current-engine A320s in 2012 and targets more than 200 in 2013. The company also emphasizes that for 2011 and 2012, its market share held steady at 52%.

In spite of its stronger-than-expected sales in 2012, the company is taking a relatively cautious approach for the

current year. Leahy forecasts approximately 700 orders and the plans are to deliver more than 600 aircraft, which is likely to translate only into a modest production increase. The company has also raised list prices by 3.6%, so a new Airbus A380 is now worth \$403.9 million, before discounts.

The A350 program remains on track for first flight this summer, according to CEO Fabrice Bregier. Airbus has an “internal target” of flying the aircraft before the Paris air show in June, but he also cautions that “if we fly just after the show, it does not make any difference to me.” He points out that Airbus is still facing “supplier challenges” and that the program may still encounter an unforeseen problem. While sticking with the decision to not reengine the A330, Bregier indicates that there is an “upside” of going beyond the current 10-per-month production rate.

When it comes to the A380 program, Bregier says that the “wing rib feet issue is now behind us. We have found the root causes of the problem and we have found the solution.” Both the retrofit to existing and in-production aircraft and the line fit for new deliveries are going to be implemented this year. In spite of the difficulties, Airbus plans to deliver 25 A380s in 2013 and to sell a similar number while increasing output in 2014.

The European Aviation Safety Agen-

cy (EASA) is moving closer to certifying proposed permanent repairs and newly designed wings for the A380 following the detection of cracks in wing rib feet onboard numerous in-service aircraft last year.

EASA expects to certify the permanent modification to wings of in-service aircraft and those that have been built—but not yet delivered—in the first quarter of the year, according to an official. EASA certified the work for in-service aircraft in late December 2012, although the approval comes with a two-year limit because some of the paperwork is not yet finalized. That preliminary certification is to be replaced with a permanent approval in the first quarter alongside full certification of the work on aircraft that are completed, but have not yet been delivered.

Certification of the newly designed wing is now expected to occur in the second quarter of this year, although EASA has not commented on the exact schedule. The new wings will become available in early 2014. Qatar Airways has deferred delivery of its first A380 by several months to enable Airbus to integrate the redesign on all Qatar aircraft.

In-service aircraft are currently subject to short-interval checks and preliminary repairs that have to be repeated, depending on utilization. The permanent fix, which includes replacement of several hybrid ribs composed of composites and the Al 7449 alloy, is expected to require aircraft to be grounded several weeks. Airbus has also offered to provide airlines with a repair schedule that can be included in C checks so that no additional ground time is needed. However, this accommodation would spread out modifications over a longer period.

The modifications to in-service and yet-to-be-delivered aircraft involve 120 units, 92 of which had been delivered by the end of last November. ☐

Reality Bites

Polish flag carrier could be next in the long line of failing European airlines

Jens Flottau **Frankfurt**

LOT Polish Airlines has been in crisis mode for years. But the situation is becoming more precarious and the carrier may soon look much different—if it manages to survive.

The airline is facing drastic downsizing, according to comments made by Polish Treasury Minister Mikolaj Budzanovsky. He told parliament that the airline will cut at least 30% of current jobs in the first quarter and significantly reduce its fleet. According to Budzanovsky, LOT will retire around 15 aircraft—more than a third of its fleet. And given the dramatic state of its finances, the further move toward an all-Boeing 787 long-haul fleet could be in doubt.

LOT declined to confirm Budzanovsky's comments, stating only that it has "set the restructuring process guidelines. Details are being developed. After taking a final decision we will announce it."

The Polish government agreed to provide a 400 million zloty (\$129.6 million) loan to LOT late last year as a first tranche of financial aid for the in-the-red airline. Former CEO Marcin Pirog was forced to resign after the extent of the airline's financial troubles became more obvious.

The LOT story is one of an airline that has failed to modernize enough. Formerly a classic Eastern European state carrier, the Polish government never succeeded in privatizing it. Partly because of state ownership, the airline could not divest itself of legacy structures and political interference. Due to relatively high unit costs, it cannot compete with low-cost carriers.

But LOT's problems extend beyond competition from Ryanair, EasyJet and Wizz Air. The Polish airline is being squeezed out by the big three European airline blocks—Air France-KLM, Lufthansa and International Airlines Group (IAG)—which dominate the more-profitable long-haul markets. Lufthansa, the Polish carrier's partner in Star Alliance, has no interest in LOT operating an extensive long-haul network in its own right, but would rather it feed traffic via Munich and Frankfurt to fill the German carrier's widebodies.

Early in 2012, Malev Hungarian Airlines became the first of the former Eastern European flag carriers to collapse. Like LOT, the airline had been under financial duress for years, but it ultimately failed because the European Commission demanded payback of a government loan.

LOT's case is more nuanced, however, because Poland is now one of the larger European economies, healthy enough and growing, so it should be able to sustain a well-run airline. The carrier has shifted its focus to Eastern Europe in a quest for underserved markets.

That decision has consequences for its fleet strategy. While LOT wants to continue to operate trunk routes, it is looking at outsourcing all of its narrow-body flying to a partner carrier. For its own short-haul routes, LOT wants to use a fleet of Embraer E-Jets that can serve legacy routes below the classic Airbus A320 and Boeing 737 markets. The danger, however, is that by operating smaller aircraft LOT becomes even more vulnerable to low-cost carriers

if they place larger jets on competing routes.

It is still unclear what part of the fleet is going to be retired. LOT has said earlier that it will phase out its remaining four Boeing 767-300ERs by March. The carrier has ordered eight 787s and has taken delivery of the first two aircraft so far. Whether it can afford the rest of the 787s will depend on a pending EC review on whether the government loan provided in December complies with European Union competition rules. LOT earlier on had planned to grow its Embraer fleet to around 40 units, but that seems highly unlikely in light of its current predicament.

LOT is not the only Eastern European carrier in distress. The situation is particularly dramatic at Aerosvit, so far Ukraine's largest airline. The carrier is struggling to keep up a regular flight schedule owing to its growing financial difficulties, but has not yet stopped operations. Aerosvit operated a limited number of flights from its hub, Borispol International Airport, lately, but was forced to cancel numerous services.

Aerosvit says it is "continuing operations and fulfillment of current commitments to its contractors." The reorganization is "part of the change program initiated by the airline in order to restore its operating efficiency and increase revenue inflows." Several of its aircraft have been impounded by its creditors.

Aerosvit has been struggling financially for months, as witnessed by its string of serious service cutbacks. The airline recently initiated bankruptcy protection proceedings. As part of the filing, the company avers that it is unable to service its current debt of around \$550 million all at once and therefore needs deep restructuring and relief. Aerosvit had announced earlier that it will transfer more than 20 of its routes to rival Ukraine International Airlines and primarily focus on domestic flying. ☉

LOT has taken delivery of its first two Boeing 787-8s. Six more are on firm order.



After the Spring

Many carriers in the Middle East are still trying to cope with the fallout of political turmoil

Jens Flottau **Frankfurt**

The Middle East is one of the major growth regions for air travel. But more than 90% of air traffic there does not stay within the region. If its domestic and short-haul international air transport services are to be developed further, major political and economic change will be needed.

"The key challenge for the region is to promote and foster economic and social stability," asserts the Arab Air Carriers Organization (AACO). That is not so much an issue for the Big Three Persian Gulf carriers—Etihad Airways, Qatar Airways and Emirates—that are less exposed to short-haul markets. But most airlines in the Middle East do not have the benefit of large long-haul operations through which they could link growth markets far from their home economies. They rely on tough groundwork such as liberalization that is often painfully slow and political stability that is still a far-fetched goal in some countries.

AACO itself illustrated part of what needs to change by holding its annual general assembly in Algiers, Algeria. The number of delegates was down



To see a breakdown of leading Middle East carriers' fleets in operation and on order, check out the digital edition of AW&ST on leading tablets and smartphones, or go to AviationWeek.com/mefleets

significantly compared to past events, simply because the travel arrangements proved too difficult for many. Some were unable to obtain visas, and those that did were hardly able to leave the conference hotel without bodyguards. Algeria has not been involved in the Arab Spring uprisings or made in any serious attempt to liberalize its economy in general and air transport in particular. It is a good example of how things used to be across more of the Arab world.

But elsewhere things have changed and airlines suffer. Almost every Middle Eastern airline relies on tourism as a major source of income. It nose-dived in 2011, the first peak of the Arab Spring, according to the World Tourism Organization. Egypt saw tourist spending fall by 30.5%, Tunisia was even worse at 32.5%, and Jordan was down 16.3%. These three countries have traditionally been the most attractive destinations for tourists. And, for lack of natural resources, tourism has been their most important source of foreign capital.

If there was any hope that demand would recover quickly, reality has already surpassed it. Egypt has entered another phase of civil unrest as protests against constitutional changes proposed by new President Mohammed Mursi, who is supported by the Muslim Brotherhood, unfold. It is too early to speak of any sustainable tourism rebound anyway, but things are looking bleak again now.

Consequently, airline business models that focus on the region are suffering the most, regardless of whether their own home countries are affected by violent unrest. It goes without saying that Syrian Arab Airlines has had a hard time maintaining anything close to a normal flight schedule, and most other carriers have suspended operations into Damascus, with fighting between government troops and the opposition near the airport making the trip into the city an incalculable danger.



Royal Jordanian was forced to make serious capacity cuts and abandon several routes within the region as demand dropped, even though Jordan itself has remained relatively quiet and stable. Many of the airline's flights were into markets that have been directly affected by political instability, complicating efforts to turn around the already struggling carrier.

Air Arabia shelved plans for more bases outside of Sharjah—one of the United Arab Emirates—mainly because of the political situation and had to redirect growth to other markets. CEO Adel Ali says it is unlikely that will change any time soon. But as long as new routes can be developed from its Sharjah base, Air Arabia is still in good shape compared to others.

The situation is far worse for Gulf Air, one of the region's oldest airlines. Shortly before his long-expected departure, then-CEO Samer Majali renegotiated large aircraft orders with both Airbus and Boeing in light of its precarious state. The airline cut its orderbook dramatically as it retreated from an ambitious expansion plan.

The new agreement between the airline and Airbus "ultimately permits" it to convert an order for 20 Airbus A330-300s into a new commitment for eight A320s and up to 16 A320NEOs. The A320s are to be delivered before year-end and the NEOs will arrive in the "latter part of the decade," says Gulf Air.

The carrier also is likely to reduce

its Boeing 787 order. It had 16 787-8s on firm order and is reducing that to 12-16, depending on "strategic requirements," it says.

Gulf Air has been recording huge losses for some time, with periods of expansion interspersed with restructuring efforts, and it has suffered from legacy problems. The airline was once jointly owned by Qatar, Bahrain, Abu Dhabi and Oman, but eventually all shareholders except Bahrain pulled out. It went through a series of management changes that took it from downsizing to rapid growth and back to downsizing again. A cost-savings program initiated by Majali showed some effect in 2010. But, like Royal Jordanian, Gulf Air has had to suspend a significant number of routes lately due to regional unrest and violence in Bahrain.

One of Majali's major achievements in addition to the fleet downsizing agreement is avoiding a merger of Gulf Air with Bahrain Air, another local airline in serious financial trouble.

With Etihad, Qatar Airways and Emirates much less exposed to the regional markets than their smaller peers, the Arab Spring has also been less of a challenge for them. The Big Three have access to fresh money when they need it, too, although in-

frastructure is an issue they all face.

Emirates has the most pressing need to grow airport capacity, and it made a major step forward in early January through the opening of Concourse A at Dubai International Airport, the new home base for its A380 fleet. Concourse A will be phased in slowly to allow for teething problems to be resolved.

Runway capacity remains a constraint, however: Dubai International Airport has two runways on which aircraft cannot operate independently due to their close proximity, and Emirates can only move to the new World Central Airport once it is big enough to handle the carrier's entire operation.

Separately, Qatar Airways' home base in Doha is moving to a new airport adjacent to the old field this year, following a delay caused by the late completion of lounges in the new building. Doha's new international airport will provide Qatar Airways with a facility for the first time that is built for connecting traffic. Etihad Airways will also benefit greatly when the Abu Dhabi midfield terminal opens. ☛

Follow our live blogging from Dubai and keep track of the latest news and events from Aviation Week's MRO Middle East Conference at AviationWeek.com/mro2013

Silk Road for Cargo

Middle East airfreight market is holding its own

Douglas Nelms **Dubai, United Arab Emirates**

The Middle East air cargo industry continues to be the bright spot in an otherwise depressed worldwide cargo market, which as a whole dropped 1% for the 12-month period ending last September. The Middle East market, in contrast, has remained relatively robust, growing 8.2% during 2011 and 14.1% for the first 10 months of 2012, according to Brad Hart, Boeing's regional director for cargo marketing. Its growth is projected to continue at 5.7% per annum over the next 20 years, particularly as the region continues its movement toward economic liberalization.

While the Middle East itself is not a large origin-and-destination market, it sits astride the fabled "Silk Road," the

crossroads between Europe, Asia and Africa for trade goods moving not only east and west, but north and south.

This hub activity is becoming particularly significant with the growth of "on-demand" goods such as telecommunications equipment, which in turn is forcing a change in supply-chain management to meet the evolving market.

The Middle East is also home to three of the world's fastest-growing international air carriers—Dubai-based Emirates, Doha-based Qatar Airways and Abu Dhabi-based Etihad Airways—all of which are aggressively promoting their cargo and passenger markets, along with the home-base airports that are spending

Gulf Air has been seriously affected by political unrest in Bahrain. Many other airlines in the region are struggling, too.



millions to support that expansion.

The passenger operations of all three airlines are showing rapid growth, and they are ordering newer and bigger aircraft. These procurements relate directly to increased freight operations, since belly cargo accounts for about 70% of these airlines' total freight.

Emirates is the biggest of the "Big Three," ranking second in tons carried among the world's airlines. Emirates operates Boeing 777F, 747-400F and 747ERF freighters, most leased from Dubai Aerospace, but it can put 10-12 metric tons of cargo in the bellies of its Airbus A380s when operated with full passenger loads.

The carrier has had an aggressive global expansion program, particularly to the Americas, Europe and Africa, according to Ram Menen, divisional senior vice president for cargo. He notes that Brazil, in particular, is a growing market for Emirates, which now offers service to Rio de Janeiro and Sao Paulo. The airline launched 15 new routes in 2012, with the latest being Dec. 10 to Phuket, Thailand, giving it a total of 128 destinations.

Emirates is now the world's largest combination carrier in terms of cargo volume (second only to express-carrier

Federal Express), and third in terms of freight ton kilometers (FTK), says Menen. While Emirates reported an increase of just 1.7% during its 2012 fiscal year, it saw a 16% increase in volume during the first six months of 2012. Emirates began service in 1985 and now handles more than 35% of the region's air cargo through its SkyCargo operations. For fiscal 2012, SkyCargo recorded \$2.6 billion in revenue, an 8.4% increase over fiscal 2011 and 16.2% of the total Emirates Group revenue.

Etihad, which started service in 2004, reported a 21% increase in tonnage carried during the first six months of 2012. The airline moved to 19th in tonnage carried by the world's airlines in 2011 from 25th in 2010.

Qatar Airways, in comparison, is growing rapidly, with almost 200 aircraft on order, including Boeing 777 and Airbus A330-200 freighters. Qatar moved to 11th in tonnage carried in 2011 from 17th in 2010.

Saudia is another important cargo carrier, "although it has a bit more of a traditional approach to the business," says Didier Lenormand, Airbus's head of marketing for freighter aircraft, "not so much focused on hub activities, with service to countries with large popula-

tions compared to population of any of the [Persian] Gulf states that are small."

Saudia ranks 24th among international carriers for cargo volume. However, most of its cargo goes by freighter—71.1% main deck vs. 28.9% in the lower hold, compared to an average 27.8% by freighters for the Big Three. Saudia's tonnage grew by 13% in 2011 and by 16% in 2010, according to Boeing.

The two other largest cargo carriers in the Middle East, Egyptair and Gulf Air, ranked 47th and 50th, respectively, among the International Air Transport Association's top 50 airlines for freight tons carried.

Overall, airfreight traffic through the Middle East is expected to triple in the next 20 years, although at a reduced rate, according to Airbus's world forecast. Historically, it grew from just under five billion FTKs to just over 10 billion at a rate of 5.9% in the past 20 years, but it is expected to grow at a rate of only 5% to about 30 billion in the next 20 years, increasing by 2.8 times.

Overall, Airbus forecasts the Middle East fleet will increase to 42 midsized and 80 large freighters by 2031 from 19 midsized and 31 large freighters in 2012. However, the number of freighters being operated is not indicative of the



Emirates operates Boeing 777F, 747-400F and 747ERF freighters.

market because the predominant percentage of cargo is carried in the bellies of the combination carriers.

While there are numerous reasons for the growth of air cargo in the Middle East, two of the major ones are simply a dedication toward growth by the major airlines and what Menen calls egocentricity. It goes back to the Silk Road concept.

"You have 5.8 billion people within eight hours' flight time [from Dubai]. Extend that up to 14 hours and you have about 6.2 billion. Two-thirds of those are east of [Dubai] and of that, two-thirds are [in] India and China. So that is the basic ingredient of the success of this region, why it has become a major hub," says Menen.

The biggest market for the Middle East continues to be Western Europe, with 1.4 million metric tons of air cargo representing 42.3% of the total Middle East traffic, according to Boeing's 2012-13 World Air Cargo Forecast. This tonnage is projected to average 5.7% per year over the coming two decades.

Asia was the second-biggest market for the Middle East, with 1.2 million metric tons representing 35.4% of the market, followed by Middle East-North America, with 283,000 metric tons comprising 8.4% of the air cargo traffic.

China is still a major source of air cargo for the Middle East, although as the economy on China's east coast improves, the cheap labor driving the manufacturing of goods is moving toward northwestern China.

India is also growing as it moves from a traditional service-centered economy into a manufacturing-based one.

"And don't forget Africa," Menen says. "It is a continent unto itself with over 1 billion people. Fifty-five to 56% of the world's minerals are in that continent, and just east of here are the factories of the world. We are already seeing a lot of infrastructure development. That is always a good sign because they are leapfrogging technology."

Only 8-10% of cargo entering the Middle East actually stays there, says Menen. The rest is transient. This allows the Dubai, Doha and Abu Dhabi airports to serve as hubs, with very large aircraft such as Boeing 747s and 777s and Airbus A340s flying goods between major cargo centers while the smaller Boeing 757s and 737s and Airbus A320s serve the smaller markets.

Airports and airlines in the region are spending a good deal of money to

Etihaad Airways could benefit from Abu Dhabi's \$6.8 billion redevelopment project for a third midfield terminal.



develop their individual hubs to enable them to channel a lot of cargo business away from other areas. "That is basically what you do with a hub," says Airbus's Lenormand.

Dubai's new Al Maktoum International Airport, near the Jebel Ali Free Trade Zone, is an \$8.2 billion project to build what will be the world's largest airport when it is finished in 2027. It is now open only to cargo operations. When complete, it will have 16 cargo terminals with a 12-million-metric-ton capacity.

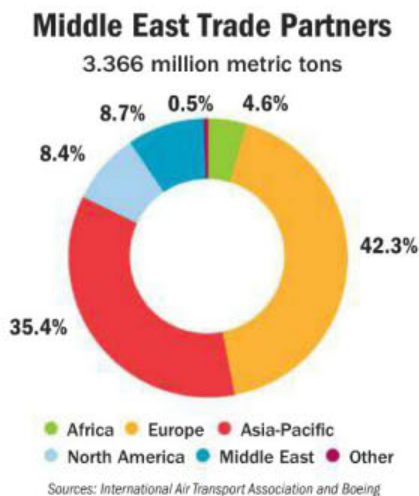
However, Emirates plans to use that capacity only for ad hoc traffic. Menen

need for supply-chain management, involving logistics and inventory management.

Manufacturers have used "just-in-time" shipments to control their inventory for making finished products, but the delivery of those finished products is also becoming more time-critical.

A major item is telecommunications. "Go back to the [cell] phones we used to carry," Menen says. "They were bricks. If you take a thousand units of those bricks and compare them to a thousand units of the Apple iPhones of today, you have just a 10th or 15th of the shipment size. So there is a shrinking [of product volume] going on, but the cycle time, or live time, of these electronics is getting shorter and shorter. The value of any electronic shipment drops by 1.0-1.5% per week.

Europe is the Middle East's largest trading partner by metric tons, according to Boeing's World Air Cargo Forecast for 2012-13.



tells Aviation Week that Emirates plans to continue using its large cargo center at Dubai International Airport, investing \$7.8 billion to expand it into a new "mega cargo facility."

Doha also is building a new airport, at a cost of \$15.5 billion, that is being designed to handle A380-sized aircraft and 50 million passengers per year by 2016.

Abu Dhabi is undergoing a \$6.8 billion redevelopment project for a third midfield terminal as well as new cargo and maintenance facilities, the Mombberger Airport Information report says.

Beyond infrastructure and airline expansion, another impact on growth in the Middle East is the increasing

So the shelf life is very, very short."

Because of these shorter usages, Menen says the manufacturing and product shipping process "takes careful choreographing."

The Middle East freight forwarders are now starting to transform from their traditional role of simply picking up and delivering the freight to being "full-blown supply-chain management companies," says Issa Baluch, a senior fellow at the Advanced Leadership Initiative at Harvard University and founder of the Swift Group in Dubai, a leading logistics provider in the UAE.

The Swift Group also is "working hard toward achieving the goals of e-freight," the movement to eliminate paperwork involved in the movement of airfreight, thus reducing time, cost and effort in the industry, says Baluch.

Menen notes that "we don't use paper any more" at the Dubai hub, and that by 2014 "the industry is looking at taking the paper waybill away." ☐

Emirati Entree

A former C-130 post welcomes the global jet glitterati

William Garvey

Like goldfinches to suet, business jets are drawn to gold, and Abu Dhabi, arguably the richest member of the United Arab Emirates, is capitalizing on that feeding habit. The city/state is in the middle of a multi-year, \$50 million-plus project to transform its original international airport into the region's premier executive jet facility, the only such dedicated airport in the Middle East.

Constructed in the 1960s just a few miles southeast of city center, Al Bateen served as the capital's primary airport until Abu Dhabi International

fixed-base operation (FBO) nor business jet maintenance capability, which have come to be standard features in Western business aviation infrastructure. Eager to attract aircraft and passengers from Europe and North America, as well as the Middle East to what was renamed Al Bateen Executive Airport, ADAC began a major construction and commercial development program, which is still underway.

Among its first moves was to establish a Category 1 instrument landing system (ILS), a key element in guaranteeing the airport's promise of

for the airport, Jet Aviation has established a maintenance facility there. More recently, the operator refurbished three former military hangars, including upgraded offices and workshops. ADAC plans to develop a retail shop area, and lease office and storage space. And co-located on the site is the Gulf Center for Aviation Studies, another ADAC subsidiary, dedicated to training people for aviation careers.

The investment seems to be having positive effect. Three operators—Falcon Aviation, Rotana Jet and AJA—now base 11 aircraft at Al Bateen, comprising four Embraer Legacy 650s, two Embraer Lineage 1000s, two Gulfstream G450s, two Airbus ACJs and several helicopters. Those and transient aircraft accounted for 8,700 movements in 2011, which increased by more than 10% to nearly 10,000 last year. The airport operator anticipates the number of movements, along with the number of based aircraft will increase further in 2013.

In addition to its importance as a financial center, Abu Dhabi is becoming a cultural, tourist and vacation destination, with a number of museums under development, along with marinas, resort hotels and attractions

Close-in Al Bateen Airport is surrounded by residences and commercial properties.

and events such as Formula 1 racing. In fact, the Emirates has announced plans to invest \$500 billion diversifying its economy and infrastructure "in the next few years." All that impacts airport activity. For example, during the race event last November, there were more than 40 aircraft parked at Al Bateen and the airport experienced more than 150 movements.

And, according to Yousif Hassan Al Hammadi, general manager for Al Bateen and two other smaller ADAC airports, the former is becoming a draw for aviation events as well. The inaugural Abu Dhabi Air Expo, the region's only general aviation event, was held there last year. He says the second, planned for March 5-7, will have more visitors, exhibitors and display aircraft, likely to range from light sport models to intercontinental jets.

The airport operator notes that the UAE accounts for one-third of all aircraft in service or on order in the Middle East, pretty much ensuring Al Bateen's future. ☐



AL BATEEN EXECUTIVE AIRPORT

opened for business 20 mi. east of the city in 1982. At that point, the close-in airport, which features a single, 10,499-ft.-long runway, began operation as a military air base, primarily handling transport and cargo aircraft.

In 2006, the Abu Dhabi Airports Co. (ADAC) was formed, charged with developing the Emirates aviation industry, including Al Bateen. The changeover from military to executive airport began two years later. Today, only a handful of UAE Navy and Italian air force C-130s remain, and these are scheduled to transfer permanently in the near future, thereby completing the transition.

While the military base featured an ornate, airside VIP reception building for visiting sheikhs and other dignitaries, there was neither a sophisticated

continuous operation, day and night, throughout the year, despite occasional sandstorms, fog and haze. The ILS also assures approaching aircraft will remain well clear of the blazing white, expansive Sheikh Zayed Grand Mosque—eighth largest in the world—just west of the extended centerline to Runway 13/31. The airport also features non-precision approaches.

The next major undertaking was construction of DhabiJet, the ADAC-owned FBO. Similar in style and amenities to its Western counterparts, it offers a full range of features including pilot and passenger lounges, planning rooms, catering, concierge services, limousine service, and on-site immigration and customs support. The VIP reception and meeting terminal is adjunct to it.

While no other FBOs are planned



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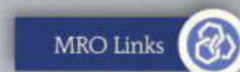
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2013 Laureate Award Nominees

56TH ANNUAL HONORS

Aviation Week's *Laureate Awards* honor remarkable individuals and teams in aviation, aerospace and defense in the preceding year. They range over technology, operations, business and public policy and include both individual feats and organizational accomplishments. Hopefully, they will inspire others to new levels of their own achievements.

Nominations were submitted by our editors, readers and from outside organizations. They included stories of extraordinary leadership, imagination, even heroism. The editors then reviewed all the candidates and, after a sometimes spirited debate, designated finalists in eight disciplines and named one honoree for the Lifetime Achievement Laureate. The remaining Laureates will be announced at a black-tie dinner in Washington on March 7, and fuller explanation of their exploits will appear in the magazine later that month.

AERONAUTICS AND PROPULSION

Working in secret, the **Eurocopter X3 Hybrid Helicopter team** designed, built and flew the high-speed compound helicopter demonstrator in under two years, using company funds. The hybrid has exceeded its design goal, reaching 232 kt.—50% faster than a conventional helicopter.

Few entities burn through more fuel each year than the U.S. Navy, and the service has charted a course to develop the use of alternative fuels unmatched around the globe. **Navy Secretary Ray Mabus** has spearheaded the effort, even in the face of mounting opposition in Congress.

The first flight of the Shenyang J-31 stealth fighter, the first operations of a Chinese-built fighter from an aircraft carrier and the unveiling of an all-new military airlifter in 2012 continued the pace of Chinese innovation in airpower. In 2012, **China's combat aircraft developers** unveiled two new attack helicopters and continued tests of the Chengdu J-20 heavy stealth fighter.

Over a decade, culminating in 2012 with a large-scale wind-tunnel demonstration, the **Speed Agile Powered-Lift Demonstration team**—the U.S. Air Force Research Laboratory with NASA, Boeing and Lockheed Martin—collaboratively developed a revolutionary approach to airlifter design that combines short-takeoff-and-landing utility with airliner-class cruise efficiency.

BUSINESS AND GENERAL AVIATION

A former corporate pilot, **Ron Henriksen** went on to found and head Logix Communications, a Houston-based telecommunications company. Then, as a business aircraft operator, he grew so disappointed with airport inadequacies he



experienced that he went on to address the problem directly, building Houston Executive and Austin Executive airports to serve operators like himself.

After a frustrating experience eliciting information from the FAA as a private pilot faced with enforcement action, **Sen. James Inhofe** (R-Okla.) came to understand personally the problems other pilots encounter in similar circumstances. The result—remarkable considering the paralysis in a divided Congress—was bipartisan passage of his “Pilots Bill of Rights,” which became law in 2012.

Walter Fricke was severely wounded while in combat in his Huey gunship during the Vietnam War. He spent months in hospitals, lonely, worried and in pain. He never forgot that experience and after a successful career in finance, created the Veterans Airlift Command, a nationwide system of business jet operators who transport wounded soldiers and their families—a record 1,800 of them in 2012—wherever they need to go, for free.

COMMERCIAL AIR TRANSPORT

Rusdi Kirana started Lion Air in 1999 with just one aircraft. Today it boasts a fleet of nearly 100, making it one of the world's largest low-cost carrier groups. Lion is the world's biggest customer for 737-900ERs and ATR 72s. It placed an order last year for 230 737s, the single largest order in Boeing's history.

Richard Anderson, CEO of Delta Air Lines, made bold moves with potentially big impacts for Delta and the industry. The airline acquired an oil refinery to reduce fuel costs, purchased a 49% stake in Virgin Atlantic Airways, commandeered the restructuring of regional carrier Pinnacle Airlines, and reached an early labor agreement with its pilots that gives Delta the tools to get rid of more than 200 50-seat jets by 2015.

Shinichiro Ito, CEO of All Nippon Airways, guided the carrier to some major industry milestones while also overseeing the recovery from a 2011 demand slump. ANA became the trailblazer for Boeing 787 operations as the first to introduce the aircraft, and also helped launch two low-cost carriers that are among the first in Japan.

Mark Dunkerley, CEO of Hawaiian Airlines, pursued an ambitious network expansion plan that has seen the carrier look to new Pacific Rim international routes. In an era when growth is seen as risky, Dunkerley has proved that it can pay off when handled properly.

Alex Cruz has turned what looked initially like a shaky undertaking into a real success. Vueling, the Spanish low-fare airline, is not only highly profitable, but very innovative, having long-abandoned the traditional low-fare carrier rule book. This was achieved in spite of the deep recession gripping Vueling's home market.

DEFENSE

Working to a tight schedule to provide reconnaissance teams with an unprecedented combination of protection and mobility, the **British Army/General Dynamics Force Protection (U.K.) team** incorporated advanced composite armor with running gear based on Formula 1 racing expertise, in an innovative architecture that melded ruggedness with low weight. The Foxhound was fielded to Afghanistan in 2012.

MBDA's Meteor team developed the world's first air-to-air missile with an air-breathing engine, completing its development test-firing series in 2012, along with its first integration firings on the JAS 39 Gripen—the missile's first operational platform—and initial firings from the Dassault Rafale and Eurofighter Typhoon. Meteor's variable-thrust ramjet engine operates from launch to impact and provides the weapon with unprecedented controllability and flexibility.

Selected to equip U.S. Air Force A-10s and Air National Guard F-16s, and deployed on special-operations MC-130W Dragon Spears, the helmet-mounted integrated targeting system developed by the Gentex and Raytheon **Scorpion**

Helmet-Mounted Display team went from a clean-sheet design to full-rate production in less than five years.

The U.S. Air Force/Science Applications International Corp. **Blue Devil I team** quickly provided a wide-area surveillance and signals-intelligence collection capability to commanders in Afghanistan with the delivery of a system on the King Air 90 that is used to support anti-improvised explosive device operations. The Air Force and SAIC built on success of the Marine Corps' Angel Fire program by adding a day/night capability as well as a camera system capable of imaging a larger swath of land.

Lockheed Martin and Kaman joined forces as the **K-Max Cargo Unmanned Aircraft System team** to develop an unmanned version of the K-Max helicopter to meet an urgent U.S. Marine Corps requirement to resupply forward bases in Afghanistan, reducing the riskier use of convoys. Since being deployed in December 2011, two K-Maxes have carried more than two million lb. of cargo.

IT/ELECTRONICS

Ray Zaroni and his Rockwell Collins team developed and proved out a compact, photonics-based analog-to-digital converter that will pave the way for further miniaturization of radios by eliminating the bulky hardware needed to sample an antenna across a broad frequency range.

The worldwide move to satellite-based navigation will require technical solutions for a persistent problem—interference. **The Newark Liberty International Airport Ground-based Augmentation System team** from the Port Authority of N.Y.-N.J., Honeywell and the FAA is on the leading edge of those solutions following a three-year effort to analyze and make more robust what is now the first fully certified Category 1 public ground-based augmentation system at a major airline hub.

Synthetic vision, a 3-D rendering of the terrain and obstacles along an aircraft's flight path, is a relatively new situational awareness booster in business and general-aviation aircraft. **Rockwell Collins** has taken the idea one step further, putting synthetic vision on its trademark head-up guidance system. The technology, which the company says allows for "head-up, eyes forward" flying, entered service on the Bombardier Global 5000 business jet in March 2012 and will proliferate to other aircraft in the years to come, says the company.

Israeli Air Force Maj. Gen. (ret.) Itzik Ben-Israel, the head of Israel's Space Agency and a leader in cyberefforts, has been the guiding force in identifying and training the country's cyberdevelopers for the last 15 years. Currently Israel selects a few dozen top high school students with special traits each year to immerse in cyber operations. Israel's cyberoffense tools were likely among those that have slowed Iran's nuclear weapons and missile development.

MAINTENANCE, REPAIR AND OVERHAUL

Millville (N.J.) Modification Center, which provides post-production modifications on new H-47F Chinook helicopters, has delivered more than 100 aircraft ahead of schedule and under budget. This has allowed the U.S. Army to expedite equipping units and meet mission requirements.

The partnership between the **Corpus Christi (Texas) Army Depot and Boeing** developed a material availability model that substantially reduced MRO costs. This type of improvement contributed to an overall reduction of 28% in forecasted inventory levels.

Alan Butterfield, vice president, maintenance and engineering of Air Canada, led the organization through an unprecedented challenge after Aveos, the MRO that provided 75% of the airline's maintenance, abruptly went bankrupt. He used this opportunity to make major changes to its IT system, improve configuration management, enhance performance data and set up the operation for the future.

During his nine years at Boeing, **Lou Mancini**, who leads its Commercial Aviation



Services, has brought the customer perspective to how the company provides support and services. In 2012, he introduced the Boeing Edge, one of the most comprehensive support and services portfolios in the industry.

SPACE

Curiosity Entry, Descent and Landing team, led by JPL engineer Adam Steltzner, conceived the “sky crane” approach to placing the Curiosity rover on the surface of Mars, and then endured “7 min. of terror” during the landing to see if their untried technology worked. It did, and now the technique is state of the art for placing large payloads—perhaps including humans—on the red planet.

Elon Musk, the founder, CEO and chief designer of **Space Exploration Technologies**, better known as SpaceX, already has one space laureate for building the Falcon I rocket from scratch and using it to orbit a satellite. This nomination lauds the use of the Falcon 9 to deliver the SpaceX Dragon cargo carrier to the International Space Station and returning scientific samples safely to Earth—twice, so far.

Arianespace CEO **Jean-Yves Le Gall** was a driving force in bringing Soyuz launch vehicles to French Guiana through a Franco-Russian alliance few thought could be forged. Last year, he oversaw the debut of Vega, Europe’s first all-new rocket in 15 years, and led the recovery from a disastrous 2002 failure of Ariane 5 to successfully undertake 53 consecutive missions by the end of 2012.

The **Operationally Responsive Space-1 Satellite team** quickly adapted the high-flying Goodrich Senior-Year Electro-Optical Reconnaissance System (Syers) camera, designed for the high-flying, but air-breathing U-2, for exclusive use on an Alliant Techsystems satellite by U.S. Central Command. Fielded in June 2011 in a mere 30 months for \$250 million, the spacecraft has surpassed its one-year expected lifespan and continues to provide timely intelligence direct to commanders overseeing activities in Iraq, Afghanistan and Iran.

WORKFORCE

Marion Blakey, president and CEO of the Aerospace Industries Association, and **Susan Lavrakas**, AIA’s director of workforce, have led the association’s work as the voice for of the industry’s top issues—people and the workforce. AIA worked with Aviation Week to coalesce five different workforce studies under a single effort, bringing credibility and authenticity to the data surrounding the aerospace workforce, and launched a young professionals and university student study to determine how and why young people make career decisions.

Ralph Coppola, director of the Worldwide Education Parametric Technology Corp., created the Real World Design Challenge in which high school students receive design software, “virtual mentoring” and support free of charge to respond to a significant aerospace/defense engineering challenge. In just four years, the program has grown dramatically and this year offers students a chance to improve a heavy-duty truck design to boost fuel efficiency and comply with federal safety regulations.

The Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado selects undergraduate and graduate students to conceive, develop, design, test, integrate and operate space systems, providing hands-on experience as well as classroom learning and mentoring. More than 150 recipients have completed the program with LASP, generating strong engineering leaders with valuable spacecraft operations experience—before they begin their careers.

LIFETIME ACHIEVEMENT

C. Don Bateman, then-chief engineer at Honeywell Corp.’s Flight Safety Systems, was instrumental in the development of a range of innovative technologies that likely have saved countless lives in both commercial and military aviation. These include ground-proximity warning systems, predictive wind shear warning, wake vortex warning, the algorithm to warn pilots of controlled flight into terrain and head-up displays. 🍷



Dizzying Agenda

NASA and Roscosmos work toward research goals for one-year space mission

Mark Carreau Houston

U.S. and Russian medical experts will draw from seven broad areas as they establish a research agenda in early 2013 for a one-year mission aboard the International Space Station (ISS) flown by NASA astronaut Scott Kelly and Mikhail Kornienko, test cosmonaut from RSC Energia.

The ISS veterans were selected in late November by the U.S. and Russian space agencies to train for the long flight expected to launch in March 2015 and potentially reveal health or performance concerns for deep-space exploration by humans.

The flight, the first of its kind since cosmonaut Sergei

seen in their previous shorter-duration missions—impairments that could influence discussions over expeditions to the Moon, a near-Earth asteroid and Mars. An expedition to Mars, the most challenging of those destinations, would require 2-3 years roundtrip, using current propulsion technologies.

The focus areas include an intracranial pressure rise blamed for blurred vision—a recent concern discovered by U.S. researchers and affecting one-third to one-half of astronauts logging an average of 108 days in space—as well as

Avdeyev returned from a 380-day mission to what was Russia's Mir space station in August 1999, will serve as a "checkpoint" for the studies now carried out on the multinational crews that spend 4-7 months aboard the six-person ISS, according to Julie Robinson, NASA's ISS

The health of two veterans headed for the International Space Station for a year will be studied at length.

program scientist, and Igor Ushakov, director of the Institute for Biomedical Problems in Moscow.

Kelly, 48, and Kornienko, 52, will be monitored closely for the emergence of health issues not

Imaging an Inferno

Supercomputers crunch solar data that may bring Earthly benefits

Michael Mecham San Francisco

Final pre-launch tests are underway on a NASA Small Explorer mission that is expected to obtain ultraviolet spectra and images of the Sun's photosphere and corona with an unusual resolution, just 0.33 arcsec., helping physicists better understand how the Sun transports energy and, perhaps, helping advance fusion energy research.

After finishing the integration of the science instrument package for the Interface Regional Imaging Spectrograph (IRIS) satellite, Lockheed Martin Space Systems has begun the spacecraft's thermal vacuum testing. IRIS Program Manager Gary Kushner says the spacecraft is on schedule for a March 1 shipment to Vandenberg AFB, Calif., for an April 28 launch.

Launch will be by an Orbital Sciences Corp. Pegasus XL booster, air-dropped from an L-1011, which is to place the satellite into a 600 km (373 mi.) sunsynchronous orbit inclined 6 deg.

IRIS's \$170 million budget assumes a nominal two-year mission, but there is every likelihood the spacecraft's 20-cm (8-in.) UV telescope and spectrograph can operate much longer, given an accurate orbital placement along the solar sunrise orbital line, says physicist and Principal Investigator Alan Title, a senior fellow at the Lockheed Martin Advanced Technology Center in Palo Alto, Calif. He is a veteran of the 1998 Transition Region and Coronal Explorer (Trace) mission, another study of the photosphere launched on a Pegasus.

Like Trace, IRIS has no station-keeping propellant system, so mission longevity depends on accurate orbital placement. Trace's placement was so good that it lasted until 2010's Solar Dynamics Observatory (SDO) launch.

The Pegasus XL uses the same fairing design as Orbital's Taurus XL launcher, which NASA is investigating after two failures (AW&ST Dec. 17, 2012, p. 24). NASA says there is no hold on the IRIS launch due to the inquiry.

IRIS is a 140-kg (300-lb.) disk-shape spacecraft with a power rating of 200 watts. Protruding from the disk is the 3-meter-long (9.8-ft.) UV telescope built by the Smithsonian Astrophysical Observatory. Lockheed Martin's multichannel imaging spectrograph, designed with Montana State University, will observe in the extreme ultraviolet, between 1,200-3,000 angstroms, far higher than previous missions. The instrument's mirrors have a quality better than the Hubble Space Telescope's, Title says.

The mission slipped from 2011 for an unusual reason. IRIS uses the same mo-

nutrition and bone loss. The latter, first noted among NASA's Gemini crews, appears to have been overcome through diet, adequate vitamin D intake and regular, vigorous, in-space, load-bearing exercise involving resistive exercise devices.

Other focus areas include degraded immune function; neuro-vestibular changes that affect astronauts as they readapt to gravity; behavior, performance and interpersonal interactions; radiation exposure; and the ability to retain preflight training on missions lasting many months.

The merits of a "checkpoint" mission have yet to fully emerge. There are no plans to repeat the marathon prior to 2020, the scheduled end of station operations agreed to by the U.S.-led, 15-nation ISS partnership.

"Virtually all research data for ISS are based on regular six-month missions. It is important that we continue to collect data at these intervals so that we can begin to draw statistically significant conclusions [from a significant sample size]," says Leroy Chiao, who commanded a 6.5-month mission to the ISS in 2004-05 and currently chairs the National Space Biomedical Research Institute's (NSBRI) user panel, a group of 20 former flight surgeons and astronauts that assesses research on space health issues.

The source of the blurred vision issue and an effective countermeasure, a new NSBRI focus, are among the issues in need of a significant sample size, he notes.

"A one-year mission would have some value," Chiao says. "Data could be used to compare to extrapolations made from six-month flights."

Russians account for all four space missions of a year or more, each flown on Mir between 1987 and 1999. Since then, the ISS has greatly advanced opportunities for peer-reviewed medical research, a factor in Russia's enthusiasm

for undertaking at least one more marathon flight while the ISS is in orbit.

"We would like to renew this experience," says Alexey Krasnov, director of piloted space programs for Russian federal space agency Roscosmos. "The time is short. There are many things we don't know in spite of the fact that we have a lot of experience in spaceflight."

Kelly and Kornienko will face twice the usual 7% chance that one of them will require a minor or major medical intervention during their flight, yet another opportunity for lessons learned, according to Ushakov.

Nonetheless, Avdeyev; Vladimir Titov and Musa Manarov, who ended a 366-day stay on Mir in late 1988; and Valery Polyakov, who completed a world-record 438-day mission to Mir in 1995, are alive and well.

"Their health status is quite good for their age," says Ushakov, whose institute keeps up with their status. "So, the flights that happened 13-24 years ago did not negatively impact their health."

Kelly's three space flights include a 160-day ISS mission in 2010 in which he served as commander for much of the stay. Kornienko served as an ISS flight engineer in 2010. NASA expects to name a backup for Kelly within several months; Kornienko identified cosmonaut Sergei Volkov as his backup.

"It's definitely a challenge," says Kelly, a retired U.S. Navy aviator. "It's fun when you are done with it, not while you are doing it. It's like climbing Mt. Everest, not the kind of fun you have riding a roller coaster."

"It's a unique opportunity for me," says Kornienko, an experienced climber who includes Mt. Kilimanjaro among his summits. "I'm very eager to do this. I understand it will not be easy." ☐

mentum wheels, from Goodrich Aerospace, as NASA's 2011 Grail (Gravity Recovery and Interior Laboratory) mission. Grail's wheels have performed without incident. But when pushed to extremes in IRIS testing, the wheels blew a fuse. An investigation revealed that their logic control can draw excess current if they are accelerated too quickly. Lockheed Martin verified that if they are started "gently," they will operate nominally, Title says. The issue mainly pertains to an unanticipated spacecraft shutdown and restart, he notes.

The dynamics of solar energy have been studied for decades, but the interface between the Sun's photosphere and corona remain a challenge in solar and heliospheric science. Where past instruments, such as the Atmospheric Imaging Assembly (AIA) on the SDO, view the solar surface and atmosphere broadly (2,000 arcsec.), IRIS must take a narrow view of just 50 arcsec,



NASA's IRIS, here with solar arrays deployed in the Lockheed Martin cleanroom, has a 20-cm UV telescope from the Smithsonian Astrophysical Observatory.

as if it were a P-3 Hurricane Hunter flying into a hurricane's eye instead of a weather satellite viewing the whole storm, as AIA does.

The big leap that distinguishes IRIS is advances in supercomputing. "We've finally reached the state where we can interpret the data that [IRIS's spectrograph] will capture," Title says. "The

region of the Sun that we're looking at is where temperatures go from 6,000K to several million degrees. There's a lot of complex physics and until quite recently the data were hard to interpret."

The spacecraft will transmit enormous data sets—0.7 Mbps.—in X-band to Norway's Svalbard ground station. Number-crunching, chiefly by NASA Ames Research Center's Pleiades supercomputer, is so important to the mission's success that "Ames has had a presence from the beginning of the design," Title says.

Understanding the energy transfers that take place in the corona may play a role for energy projects on Earth. The Sun is an excellent laboratory for understanding the electro-mechanical processes necessary to make fusion reactors practical, and for that reason IRIS's science collaborators include physicists at the Princeton University Plasma Physics Laboratory. ☐

Turkey Trot

Turkey may see the first test of Germany's new C-RAM air defense system

Nicholas Fiorenza **Husum, Germany**

The official handover of two new Mantis counter-rocket, artillery and mortar (C-RAM) system to the German military took place two months ago. Although the air-defense weapon was developed for Afghanistan, initial deployment could be much closer to home, in Turkey along the Syrian border.

The Mantis handover to the Luftwaffe's air-defense group (FlaGrp), which comprises all of the military's air-defense assets, took place as the unit prepared to send a team to scout locations for the NATO deployment of Patriot air-defense systems to eastern Turkey at Ankara's request, after a village near the border came under Syrian mortar attack last year. The Patriot deployment is a symbolic gesture of solidarity with Turkey, as the systems have no C-RAM capability, although NATO has reported Scud missile attacks inside Syria, which they are designed to counter.

No decision has been made to send Mantis to Turkey, but German officers say the system could defend a village, though not the entire border, as well as forces such as the German Patriot deployment module in Turkey. Debris from firing Mantis is too small to harm civilians, and the system's automatic firing mode can be stopped manually if a friendly target is in the way, says Capt. Carsten George of the Luftwaffe, commander of one of the two Mantis units.

The development of Mantis, an acronym for Modular, Automatic and Network-capable Targeting and Interception System, was driven by rocket attacks on German camps in northern Afghanistan. These were a regular occurrence, but have been reduced as NATO's International Security As-

sistance Force, of which Germany is a member, started to withdraw last year.

Mantis is based on an improved version of the Skyshield system—specifically the ammunition and fire-control radar—which was developed by Oerlikon, now part of Rheinmetall. Mantis can defend against 107-mm rockets fired from 4 km (2.5 mi.) away. It fires programmable 35-mm “Ahead” (airburst ammunition) rounds to an effective range of 1,000-1,500 meters (3,300-

erably strengthening the operational capabilities of ground-based, close-in air defense.” Bodo Garbe, who represents the electronic solutions division on the executive board of Rheinmetall Defense, adds, “Mantis is conceptually one of the pillars of the [German military's] future air-defense network 2020.” Patriot missiles would provide longer-range air defense against aircraft and ballistic missiles.

Mantis also has an anti-aircraft capability against low-flying vehicles, manned and unmanned. The system has been integrated into German command and information systems and radar tracks from FlaGrp's mobile ground surveillance radars, which give Mantis a capability against air-breathing threats such as cruise missiles.

Germany is looking with interest at

Israel's recent experience with its Iron Dome C-RAM system during Operation Pillar of Defense last November. Iron Dome has a longer range than Mantis, which could fill in the gap at shorter ranges.

Lt. Col. Arnt Kuebart, commander of FlaGrp, says Mantis is operational, with one system designated for deployment and the second for training, although both can be deployed if necessary. George says deployment to Afghanistan would have required 36 troops. For ground mobility, Rheinmetall has

conducted tests of Mantis mounted in trucks. A challenge is keeping the guns stable during firing.

Garbe says Mantis has an “open architecture for the integration of further sensors and effectors, be they high-energy lasers or new missiles.” The system may also be used offshore. Kurt Rossner, head of Rheinmetall Air Defense, says a Mantis gun was tested on an oil platform with a computer program to stabilize it.

The Bundeswehr has an option for two more Mantis systems, but Naskrent says no decision has been made to acquire them. Mantis cost €48 million (\$62.4 million) to develop, and the first two systems cost €138 million, according to Rheinmetall. ☐



Mantis is based on 35-mm guns firing timed-airburst ammunition to destroy small targets.

4,900 ft.), in bursts of up to 36 at 1,000 rounds per minute, to destroy RAM rounds. Ahead shells release tungsten projectiles in the path of incoming rounds. Kill probability is 30% at 1,000 meters, 70% at 500 meters and 98% at 200 meters, Rheinmetall says. Each system consists of six 35-mm guns, two radars, a command post, maintenance console and operator simulator.

Lt. Gen. Dieter Naskrent, deputy chief of staff of the Luftwaffe, describes the delivery of Mantis as “a further important step in the transformation of the Luftwaffe, ... consid-

Bigger, Yet More Flexible

Expanded MTU Maintenance Zhuhai finds way to cope with unpredictable workloads

Bradley Perrett **Zhuhai, China**

Sometimes, when an airline calls, it wants an overhaul shop to receive its turbofan in three months. Getting that much notice is good, because anyone running an engine overhaul plant likes to know just what the technicians and equipment will be doing at least four weeks ahead. A long, dependable schedule is an efficient schedule.

But sometimes the customer wants its engine in the shop in two weeks. Or next week. Or even tomorrow. "And sometimes they want tomorrow but the engine turns up a week later," says Frank Bodenhage, chief executive of MTU Maintenance Zhuhai. While com-

Technicians at MTU Maintenance Zhuhai are usually skilled on working on at least two engines.

mercial aviation does not always work the way engine overhaul managers would like, the challenge is particularly great in Asia, where many airlines seem to forget that pulling apart and reconditioning a commercial turbofan takes a bit more planning than, say, servicing the chairman's Mercedes-Benz.

MTU Maintenance Zhuhai, which overhauls CFM and IAE engines for narrowbody airliners, has accepted that it cannot change Asian airline habits. While expanding its plant by 50%, the company has also reorganized its work practices to increase flexibility.

Most of the work at the company, owned equally by MTU Maintenance and China Southern Airlines, is now performed by multi-skilled teams who can be quickly switched between disparate engines. So the people who disassemble newly arrived engines normally know how to pull apart two different types. Those who assemble the cores of one type can also work on the cores of another, and so on.

In each area of activity—say, assembly or turbine blade inspection—a single manager has the authority to

switch teams from one job to another. Bodenhage says the company has eliminated a layer of supervisors that would have resulted in meetings being held to discuss which teams could be moved to where.

MTU Maintenance Zhuhai has targeted a particular market segment that is a boon to flexibility: CFM56-3s, the engines used by Boeing 737-300s and

flow-line production process, in which engines and parts would move one after another from station to station. The flow-line helps efficiency in part by keeping everyone aware that if a job is not done on time then other jobs are held up, but Bodenhage says it demands the careful scheduling that is hardly possible when too many customers want work done at short notice. With docks, a team can just walk away from one engine and begin work on another without affecting anyone else.

If there is a loss of efficiency there, another process makes up for at least some of it. Traditionally, mechanics pulling apart an engine would take off each piece, set it aside, take off the next and so on. Then, at the end of the day, they would take all the parts to the various places in the plant where each would be worked on next. At



MTU MAINTENANCE ZHUHAI

737-400s. Since such engines are no longer very valuable, their owners are happy to accept longer turnaround times as part of a job that usually will not be very expensive. By having such non-urgent engines on the floor, the process managers at Zhuhai can switch teams to and from them according to the demands of engines under shorter contracts.

The work is organized mainly with simple paper and magnetic-whiteboard processes that the company has found to be robust and easy to use. Simplicity helps flexibility.

Another old-fashioned point of simplicity is that MTU Maintenance Zhuhai uses traditional docks—fixed spaces in which an engine is worked on. In doing so, it has rejected the

a cost of just €60,000 (\$80,100), the plant has introduced a new system in which, during the course of the workday, mechanics periodically signal that certain parts have been removed. Forklift drivers, directed through the plant by software, presently turn up, collect the parts and take them immediately to their destination. Parts flow continuously in small batches.

This has three advantages: turnaround time is saved, because work can begin on a part within an hour or so of its removal, rather than the next day; costly and scarce mechanics do not spend their valuable time in transporting parts; and work on assemblies is not hampered by the accumulation of parts around them. The process

works in reverse, too. As mechanics build an engine assembly, the forklift drivers arrive every hour or so with parts that will shortly be needed.

The staff developed these new practices, says Bodenhage. In looking for ways to increase flexibility and cut costs, the company decided not to pay for consultants and relied instead on its staff for ideas, partially because workers would be more committed to a system they helped to craft.

The facility also overhauls CFM56-5s, CFM56-7s, and V2500-A5s, the latter two accounting for 80% of its work.

The Zhuhai plant was always designed for expansion. It went into operation in 2003 with three structural bays, each 24 meters (79 ft.) wide. The first, with spare room, housed equipment for all types of engines, such as machines for cleaning, non-destructive testing and plasma spraying. The rest of the work was completed in the other two bays, with a total capacity of 200 engine shop visits a year. With about 600 people, the plant is now running at that rate, up from about 140 in 2007.

The plant's designers left space on site for two more bays, one of which has now been built, providing enough area for 300 shop visits a year, although the company does not have that much work yet and therefore has not hired all the people nor installed all the machines it would need for that capacity. Boden-

hage says that the new limit should be reached in about five years. Presumably the plant will eventually be widened with a fifth bay. Beyond that, the site is big enough to double the length of the plant. At some point, if business warrants it, four times the original capacity could be built. The plant is taller than needed for CFM56s and V2500s. China Southern has ordered Boeing 787s with General Electric GEnx engines, so that type is a likely candidate as the first widebody engine at the site.

MTU Maintenance Zhuhai has an assured base load of work from China Southern, but the company has been growing faster than the demand for overhauls for that shareholder, because it has been receiving strong orders from unaffiliated customers. China Southern now accounts for about half of the plant's work, other Chinese airlines for about a quarter, and airlines from elsewhere, mostly Asia, for the rest. Bodenhage expects the outside work will continue to grow faster than demand from China Southern.

Chinese commercial traffic development suggests that China Southern's requirement for CFM56 and V2500 overhauls should grow at something like 10% or more a year. Even if, as seems likely, the carrier's demand slows with a general moderation in the industry and a switch in emphasis to long-haul international business, it

is not hard to see the overhaul shop needing that fifth bay later this decade.

The perennial problem in Chinese airframe and engine maintenance is attracting and retaining technicians. Bodenhage says the company has effective methods of finding people, but notes that an expansion in aviation activity in the area—for example, at Zhuhai-based general aviation manufacturer Caiga—could make things tougher. Competition for staff comes from non-aviation industries, too, such as automobiles.

Keeping employees turns out not to be a problem, however. Bodenhage says annual turnover is significantly less than 5%. Wages across the industry are rising at about 10% a year.

Because of the rapid growth, the average worker at the site is still younger than 30. Experience takes time to accumulate, and so the company probably must always trail other MTU Maintenance narrowbody engine shops at Hanover, Germany, and Vancouver, British Columbia. It sends people to the other plants to help with work surges, and they pick up ideas there. In one case, still most unusual for a Chinese aviation operation, the skills flowed the other way: once, when the Vancouver facility had to quickly gear up its CFM56 work, experienced hands from Zhuhai were sent to help refresh the Canadian plant's skills. ☛

MTU Maintenance Zhuhai is keeping the traditional docks for working on engines, which it sees as more flexible than flow lines.



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Serious 787 Questions For Both Boeing and FAA

One occurrence of an event is interesting, two is a trend. So the FAA had no choice but to ground the six 787-8s under its authority following battery overheating incidents on two of the innovative Boeing transports flown by Japan Airlines and All Nippon Airways (see p. 22). That a battery can catch fire—and could catch fire in flight—is a grave matter that needs urgent attention. Grounding was the only responsible action.

Still, the issues are not whether the 787 can or will be made safe to fly but how to do that, how long it will take and at what cost, both to Boeing and the airlines that may face delays in the delivery of some of the 800 aircraft still on order. And while no major U.S. aircraft type has been grounded in decades, significant technical issues have beset many new airplanes.

Nonetheless, the events of last week raise serious questions about Boeing's technical thoroughness. At least as important, they call into question the competence of the FAA. Lithium-ion batteries have been responsible for 80% of battery fires on aircraft since 2009.

Why has the FAA been confident enough to certify as safe lithium-ion batteries on the 787 and other aircraft—a step that each time required a “special condition” allowance? And while we cast no such aspersions, we will not be shocked if others wonder aloud whether this U.S. regulatory body has too cozy a relationship with the nation's largest industrial exporter.

If Boeing and the FAA are to clear any clouds of suspicion before they can form, the agency must do some soul-searching about the review it is about to undertake. There is a procedure on the books for thorough new examinations of aircraft designs that have already been certificated, but so far, the FAA has not said it will employ this established mechanism (see p. 25).

While they may well be involved in finding a fix for the technical problem, it would be an obvious

“The events of last week call into question the competence of the FAA's certification of lithium-ion batteries on aircraft.”

conflict of interest to ask the same people who designed the 787 electrical system or certificated the aircraft to determine whether that work is done correctly. Both Boeing and the FAA know the battery issue must be resolved. They must not underestimate the importance of doing so in such a way that outsiders can be confident in the thoroughness and disinterest of the personnel who vouch that the airplane is once again safe. ☐

U.S.-Manufactured Crises Threaten Global Stability

As Barack Obama starts his second term and a new Congress begins, our fervent wish is that the U.S. president and congressional Republicans will put aside the extreme partisan infighting of the last two years. Their zero-sum-game approach has led to legislative gridlock and uncertainty. The nation's economic and budget challenges are large, but they are solvable

“Lawmakers narrowly forestalled across-the-board cuts with a last-minute New Year's deal, but the delay bought only two months' breathing room.”

with smart long-term planning and compromise.

Unfortunately, such pragmatism seems more elusive than ever as the U.S. barrels toward its second major political crisis in as many months, the debate over raising the government's borrowing limit from its current level of \$16.4 trillion. Obama, who took office four years ago pledging to be a unifier, refuses to discuss spending cuts—particularly to unsustainable “entitlement” programs

like Medicare and Social Security—in return for raising the debt ceiling. And House Speaker John Boehner (R-Ohio)—who helped turn the once routine task of raising the debt ceiling into a political football—says spending reductions must be part of any debt-limit deal. It is a manufactured crisis. At stake is more than the full faith and credit of the U.S. Can a nation that threatens default on financial instruments that undergird the world economy be trusted to help lead the world?

On the heels of the debt fight is the threat of “sequestration”—automatic budget cuts that would cut “discretionary” federal spending of all sorts and the Pentagon's in particular by about \$500 billion each during the next decade. Lawmakers narrowly forestalled it with a last-minute New Year's deal, but the delay bought only two months' breathing room. So far, there is scant evidence that the new Congress has the gumption to make the hard political compromises needed to craft a more rational and long-lasting solution to reducing the nation's massive and unsustainable budget deficit.

This magazine has never accepted the argument that defense, space and aviation spending were untouchable. Sequestration would reduce the base U.S. defense budget to roughly its level in fiscal 2007, which was hardly paltry. But imposing across-the-board cuts is an unthinking and irresponsible approach to reducing defense spending. It would harm both the military and its industrial base. The Joint Chiefs of Staff are warning Congress that sequestration would cut the Pentagon's operating budget by more than 20% from what Obama requested for 2013. Training funds would be reduced by almost half, and plans are in place to furlough nearly 800,000 civilian workers that support maintenance, intelligence, logistics contracting and military health care.

That is no way to run a government—and it does not have to be. ☐

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