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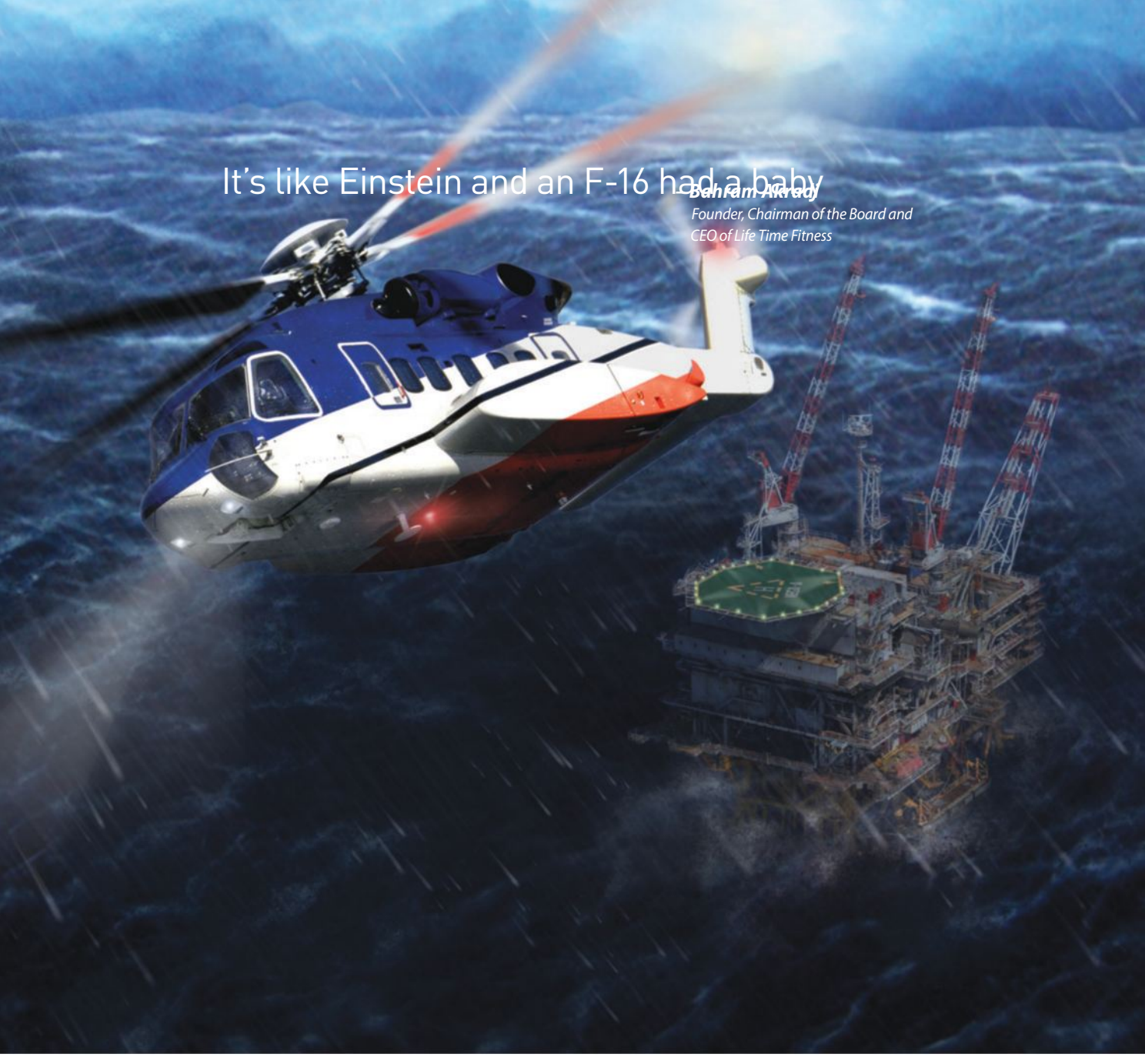

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Volume 177 Number 4

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DEFENSE

COMMERCIAL AVIATION

FLIGHT TRACKING

ON THE COVER

In an uncertain business environment, there are nonetheless several helicopters and a commercial tiltrotor in development (see page 52). Bell Helicopter has returned to the light single-turbine market it once dominated with the Model 206 JetRanger, and is developing the five-seat Model 505 Jet Ranger X, seen here in flight test near Montreal, with certification expected by year-end. Bell Helicopter photo by Pierre Seager. Also in this issue are reports on flight rules for civil UAS (page 61), Japan's defense exports (page 29) and the Single European Sky (page 32).

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Feedback

Aviation Week & Space Technology *welcomes the opinions of its readers on issues raised in the magazine. Address letters to the Executive Editor, Aviation Week & Space Technology, 1911 Fort Myer Drive, Suite 600, Arlington, Va. 22209. Fax to (202) 383-2346 or send via e-mail to:* **awstletters@aviationweek.com**
Letters should be shorter than 200 words, and you must give a genuine identification, address and daytime telephone number. We will not print anonymous letters, but names will be withheld. We reserve the right to edit letters.

COMING UP SHORT

After reading your editorial "Act Now to Avert a Pilot Shortage" (*AW&ST* Feb. 16-March 1, p. 74) and the Viewpoint by William Swelbar (*AW&ST* Oct. 6, 2014, p. 58), I'm reminded of candiate Ronald Reagan's iconic reply in a debate with then-President Jimmy Carter: "There you go again."

In both cases it is suggested that the answer to the absurdly low starting wages at regional carriers is to cut the wages of mainline pilots. While Swelbar suggested pilots at the larger legacy carriers directly subsidize the salaries of regional pilots employed by completely separate companies, Aviation Week comes along with a plan to lower the top wages at legacy carriers in order to increase entry level wages at regional airlines.

Well here are some crazy ideas: Pay wages commensurate with the skills and responsibilities needed for the job. Stop trying to cut one group's earned income.

The real problem is the cost and requirements to become a pilot combined with ridiculously low entry-level wages.

Funny, when I hear about the shortage of rural physicians in the U.S., I never hear anyone suggest we cut the salaries of surgeons.

Craig Kronfeld
OAK PARK, CALIFORNIA

LAUGHABLY INADEQUATE SOLUTION

I love to laugh. I don't mean a sarcastic laugh, but a genuine, tears-in-the-eyes laugh. I should mention at this point that I am a pilot for a major airline. After reading the suggestion that senior pilots ought to voluntarily give up some salary to be redistributed to the other end of the seniority list (where all senior pilots began their careers) laughter ensued.

Let's see, we just came out of the toughest decade that the profession has ever seen—a giant slide backward in all respects. The impact was so severe that most kids are not even considering an airline career. Now that the situation is looking a bit more stable going forward, we are supposed to voluntarily surrender the fruits of our long-endured struggle to attract kids who have little interest anyway?

While I have the highest regard for those who sacrifice themselves for others, I just don't think that would apply here. It would be a bit like jumping on the grenade only to find out too late that there was nobody else in the foxhole with you.

Matt Marohn
MAPLE LAKE, MINNESOTA

HELPFUL AND NEEDED

Your editorial listing tips to averting a pilot shortage was great. I can attest to the statement: "Some aviation college officials say students are no longer enamored of the lifesytle of a pilot that can be affected by the heavy travel schedule" and the vagaries of the industry's health.

I have two years as a commuter pilot and 37 years mainline.

Here is the answer to attracting qualified youth: Make this wonderful career choice more appealing by assuring time for flying and a family life. I never worked for Netjets, but I hear they have a 6-hr.-on/6-hr.-off schedule and supply pilots with real airline seats to their flight's point of origin and and back to the home base. Let's say you work an office job and you put in 8 hr. a day, five days a week, four weeks a month. That equals 160 paid hr. on duty. Airlines should pay a salary. Why is my pay dependent on whether the doors are closed and the brakes are released, or if a wheel is turning?

Other "gotchas" include mashups of trip pairings for scant recompense. We have one trip pairing that is three days long and pays 20 hr. and another that is four days long and pays a minute amount more for being away 24 additional hours. Yes, airlines operate 24/7 and you do have to be away from home, but this time should be compensated. A new paradigm is needed for airline pilot pay. We should not have to work exhausted and raise our kids via Skype.

Name Withheld by Request
KEY COLONY BEACH, FLORIDA

LOOK BACK TO GO FORWARD

Shortly after World War II, the nascent U.S. Air Force started pilot training—a continuation of the "Aviation Cadet" program. Two years of college or the equivalent was required. In one year, 21-26-year-old candidates who had never flown an airplane were trained to fly AT-6s, F-51s, F-80s, or B-25s.

At first NA AT-6s with 600-hp engines, flaps and retractable landing gear were used. The accident/fatality rate was not good, so the program switched to Cessna 175s and then T-34s. It is possible to produce a proficient pilot in one year's time if an appropriate program is implemented.

I was the "Aircraft Commander" of a Convair T-29, Douglas C-47, and North American B-25 at the age of 23. About 85% of my squadron were about the same age. We operated—accident free—out of Ellington Field, near Houston, in almost all weather. I obtained almost 2,000 hr. in three years with a lot of night and weather landings.

The airline industry should form a common "academy" for pilot training.

USAF Lt. Col. (ret.) Charles D. Foran
DALLAS, TEXAS

'LEVEL' APPROACH TO STALLS

I would like to add to readers Guy Wroble and Stephen Casner's observations about stall recovery training (*AW&ST* Feb. 16-March 1, p. 8).

As a Navy P-2 and P-3 pilot for two tours, I found that proper stall recovery depends upon an aircraft's capability.

In the P-3 with four big turboprops, a stall could be powered out of while holding attitude because of the induced flow over the wing. With turbojets, it is important to reduce the angle of attack while the power is brought up. In all cases, the wings should be leveled.

Donald A. Hallwachs
TWO RIVERS, WISCONSIN

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Who's Where

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Ulf Huttmeyer

Steve Hogan

John Parker

Steve Hughes

Neil Vernon

To submit information for the Who's Where *column, send Word or attached text files (no PDFs) and photos to:* **stearns@aviationweek.com** *For additional information on companies and individuals listed in this column, please refer to the* Aviation Week Intelligence Network *at* **AviationWeek.com/awin** *For information on ordering, telephone U.S.: +1 (866) 857-0148 or +1 (515) 237-3682 outside the U.S.*

Andrew Harrison has been appointed executive vice president/chief revenue officer of the *Alaska Air Group*, and **Shane Tackett** vice president-revenue management and **Jay Gupta** managing director of infrastructure and modern platforms in the Information and Technology Services Div. at Alaska Airlines. Harrison has held several financial positions at Alaska Airlines and Tackett was vice president-labor relations. Gupta was senior director of infrastructure with Thomson Reuters.

Arnd Schwierholz (see photos) has been named CFO of *Air Berlin*, effective April 1. He has been deputy CFO and succeeds **Ulf Huttmeyer**, who will become senior vice president-finance for equity partners for partner Etihad Airways. Schwierholz was head of mergers and acquisitions for Deutsche Lufthansa and CFO North America for its LSG Sky Chefs subsidiary.

Scott Seymour has become president of the Aerojet Rocketdyne unit while remaining chief executive/president of parent company *GenCorp Inc.* He succeeds **Warren Boley**, who has left Aerojet Rocketdyne.

Faye Malarkey Black has been appointed interim president of the Washington-based *Regional Airline Association*. She has been senior vice president-government affairs and succeeds **Roger Cohen**, who has resigned.

Timothy J. McBride has been named senior vice president-government relations for the *United Technologies Corp.*, Hartford, Connecticut. He succeeds **Gregg Ward**, who plans to retire later this year. McBride has been vice president-global government affairs for Covidien.

Steve Hogan (see photos) has become vice president-global sustainment and **John Parker** vice president/general manager of the Integrated Logistics and Modernization Div. of the Herndon, Virginia-based Technical Services Sector of the *Northrop Grumman Corp.*

Egon W. Behle, Christian Korfgen and **Andreas Seidl** have joined the advisory board of the *Recaro Group*, Stuttgart, Germany. Behle is a member of the board of directors of Ruag and was chairman of MTU Aero Engines. Korfgen is managing director of the NH Hotel Group Europe and was vice president-product management and innovation at Deutsche Lufthansa. Seidl is a managing partner of the Human Solutions Group of Kaiserslautern.

Raphael Haddad has been appointed president of *Jetcraft Commercial*, Raleigh, North Carolina. He was vice president-sales for the Middle East and Africa for Bombardier.

Jeff Yorsz has been named president of *Qinetiq North America*, Waltham, Massachusetts. He was general manager of Northrop Grumman's Adaptive Optics Associates.

Gregory Melan, Andrew Weinlein and **Paul Price** have become pilots for Europe-based helicopter charter company *Starspeed Ltd.*

Stephen C. Foster has been appointed director of operations for *Sabreliner Aviation*, Perryville, Missouri. He held similar positions with the Eaton Corp. in Mountain Home, Arkansas, and Gulfstream Aerospace in Phoenix.

Steve Hughes (see photos) has been named vice president-transatlantic sales and **Neil Vernon** Hong Kong-based vice president-international sales for *Virgin Atlantic Cargo*. Hughes has been vice president-sales for Europe, the Middle East and Africa, while Vernon headed sales in Asia and Australasia.

Michael Young has become director of training operations and quality for *SimCom Training Centers*, Orlando, Florida. He was director of Embraer programs at FlightSafety International.

USAF Lt. Gen. **Ellen M. Pawlikowski** has been nominated for promotion to general and assignment as commander of Air Force Materiel Command, Wright-Patterson AFB, Ohio. She is military deputy in the Office of the Assistant Secretary of the Air Force for Acquisition at the Pentagon in Washington. Maj. Gen. **John L. Dolan** is one of four of his rank to be nominated for promotion to lieutenant general. He would be named commander of U.S. Forces Japan/commander of the Fifth Air Force, Pacific Air Forces, Yokota AB, Japan, and has been chief of staff at Headquarters U.S. Pacific Command, Camp H.M. Smith, Hawaii. The other three are: **John B. Cooper**, who would become deputy chief of staff for logistics, engineering and force protection at USAF Headquarters, from director of logistics at Headquarters Air Combat Command, Joint Base Langley-Eustis, Virginia; **Mark A. Ediger**, who would be promoted to surgeon general from deputy surgeon general of the Air Force; and **Lee K. Levy, 2nd**, who would be commander of the Air Force Sustainment Center of Air Force Materiel Command, Tinker AFB, Oklahoma, promoted from vice director for logistics of the Joint Staff at the Pentagon.

HONORS AND ELECTIONS

Jorge Luis Villarreal Schutz, CEO of Mexico-based Elara Comunicaciones, has been named the New York-based *World Teleport Association's* 2015 Teleport Executive of the Year. The award is presented "for demonstrated entrepreneurship, leadership and innovation in the development or operation of a teleport-based business." Villarreal Schutz was cited as the founder of a telecommunications company that has transformed satellite connectivity.

Peter F. Hartman, vice chairman of Air France-KLM, is scheduled to be the keynote speaker for the delegate's program at the *World ATM Congress* in Madrid on March 10. He is expected to comment from the airline viewpoint on the air traffic management industry, including transforming the ATM/aviation industry, implementing new technologies and infrastructure, improving efficiency and working in partnership.

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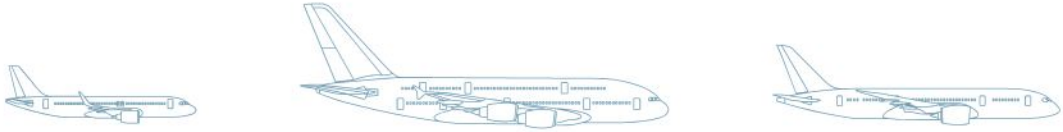
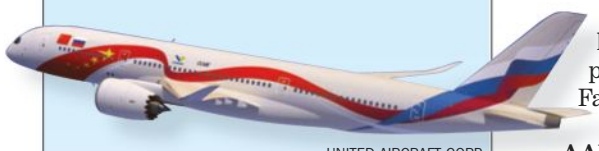


First Take

COMMERCIAL AVIATION



UNITED AIRCRAFT CORP

Russia's United Aircraft Corp. will seek government funding to develop a 250-280-seat widebody airliner with China's Comac. But development cost, estimated at $13 billion in 2014, will be revised thanks to a weakening ruble. "We will need less than asked," UAC President Yury Slyusar said after Moscow, facing economic difficulties, suggested cutting the project's 2015 budget from 3.6 billion rubles ($56 million) to 50 million from non-budget sources.

Lufthansa is proposing resuming growth, in return for lower unit costs. The airline wants to grow its mainline fleet to 340 aircraft by 2020, from 313, for an additional 500 pilot and 1,300 cabin-crew jobs. But Lufthansa is only prepared to invest in growth again with substantial employee concessions, which it wants in place by September.

The new chief executive of engine-maker Rolls-Royce's North American operations will be Marion Blakey, CEO of the Aerospace Industries Association trade group. A Washington insider, Blakey's previous positions include five years as FAA administrator and a year as chairman of the National Transportation Safety Board. She will succeed James Guyette, who is retiring (page 24).

Ireland's government is not convinced it should give up control of national airline Aer Lingus as unions continue to oppose the proposed takeover by International Airlines Group (IAG). Dublin says it will not give an "irrevocable commitment" to sell its 25% holding on current terms, but will consider "any improved proposal which IAG may bring" (page 33).

The Dornier 328's checkered history turns another page with Sierra Nevada Corp. (SNC) acquiring 328 Support Services, owner of the type certificate and design rights to the out-of-production commuter, 200 of which are flying. SNC previously supplied 17 328s to U.S. Special Operations Command as C-146A Wolfhounds. Before the 328, the program was owned by Dornier, Fairchild Dornier, then AvCraft.

AAR is selling its Telair cargo systems manufacturing businesses to TransDigm for $725 million in cash and has put its aerostructures operations up for sale to focus on global aviation services. AAR bought Telair in late 2011 to diversify due to a weak airline market, but CEO David Storch sees greater opportunities in being a "pure-play aviation services business."

General Electric is introducing final software and hardware changes to mitigate core-icing in GE90 and GEnx engines. Faster ice-crystal icing detection clears operators of GEnx-powered Boeing 747-8s and 787s to resume flying at higher altitudes. Several aircraft lost thrust after ice formed behind the fan then broke off to be ingested by the compressor (page 35).

DEFENSE

PILATUS AIRCRAFT

Pilatus Aircraft has rolled out its 100th PC-21 on Feb. 20, the 1,000th turboprop trainer built by the Swiss manufacturer. Just days later, the Stans-based company delivered its 1,300th PC-12 single-turboprop utility aircraft. Three air forces fly the PC-21, and Pilatus has orders for 55 from Saudi Arabia and 24 from Qatar.

India needs 1,000 helicopters by 2020, says its defense minister, but industry officials think it unlikely to receive even half that number. India's prevarication on procurement has programs piling up. Four competitions totaling 434 rotorcraft are pending, while three for 53 helicopters have been decided, but have not progressed to contracts. Meanwhile India's Hindustan Aeronautics Ltd. is developing two types for which production is expected to exceed 500 (page 50).

Indian designers have frozen the configuration of a medium-weight fighter they hope to fly early in the 2020s. The stealthy, 20-25 metric-ton Advanced Medium Combat Aircraft needs a pair of 25,000-lb.-thrust-class afterburning engines and General Electric is the preferred supplier, but India's Aeronautical Development Agency is talking to other vendors (page 30).

Raytheon and the U.S. Air Force have completed testing required for a decision on low-rate initial production of the Small Diameter Bomb (SDB) Increment 2; the glide weapon destroyed moving targets in two live-fire tests. With a range exceeding 40 nm, SDB 2 has a tri-mode seeker combining millimeter-wave radar, uncooled imaging infrared and semi-active laser.

India's Dynamatic Technologies is to work with AeroVironment to develop and produce an unmanned aircraft system, the Cheel, based on the U.S. company's family of Raven, Puma and Wasp small UAS. The tie-up, part of the U.S-Indian Defense Technology and Trade Initiative, is still subject to approval by both governments.

The United Arab Emirates (UAE) has ordered two additional C-17s for a total of 2.27 billion dirhams ($613 million), leaving Boeing with five to sell of the final 10 airlifters being produced speculatively. Canada is to order one and Australia will take two. At the IDEX defense show in Abu Dhabi, the UAE also placed a 3.75 billion-dirham order for two optical observation satellites with Airbus Defense & Space and Thales Alenia Space, and ordered six search-and-rescue and three VIP AgustaWestland AW139 helicopters for a total of 732 million dirhams (page 26).

The four Eurofighter partner nations have signed a €200 million ($224 million) contract for the next phase of enhancements to the Typhoon fighter. These include integrating the MBDA Brimstone 2 air-to-surface missile for the U.K. Royal Air Force by 2017, and capability improvements for the MBDA Storm Shadow, Meteor and

Asraam missiles, and Raytheon Paveway IV precision-guided bomb.

BUSINESS AVIATION

BELL HELICOPTER

Bell Helicopter's second Model 505 Jet Ranger X light turbine single entered flight tests at Mirabel, Quebec, on Feb. 25, with a goal of certification by year-end. The company has more than 300 letters of intent for the five-seater, its return to a market dominated by the Bell 206, which was last produced in 2010 (page 52).

After repositioning its X4 and significantly increasing the power demand, Airbus Helicopters has selected Turbomeca's Arrano turboshaft to power the new medium twin, and agreed with Pratt & Whitney Canada not to pursue a growth version of the PW210E originally offered. To be unveiled on March 3, X4 is the launch application for the 1,100-1,300-shp Arrano.

Enstrom Helicopters is flight-testing the first prototype of its TH180 two-seat training helicopter. The scaled-down version of the 280FX made its first flight early in February and is powered by a 210-hp Lycoming HIO-390 piston engine. Certification and first deliveries are planned for the first half of 2016.

SPACE

Despite political tensions, Russia says it will extend its participation in the International Space Station to 2024, after which it plans to disengage three modules from its segment of the orbiting outpost and use them to develop a Russian space station in low Earth orbit. So far, Russia is the only one of the five ISS partner nations to formally state its intent to continue participating in the program beyond 2020 (page 24).

FAA's Proposed Small UAS Rule

(see p. 61)

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Minuses

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Insitu ScanEagle – 48.5 lb.

Source: FAA

An infrared camera collecting data inside Europe's fifth and final Automated Transfer Vehicle as it reentered Feb. 15 failed to return images, the European Space Agency says. The

EUROPEAN SPACE AGENCY

camera worked, but failed to send the pictures via Iridium satcom before the vehicle broke up. The images were to be used in planning for the eventual deorbit of the International Space Station (page 59).

Japan's only team in the Google Lunar Xprize, Hakuto, has signed a contract with competitor Astrobotics to fly its twin Moon rovers on a SpaceX Falcon 9 launch booked for the second half of 2016. The rovers will piggyback on Astrobotics' lunar lander and be released simultaneously with its rover to race for the $20 million grand prize for the first to travel 500 meters.

47 YEARS AGO IN *AW&ST*

The Anglo-French Concorde supersonic transport prototype made its first flight, of 28 min., on March 2, 1969, from Toulouse-Blagnac Airport in France. The Concorde entered commercial service in 1976, but only 20 were built—including six prototypes—and the speedy passenger jet was retired in 2003.

Read our original coverage of these and other momentous events at:
AviationWeek.com/100

By Byron Callan

Contributing columnist Byron Callan is a director at Capital Alpha Partners.

COMMENTARY

About That Upturn

Defense contractors are facing a no-growth environment

Along with the rest of the U.S. federal budget, the fiscal 2016 request and plan through 2020 was released on Feb. 2. While there is a consensus that the administration won't get what it's requesting because Congress would have to make too many compromises on non-defense discretionary spending, taxes and entitlements, the belief stands that the final figures for fiscal 2016 will fall between the request and the budget caps in the Budget Control Act.

Wall Street is sanguine about the potential compromise because the sum of procurement and research, development, test, and evaluation (RDT&E) budget authority should still show growth over appropriations for fiscal 2015. A common theme analysts are heralding is that investment, which is shorthand for the sum of procurement and RDT&E, has bottomed out and a new up-cycle is about to emerge. This is based on the administration's plan and is bolstered by views that, as underscored by the atrocities of the Islamic State, the war in Ukraine, conflicts in Yemen and Libya, and simmering disputes in Asia, the world remains a dangerous place.

While Wall Street may be focusing on budget authority in its belief that the cycle has bottomed, the administration's projections for outlays show something that many might not consider an upturn. Outlays are a closer approximation to contractor sales from the Defense Department. Budget authority may not expire for several years, so while it might be considered a leading indicator, outlays—which are what the Treasury actually spends of appropriated funds—paint a better picture of industry prospects. In thinking about company growth rates, clearly other U.S. government sales—international defense and commercial—have to be included.

The Office of Management and Budget (OMB) outlay projections released in early February for fiscal

2016-20 for investment show flat outlays in current-year dollars. Fiscal 2015 investment outlays are projected to be $172 billion. They are flat in fiscal 2016 at $172 billion, then increase 1% annually in fiscal 2017-19, with 2% growth in fiscal 2020 and then flat again for fiscal 2021. Those figures are in current dollars and have not been adjusted for inflation. They also reflect the administration's request and plan, so could be considered a best case. A cut to the fiscal 2016 investment budget authority request will ripple through these outlay estimates. If inflation is 1.8% per year, then in constant dollars over this period, investment outlays slide to $166 billion by fiscal 2020. That's a downturn in constant dollars.

This "upturn" that is now widely anticipated could also see some other changes. The Defense Innovation Initiative is just getting underway, and teasing out how much funding was allocated in the Defense Department request and plan was complicated by the fact that amounts have not been articulated by senior leadership and because some programs are classified. As department study groups complete their work in 2015, however, they should be able to better inform the fiscal 2017 budget process.

One outcome could be more funding for RDT&E to nurture breakthrough weapons programs, though it remains to be seen where this funding could originate. In the first "offset strategy" of the 1950s that department officials talk about, RDT&E in constant dollars more than doubled to $41 billion by 1961 from $20 billion in 1955. That sort of shift was not as apparent in the second "offset strategy," at least during the gestation periods for GPS, precision strike and stealth. In constant dollars from 1975 to 1980, RDT&E was close to flat, but those efforts seemed more targeted than the sweeping investments in smaller nuclear weapons, ICBMs and air defense of the first offset.

Another outcome is that flat outlays imply that the industry environment is going to remain tough. Arguably, at least as evidenced by the financial health of many public companies, Wall Street could be thinking that a stable, predictable spending upturn could only further support the sales, earnings and cash flows that companies have been producing. However, new program starts are going to be extremely hard-fought and without increased budgets, extensions of mature lines also may be more difficult. Internal investment may matter more as a competitive differentiator.

Finally, department leadership has been signaling loudly that it needs to access commercial technologies. Adding more to RDT&E budgets might help contractors bring more commercial technologies to bear toward solving defense problems. But this "upturn" conceivably could see more commercial competitors emerge if there are real growth opportunities and some of the barbed wire and trenches that have kept them from pursuing defense work are removed. For autonomous systems, satellites and information technologies, there could well be more competition from non-traditional companies.

About that upturn: OMB data suggests there isn't one. Other trends suggest this is going to be challenging period for heritage defense companies to navigate.

By Michael Bruno

Senior Business Editor
Michael Bruno blogs at:
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COMMENTARY

Armed and Profitable

In U.S. policymaking and profits, military UAS will lead the way, once again

Lost amid the clamor last month over the FAA's proposed regulations for domestic commercial UAS operations was the announcement that the State Department finally had laid down a new policy for exporting military and commercial UAS.

U.S. AIR FORCE

The developments were related, of course, as some of the first, formal U.S. government efforts to devise standards for all things unmanned as they increasingly affect life beyond just war zones overseas. But the reaction to the developments from the public, the business community and the UAS industry were significantly different and telling.

The FAA proposal relieved many UAS advocates in America, but curbed the enthusiasm of some businesses that might have hoped for final-and-generous rules (think real estate agents and pizza deliverers), while also broadly disappointing many industrials. The military UAS export policy, meantime, received comparatively scant public attention but is making the industry salivate.

Why? Follow the money.

According to Dutch market research company ASDReports, the global UAS market will see a compound annual growth rate of 5.66% through 2025. Unmanned combat aircraft are expected to dominate with a market share of 34%. In a January report, ASD analysts attribute this market share to the rise of asymmetric warfare and the growing need for intelligence, surveillance and reconnaissance (ISR) missions, as well as the demand by military strategists worldwide for situational awareness, interoperability and integrated solutions.

Likewise, as Aviation Week and data provider Forecast International reported about two months ago (Dec. 29, 2014-Jan. 14, 2015, p. 79), the military UAS market for reconnaissance and attack missions will be worth $72.7 billion through 2024. Production of hobbyist drones, by comparison, is usually of lower-priced systems and can soar one year and plummet the next; hobbyist sales could generate a range of $150 million-800 million a year in market value.

Indeed, the Feb. 17 export policy announcement may have had far less to do with producing domestic headlines, otherwise filled with stories about straying quadcoptors and alleged airliner encounters. Capital Alpha Partners analyst Byron Callan said the rollout was noteworthy, coming a day before the start of Aero India, a major aerospace and defense trade show in Bengaluru, and the International Defense Exhibition and Conference in Abu Dhabi. "Both shows have significant U.S. company participation," he noted.

Large UAS markets could include India, Indonesia, Middle East countries and Latin America. But the value in military UAS is not just the air vehicle, it includes the entire command-and-control system used in operations, Callan added. These systems consume satellite bandwidth during longer operations and require ISR to ensure the effectiveness of armed missions.

General Atomics Aeronautical Systems, with its Predator (shown) and Reaper lines, and Northrop Grumman, with its iconic Global Hawk series, are seen by analysts as primary beneficiaries of the new export policy. But Textron, which makes the RQ-7 Shadow, also could enjoy a lift, along with L-3 Communications and AeroVironment.

Still, competition is heating up. "Though the U.S. remains the lead actor in terms of possession and using armed drones, the rest of the world is quickly catching up," analysts at the Council on Foreign Relations wrote in a report last year. "Russia, China, Iran, South Korea and Taiwan, for example, have begun to develop increasingly sophisticated indigenous drone capabilities. Other countries—including Pakistan, Turkey, Saudi Arabia and the United Arab Emirates—have publicized their intent to purchase them."

Not surprisingly, U.S. industry welcomes the export potential. Northrop Grumman Chairman and CEO Wes Bush has been prominent in calling for Washington to help make sure U.S. industry does not lose market share in UAS as is believed to have happened in commercial satellites. That and recent Pentagon efforts to stay technologically well ahead of adversaries apparently have helped make the case, according to remarks he made at a Washington think tank in late January.

"If you turn the clock back to about five years ago, it was almost an impossible conversation—the notion that we would be exporting not only some of our unmanned vehicle capability but [also] some of our truly autonomous vehicle capability," Bush said.

"The recognition, I think, has grown quite rapidly—and I have to give the leadership of the Department of Defense credit for this—that if we are not the ones who are going to be exporting it and working with our allies on the future development of that technology, [it is] going to happen whether we're engaged in it or not."

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AIRBUS

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COMMENTARY

Positive Trajectory

GA manufacturers have reason for hope

Supreme Court Justice Ruth Bader Ginsburg may have found President Obama's 2015 State of the Union address sleep-inducing, but I saw no one nodding off during the Feb. 11 General Aviation Manufacturers Association's (GAMA) State of the Industry presentation, held a few blocks down from Capitol Hill. I attribute the collective attentiveness to two factors: First, the information was generally encouraging, and second, GAMA holds its event before lunch, too early for the vintage California red that felled Ginsburg.

GAMA's good news was that the industry's climb out of its long recession continued in 2014. The hard numbers: Total worldwide shipments of general aviation airplanes rose 4.3%, to 2,454 units, up 101 units from the previous year. Meanwhile, total billings topped $24.5 billion, a $1.1 billion bump (+4.5%) over 2013 as well.

"The trajectory is positive," said GAMA President and CEO Pete Bunce.

Mind you, the final tally was still well below the 3,970 new airplanes delivered in the 2008 gusher. But the dollars are close, thanks particularly to the popularity of the luxe jets turned out by Gulfstream, Dassault Falcon and Bombardier, which accounted for $18 billion of the year's total billings.

When comparing figures from 2008 and 2014, the recession's toll is shown by the earlier year's now-absent contributors: Gippsland Aeronautics and Liberty Aerospace, among other minor players. Then, too, there was Hawker Beechcraft, now part of Textron Aviation.

The 2014 count includes output from several new members, including WACO, which added 11 biplanes to the overall tally. Notably, agplane makers Air Tractor and Thrush are now in the GAMA fold and accounted for 182 units worth $102 million.

Not in the foregoing but also now being tallied by GAMA is the output of civil helicopter manufacturers, and among them 2014 was a disappointment. Rotorcraft shipments were down from the previous year, with the 230 piston engine helicopters delivered off by 31%, and the 741 turbine-powered machines down 22%.

GENERAL AVIATION MANUFACTURERS ASSOCIATION

GAMA's Joe Brown (left) and Pete Bunce.

In explaining those setbacks, Bunce said 2013 had been a particularly strong year for helicopter deliveries and that some operators were likely holding back on equipment purchases until several new models under development enter production.

A showpiece of the presentation was a commissioned study by PricewaterhouseCoopers of general aviation's impact on the U.S. economy in 2013, the most recent year for which full data were available. Essentially, it was an update of a similar accounting conducted a decade earlier, when the industry was also recovering from a recession, making for an "apples-to-apples" comparison, Bunce says.

While the study included state-by-state details—e.g., California employs 139,000 general aviation workers; the industry contributed $2 billion to Louisiana's economy—the combined numbers were the most impactful. The study found that general aviation "supported 1.1 million jobs and $219 billion in output." So the recession saw 100,000 workers pink-slipped, but the industry's economic impact increased nearly 50% since the previous study.

Ed Bolen, president and CEO of the National Business Aviation Association, which helped sponsor the study, says its findings "will be highly valuable in our ongoing work to educate policymakers." Jobs and money matter in Washington.

And when general aviation's lobbyists climb Capitol Hill this year, the priorities are clear. First, they want both the FAA and Export-Import Bank reauthorized without delay. Second, they're cheered that the president's proposed budget was absent any air traffic control fees and want to keep it that way. On the regulatory front, they want the FAA to make better use of the stalled Organization Designation Authorization program, which they believe will expedite the certification process. Similarly, they hope the agency will coordinate its 21 databases dealing with airworthiness to help standardize interpretations and approvals by FAA inspectors.

General aviation's various Washington organizations typically present a strong, united front. But occasionally there's a break in the ranks, and so it appeared at GAMA's annual gathering.

The FAA has ruled that as of Jan. 1, 2020, any aircraft operating in controlled airspace must have Automatic Dependent Surveillance-Broadcast (ADS-B) capability, and it has been steadfast about that deadline.

A Jan. 23 joint letter to FAA Administrator Michael Huerta signed by 14 general aviation organizations (notably, not including GAMA) states that the high cost of the equipment—which they put at $5,000—would prevent many aircraft owners from complying and urged the agency to do something about it.

But Hartzell Propeller President Joe Brown, this year's GAMA chairman, says avionics manufacturers have invested "years and millions" creating the equipment and that the association is "strongly for ADS-B." As for price objections, Bunce noted that GAMA member L-3 Communications has just introduced ADS-B units priced below $2,000. "The market is working," he said.

By Jens Flottau

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COMMENTARY

MH370's Complex Legacy

One year after the disappearance of the Boeing 777, industry and regulators struggle with appropriate responses

Almost exactly one year ago, Malaysia Airlines Flight 370 disappeared en route from Kuala Lumpur to Beijing. The Boeing 777-200ER seemed to be on a routine night flight up north, and there were no indications that something onboard would go very wrong. Then, on March 8, 2014, at 1:21 a.m. local time, the aircraft disappeared from secondary radar just before the IGARI waypoint off the Malaysian coast. It later reappeared on Thai and Malaysian military radar, but was lost again at 2:22 a.m. A last full-satcom ping from the aircraft registered at 8:11 a.m., more than 1-hr. after the 777 should have landed in Beijing. Malaysia recently declared all 239 people aboard dead.

MH370 was not the first aircraft in aviation history to be lost for a long time, and some, albeit in cases not as high profile, have actually never been found. But few other aircraft crashes have dominated global news so intensely for such a lengthy period of time. Public pressure to find both the aircraft and the cause of its disappearance has been enormous; myriad theories—including a hijacking to North Korea or a landing on one of the South Pacific's remote islands—have been debated.

That the mysterious disappearance of a modern widebody aircraft leads to such scrutiny and heightened emotion is only natural. But the industry's and, in particular, regulators' response to MH370 has also been driven by pressure and emotion. It should not have been. A rational analysis shows the response has been imperfect at best. The discourse falls short of what the industry should be thinking about and discussing with rulemaking institutions, chiefly the International Civil Aviation Organization (ICAO).

What has emerged so far from MH370 is the issuance of new global regulations on flight tracking (see pages 42-47). Airlines and their suppliers must modify aircraft to ensure they can be tracked more closely. This process will take years but it will, no doubt, eventually lead air traffic control and airline-operations centers to know an aircraft's location more precisely at any time.

But that has never been the real problem. The current tracking system is not perfect, but it works in principle. What better tracking may do when another aircraft disappears is allow it to be found more quickly, given the shorter intervals between automatic position reports and some early hints as to what may have gone wrong when the system transmits data in emergency mode. But what better tracking will not do is prevent accidents.

What would be more core to the subject is a discussion about how crucial operating data should be better transmitted for analysis, and how transmission can be guaranteed. That part of the discussion has not received the attention it deserves.

What is also missing, at least in the recent ICAO decisions, is how aircraft instruments can be made more tamperproof so transponders or other data-transmitting devices cannot be turned off inflight. This is now speculation, but circumstantial evidence suggests that MH370 was tampered with. Although the transponder was no longer transmitting signals, the aircraft continued to fly for about 7 hr. The pilot community has raised concerns about an electrical system over which the crew would have no control, even in the case of fire. These concerns have to be taken seriously, but they need to be part of a broader debate.

In fairness, because so little is known about what happened to MH370, it is hard for the industry and safety authorities to draw conclusions. But it seems the conclusions drawn do not touch the core of the issue.

Dramatic events like the disappearance of MH370 often lead to drastic action. But it has to be noted that—in the theory of an inflight hijacking—there is no guarantee against a repetition should the hijacker have sufficient technical skills. And no improved tracking device will be of any benefit when its power supply is cut.

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By Pierre Sparaco

Former Paris Bureau Chief Pierre Sparaco has covered aviation and aerospace since the 1960s.

COMMENTARY

Late Takeoff

Decades have elapsed between Rafales leaving the drawing board and landing a foreign sale

Egypt will take delivery of 3-5 Rafales in the next few months after recently signing a contract for 24 aircraft—marking an unusually rapid sequence of events. Egypt has long been considered a potential customer but such haste between signing and delivery is unheard of, even considering the hostile geopolitical tensions in the region. However, Cairo's military wants to flex muscles by putting up-to-date combat aircraft into service as soon as possible.

Despite assertions by the French media, there were no secret agreements behind the sale. Egypt historically has split its military procurement between French and U.S. manufacturers. To some extent, this was Europe's turn and the Rafale seems to be a wise choice. Moreover, Dassault Aviation and the DGA French procurement agency were poised to act promptly. In the absence of any export orders more than 15 years after the Rafale's service entry with the French air force and navy, France was ready to offer some concessions, but not on price; evidently no technology transfer agreement seems to be involved. The rapidly negotiated agreement came about for more complex reasons. After years of trying to snare a foreign buyer, the Rafale has finally accomplished that aim.

Most military experts concur that the aircraft is performing extremely well but is rather expensive. As it turns out, France has paid a high price to be able to offer a "multirole" aircraft. Perhaps an error was made 20 years ago when military authorities, jointly with the air force and navy—in an effort to cost effectively produce aircraft—decided to replace seven aircraft types with one. The rationale was that this would simplify the inventory and streamline the supply chain.

Back in August 1985, European air forces and national industrial heavyweights failed to agree on a common request for a next-generation combat aircraft. The U.K., France and Germany vied for the prime contractor role, while a fierce battle between engine manufacturers Snecma and Rolls-Royce played out. The end result was the launch of the Eurofighter Typhoon and the French ACX, later dubbed Rafale.

FRENCH NAVY

Dassault Aviation produces the Rafale at the minimum rate of one aircraft per month.

In the aftermath of several consolidation initiatives, an unusual internal battle erupted—a merciless confrontation opposing two similar European products (Rafale is more biased to air-to-ground versus air-to-air combat, and may therefore be better suited to most of today's confrontations).

Perhaps Rafale is simply too sophisticated; its flyaway price is higher than its competitors'. On paper, air forces were attracted by Rafale's impressive multirole capabilities but did not necessarily need such a versatile aircraft. Dassault Aviation and its main industrial partners, Snecma and Thales, were aware of the dichotomy between admiration and need but nevertheless proposed a one-size-fits-all product.

Many years ago, engineering-driven Dassault considered the merits of a low-cost combat aircraft in an attempt to fill a niche market. It was not an all-new design but a simplified derivative of the carrier-based Super Etendard. However, the type garnered no serious customers. But now, in an environment of increasingly tight budget constraints, low cost could well become a deciding factor again. This is Textron's conviction; it has developed the company-funded Scorpion, which is scheduled to appear publicly in flight for the first time at this year's Paris air show in June. The aircraft is positioned to complement front-line fighters at a fraction of the procurement cost.

Now that Egypt has made what some consider a surprising choice, other air forces such as Qatar and Malaysia could follow. And India has been a potential customer for years. They were expected to buy as many as 126 aircraft, however, last-minute wrangling over the country's offset portion is impeding the final agreement.

Belgium is no longer a potential Rafale buyer. When the program was launched, Brussels was offered a 10% share in the production as a launching partner. But this was premature; the offer came 10-20 years before the envisioned service entry date.

Rafale's first export order clearly underscores France's patience and perseverance and the unusually long lifespan of aviation military programs. The French aircraft at long last can challenge U.S. domination in the military aircraft arena.

By Graham Warwick

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COMMENTARY

Making an Impact

Unmanned-aircraft companies need to make their designs less damaging in collisions

Education, regulation and enforcement are key to safely integrating unmanned aircraft into civil airspace. But they cannot entirely eliminate the risk of someone unknowingly—or intentionally—sending a UAS aloft to collide with a manned aircraft or rotorcraft, particularly with the explosion in consumer drones flown by people with no prior connection to aviation.

MOB

This is why part of the integration equation must be determining the impact risk posed by unmanned aircraft and deciding how they can be designed to mitigate that risk—and, if necessary, how manned aircraft might have to be redesigned to survive an impact.

The first line of defense—or second after understanding and following the rules of the air—is intended eventually to be a sense-and-avoid system aboard the unmanned aircraft. But this will have limited capability in an air vehicle weighing only a few pounds. Normally these would be flying at altitudes well below manned aircraft, but could cross paths with agricultural aircraft spraying crops or helicopters responding to medical emergencies. Even aircraft on approach or climb-out could be at risk if an inattentive or ignorant operator allows a UAS to stray into off-limits airspace around an airport.

The FAA's proposed rule for small unmanned aircraft systems, released for comment on Feb. 15, does not require airworthiness certification of vehicles weighing up to 55 lb. Instead, it places strict limits on their operation: daylight only, under 500 ft., within visual line of sight of the operator, with access to controlled airspace requiring permission from air traffic control. The FAA is also seeking comment on whether it should, like Canada, establish a special category for "micro-UAS" up to 4.4 lb., with relaxed rules but tighter operating restrictions including a 400-ft. altitude limit.

Proponents of a micro-UAS category argue they are no heavier than birds and pose no more risk to manned aircraft than a bird strike. In December, on behalf of the UAS America Fund, lawyer Brendan Schulman petitioned the FAA to establish a micro-UAS category for vehicles up to 3 lb. This was supported by a safety study based on analyzing the FAA's Wildlife Strike Database and using small to medium-size birds as surrogates for unmanned aircraft to assess the risk posed by micro UAS.

Analysis of the 24.5 years of data, which the FAA estimates represents 39% of all civilian and military bird strikes, shows there were 34 cases of damage to aircraft in collision with small and medium-size birds. Only six collisions resulted in injuries, and none caused fatalities. "This study, which is based on an analysis . . . of safety data rather than conjecture, shows that there is no significant added risk to other airspace users posed by this type of commercial drone operation," Schulman says.

But a 55-lb. small UAS is not a 10-lb. bird, the heaviest that an aircraft must be designed to withstand. "A micro-UAS at 4.4 lb. or less is mainly plastic and not much of a threat to aircraft," says Steve Justice, director of Georgia's Center of Innovation for Aerospace and former FAA-designated engineering representative at Gulfstream Aerospace. "But a small UAS at 55 lb. and birds at 5-10 lb. are very different things."

Not only are they heavier, if they are electric-powered their mass is concentrated in the batteries. "A 55-lb UAS may have a 20-lb. battery pack, which at 200 kt. can do quite a bit of damage," he says. If gasoline-powered, they carry flammable fuel. "Even in a relatively small quantity, think of the problems that could cause coming through the windscreen or being ingested by an engine."

But in the absence of FAA certification requirements, what will provide the incentive to design for crashworthiness? The insurance industry, believes Justice. "I think the manufacturers of UAS will have to start taking this into account, and mainly because of the insurance industry." Remarking he would not be surprised if aviation insurers are drawing up lists of approved vehicles, Justice expects the industry to "step in and lay out requirements for training, operations—and airworthiness."

There is much work still to be done to define and mitigate the risk. The FAA says it has begun research that "includes evaluation of the risk to persons and property on the ground, and to other aircraft structures, windshields and propellers/engines from encounters with relatively small UAS that have either lost engine thrust, lost effective control or entered the flight path of another aircraft."

Justice suggests some guidelines, such as distributing the mass. "Instead of one 20-lb. battery pack, have four 5-lb. batteries. Aircraft structure has more chance of withstanding impacts in multiple places versus one location," he says. And use crashworthy fuel tanks, which add weight but help in both airborne and ground impacts. However small UAS designs evolve, he believes "[they] will be driven by liability and insurance."

NORTHROP GRUMMAN

By Bill Sweetman

Read Sweetman's posts on our blog **Ares**, *updated daily:*
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COMMENTARY

Spot the Spook

Secret clues to the Navy's tangled drone story

What's going on with the Pentagon's longest-running drama, the Navy's Unmanned Carrier-Launched Airborne Surveillance and Strike (Uclass) program? After years of factional intrigue that made Borgia politics look like a Dick & Jane reader, the debate about Uclass specifications has been declared not over, but deferred. (How can there not be enough data to make a decision?) But instead of redoubling their lobbying, Lockheed Martin and Northrop Grumman appear to have walked away.

In January, market analysts grilled Boeing CEO Jim McNerney about the future of the company's St. Louis operations, which were facing the shutdown of their fighter programs. He seemed unworried—and whatever you think of Boeing/Lockheed Martin's chances in the Long-Range Strike Bomber (LRSB) contest, neither side has a contract in hand.

Then the U.S. Naval Institute's *Proceedings* website reported that Uclass had been designated RAQ-25. Under Pentagon rules, programs don't get designators; only vehicles do.

U.S. Rep. Randy Forbes (R-Va.), a member of the cabal that has been pushing for a high-end Uclass, was discreet in an early-February discussion. "I'm pretty comfortable with the direction that the program is taking," he said. "I'm not trying to be vague. I just don't want to go to jail."

Deputy Defense Secretary Robert O. Work (a supporter of unmanned combat air systems in his previous jobs) explained the Uclass delay in February comments: "In addition to looking at capabilities that we already have and using them differently, we're going to make sure . . . that when we go after a new platform, it's the platform that we need from a joint perspective."

A joint platform is a U.S. Air Force/Navy program—the term can have no other meaning—but if Work is arranging a marriage for Uclass, where's the bridegroom? When orbital patterns are so disturbed, it's time to look for a dark planet somewhere in the system.

In October 2010, Maj. Gen. Dave Scott, head of the Air Force's operational requirements directorate, gave a briefing that disclosed the service's plans for a long-range strike family of systems (LRS-FoS)—plans that then-Defense Secretary Robert Gates approved a few months later.

Three family members are real today: LRSB, the Long-Range Standoff cruise missile and a "penetrating intelligence, surveillance and reconnaissance" (P-ISR) vehicle, which is Northrop Grumman's secret RQ-180. (A fourth, Conventional Prompt Global Strike, was dropped like a bad habit as soon as the Pentagon's exit door closed behind its leading advocate, and was replaced by the Minuteman follow-on.)

That leaves one: Penetrating Airborne Electronic Attack (P-AEA). In the LRS-FoS plan, RQ-180 would find targets for LRSB and the P-AEA would suppress defenses. Together, they fill the capabilities gap between the cost-constrained LRSB and the Battlestar-Galactica Next-Generation Bomber (NGB) that Gates canceled in 2009.

Also, after P-AEA appeared in Scott's briefing, the Air Force terminated its nascent MQ-X project, leaving itself with no visible solution to an obvious problem, which is a large force of MQ-9 Reapers that can be shot down with World War II weapons.

P-AEA appears in no known plan, but you need not dig very deep into the Air Force's fiscal 2016 budget to find $7 billion in classified acquisition money that is neither part of the cash that the Pentagon launders for the intelligence community, nor the LRSB.

And between early 2007, when Boeing became Lockheed Martin's partner on the NGB, and October 2013, when the companies re-partnered with Boeing in the front seat, St. Louis proved it had the chops to be publicly and unequivocally identified as the lead on that huge, critical and complex program. Boeing's stealth expertise has been shown in the X-36, X-45, Bird of Prey and Phantom Ray, but that's still not the same as delivering and sustaining a complete system.

What follows is a speculative scenario, an exercise in the risky art of connect-the-dots:

A classified P-AEA program started in 2011-12. It may have involved flight demonstrations. Quite recently, Boeing won it, hence McNerney's confidence about St Louis's future. It's been designated RAQ-25, indicating it has a strike capability, and as well as pathfinding for the LRSB, it takes on the MQ-X role. RAQ-25 is somewhere in that $7 billion slush fund.

Work's comments about "capabilities that we already have" indicate he and other leaders are pushing for a joint Air Force/Navy program based on the RAQ-25. The delay in Uclass allows time for a carrier variant to be demonstrated, and competitors have deemed the battle half over.

Returning to known facts:

This would be exactly the same as the solution proposed in October by a Center for Strategic and Budgetary Assessments paper on the Pentagon's Third Offset plan for a future U.S. military. You almost wonder if they knew something.

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COMMENTARY

Moving-Parts Mission

Goal is to improve space-weather forecasting

An ingenious constellation of four identical spacecraft set for launch March 12 aims to explore a fast-moving region in Earth orbit that scientists believe could improve space-weather forecasting, much in the same way atmospheric probes of hurricanes help forecasters model the behavior of deadly storms.

The complex Magnetospheric Multi-Scale (MMS) mission will push the bounds of spacecraft control for operators at NASA's Goddard Space Flight Center. It is designed to give a science team, headed by Principal Investigator James Burch of Southwest Research Institute, a high-resolution look into the narrow boundary layer known as the electron diffusion region (EDR).

In the EDR, magnetic fields in colliding clouds of cosmic plasma de- and recouple with a tremendous release of energy that can damage electric circuitry in spacecraft and electric power grids on the ground. Burch's team hopes to use the picture of the EDR that MMS returns to refine forecasting models for space weather.

"It's the smallest, narrowest part of that overall layer between the two magnetic fields inside and outside the magnetosphere," says Tom Moore, the MMS project scientist at Goddard. "The thing about the electron diffusion layer is it is so thin that it whips over a spacecraft in less than a second, so all previous spacecraft have kind of inferred that they crossed it. But they were unable to see what went on in there as it went by because they were making 3-sec. spacing measurements, and it went by in a fraction of a second."

The EDR is at the heart of magnetic reconnection—a process common across the universe. An Atlas V will launch the four MMS spacecraft from Cape Canaveral into an elliptical Earth orbit that will take them into day/night-side regions where solar wind interacts with the planet's magnetosphere, and will tackle the problem of "seeing" the action inside the EDRs at the interfaces of the two plasmas in two ways.

First, the four identical satellites will fly in a tetrahedron-shaped constellation with as little as 10 km (6 mi.) between them. That will allow them collectively to measure the effects of an EDR as it crosses the tetrahedron. And there will be 25 identical instruments arrayed every 90 deg. around each of the spinning spacecraft, which are shaped like hockey pucks (see photo), to measure the entire sky every 30 milliseconds, according to Moore. That will give scientists a much higher temporal resolution than they have had from earlier spacecraft, such as Europe's Cluster mission, as they measure the EDR characteristics.

"It's basically wind, temperature, pressure, all those weather-like things," Moore says. "You're in the vacuum of space, but it's not really a vacuum. You've got a gas of charged particles, or plasma, and it's got a flow velocity and a temperature and a pressure, and all those can be measured. But there are few enough particles so that is done by measuring individual particles. We'll get thousands of counts per second on every pixel of this thing."

In addition to the body-mounted instruments, each spacecraft will extend an array of feelers to measure electrical and magnetic fields around the spacecraft. The Atlas V will carry the MMS spacecraft to orbit stacked like plates, and getting them configured will take "multiple weeks," according to Brent Robertson, NASA's deputy MMS project manager.

"We have a total of 44 deployments that have to occur after the four satellites are in space," he says.

Each spacecraft is 3.5 meters (11.4 ft.) across X 1.2 meters high and carries eight deployable booms. To measure electric fields in the EDR, the satellites will reel out four 60-meter wires at 90 deg. angles into the spin place. Two more 12.5-meter booms will extend "up" and "down" in the axial plane for electric field measurements, and two 5-meter booms will reach into the spin plane to keep the twin magnetometers away from spacecraft interference.

NASA/CHRIS GUNN

Technicians prepare the four identical MMS spacecraft in a Goddard clean room.

When all booms and instruments are in place, Goddard will oversee an elaborate set of commands to bring the constellation into the proper tetrahedron formation as it passes through Earth's magnetic bow wave in the solar wind, and later at the planet's magnetic tail, to measure the EDRs. In operational configuration, the spacecraft footprints are baseball-field size. They spin at 3 rpm in their near-equatorial orbit, which ranges from 12-25 Earth radii at apogee, with a 600-km perigee.

"We have to know where we are down to 100 meters, and it's quite a challenge to keep the spacing right where we want it to be," Robertson says. "We have to do propulsive maneuvers every couple of weeks to maintain the formation. The flight dynamics algorithms and processing that go into figuring out how to fire those thrusters—some are very small maneuvers, and they're made with a spinning spacecraft—are really unique.

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COMMENTARY

Economies of Scale

Tomahawk as CAS asset? It's not good for tactical targets, says top Marine

With the Air Force opting to retire its fleet of A-10 close-air-support aircraft (CAS)—and given the cost of ongoing operations in the Middle East—lawmakers are interested in finding alternatives to provide less costly firepower. Rep. John Carter (R-Texas), asked Chief of Naval Operations Adm. Jonathan Greenert whether its Tomahawk cruise missile could be used to provide CAS. The Navy is working to enhance the Tomahawk, adding the ability to loiter and linking it with information on the ground so it can track and strike moving targets, according to Greenert.

Compared to aircraft, the mission could be done for "a few million, versus tens and tens and tens of millions," Greenert said during a Feb. 26 House Appropriations defense subcommittee hearing. But that still may be more than a ground guy needs.

Asked for his view, Marine Corps Commandant Gen. Joseph Dunford said, "I can see where the Tomahawk missile would be helpful for a high-end operational target or a strategic target, but not routinely for a tactical target for close-air support."

Carter also asked whether the Navy is working on other advanced technologies that allow the military to achieve more firepower with fewer dollars. The service is testing a laser weapon aboard the USS Ponce in the Persian Gulf, says Navy Secretary Ray Mabus. "The shots are measured in cents," he says.

U.S. NAVY FILE PHOTO

'The shots are measured in cents.'

— RAY MABUS
Navy Secretary

LONG GOODBYE

With relations between the U.S. and Russia at a new freezing point, Moscow has become the first International Space Station (ISS) partner to commit to extending its participation to 2024. But then . . . Russia says it will take its three modules back and build its own national space station to meet "the challenges of providing secure access to space," according to the Roscosmos space agency.

In recent months, amid increasing tensions with Western nations over Moscow's ambitions in eastern Ukraine, Roscosmos officials had signaled a potential end to Russian participation in the program in 2020, even though NASA wants to continue using the ISS to 2024.

But now, despite its plans to take its modules and go elsewhere, Russia is the only country among the five ISS partner nations to formally state its intent to continue participating in the program beyond the end of this decade. At this point, NASA felt it best to play it straight, providing just this statement: "The Obama administration is committed to extending operation of the International Space Station to at least 2024. . . . We welcome continued cooperation from our ISS partners in support of this extension and look forward to working with them on the ISS until at least 2024."

EX-IM PUSH

With just a few months to the latest June deadline for reauthorizing the Export-Import Bank, lobbyists are swarming the Capitol to ensure their voices are heard on the matter. The Air Line Pilots Association (ALPA) and U.S. carriers including Delta Air Lines have long claimed that Ex-Im Bank financing puts U.S. carriers at a disadvantage, because they do not have the same access to export-credit financing as foreign airlines. With that financing, foreign airlines "can flood the market with excess capacity and drastically undercut market-driven pricing," ALPA says in a letter to lawmakers. This puts airline jobs at risk, they say.

While those airline jobs may be at risk, aerospace giants Boeing and General Electric depend on Ex-Im financing for sales. And those companies, with the backing of the U.S. Chamber of Commerce, have mobilized more than 500 beneficiaries of Ex-Im financing to the Hill to tell their side of the story: The bank allows for $27.5 billion in U.S. exports and supports 164,000 U.S. jobs.

MOVING ON

The Aerospace Industries Association is searching for a new president as Marion Blakey, the longtime face and voice of U.S. aerospace and defense industry concerns in Washington, will be taking a job as the president and CEO of Rolls-Royce North America. The unit's current president, CEO and chairman, James Guyette is retiring May 31.

In Blakey, RRNA is getting an executive who knows Washington and the industry. And while the former FAA administrator could not do the impossible in her time at AIA—getting Congress to reach agreement on intractable issues during a time of divisiveness—her real claim to fame was getting the word out about what had once been a rather sleepy aerospace trade association. When Blakey took over, the organization spent a little over half a million dollars on lobbying efforts. That amount increased to a peak in 2012 of nearly $3 million in 2012. The following two years in a row, *The Hill* newspaper placed AIA on its list of top lobbying organizations.

With additional reporting by Amy Svitak in Paris, Madhu Unnikrishnan in San Francisco and Michael Bruno in Washington.

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Desert Duel

Middle East shapes up as battleground for Europe's fighter manufacturers

Bill Sweetman and Tony Osborne Abu Dhabi

Big fighter orders are close to decision points in the Middle East, industry executives and government officials say, and the outcomes will be critical for the future of the competing aircraft.

USAF SENIOR AIRMAN THOMAS SPANGLER

Although the Dassault Rafale's success in landing an order from Egypt—a noncompetitive sale secured with unusual speed—will help sustain its minimum production rate for a few years, the Eurofighter consortium is making a strong pitch for the Typhoon in Qatar, Kuwait and the United Arab Emirates (UAE).

The Middle East market is increasingly seen as a Rafale-versus-Typhoon contest. The Lockheed Martin F-35 is not approved for export there. "I do not anticipate any near-term sales for the F-35 in the region," Frank Kendall, U.S. undersecretary of defense for acquisition, said Feb. 22 before the IDEX defense show here, according to Reuters. "I think it would be a very sensitive sale to try to bring about for a lot of reasons." The leading U.S. prospect in the region appears to be a possible Boeing F-15 sale in Qatar.

Also absent is the Saab JAS 39E Gripen, which currently has the most secure long-term production plans of any European fighter: Long-standing Swedish government policy bars high-profile arms sales to the Middle East.

In December 2013, the UAE abruptly ended negotiations with Eurofighter. At that time, features the UAE and other customers consider essential, including a standoff cruise missile and active, electronically scanned array (AESA) radar, were not funded on the Typhoon but available on the Rafale. Since then, the Eurofighter partner nations have put money into those capabilities.

Eurofighter may be under more pressure than Dassault, as the consortium has already manufactured parts for the last Typhoons on order, says marketing director Joe Parker. Plans are in place to mitigate the impact of any break in production. Retrenching to a single final-assembly line is on the table, as well as other changes to the production system. "The day is getting close," Parker says, to when Eurofighter will have to advise customers that prices will rise if they do not commit.

The Typhoon's best prospect may be a Saudi follow-on order, now being discussed. Bahrain, once considered a Typhoon prospect, has decided to upgrade its F-16s before buying new aircraft, which it does not expect to do until 2025. U.K. officials believe Kuwait and Qatar will likely make fighter decisions within the next six months. French sources have been predicting a Rafale win in Qatar, telling Reuters in February that negotiations for 36 aircraft were in their final stages. Since Qatar needs 72 aircraft, this could presage a split buy.

With Saudi Arabia already operating Typhoons, and Oman on the customer list, one Eurofighter executive notes there could be advantages in a "GCC [Gulf Cooperation Council]-wide solution" with shared support. According to U.K. sources, the Emir of Qatar is "very pro-British," a close relationship that could tip the balance, as he is likely to have the ultimate say in such a large investment.

Royal Air Force Typhoon fighters flew 150 sorties during the most recent Red Flag exercise in Nevada, which concluded in mid-February.

But one industry source says British hopes in Qatar are unrealistic: "If there is a split buy, it will be Rafales and F-15s." BAE Systems is leading the sales campaign in Qatar, while AleniaAermacchi is the lead in Kuwait. Dassault has imposed a lockdown on public discussion of future business in the Middle East but met with numerous top-level regional delegations at IDEX.

Eurofighter's Parker says the company "is ready to offer a proposal" to the UAE, "and is in a much better position than we were." UAE Staff Maj. Gen. Obaid Al Ketbi, chairman of the IDEX organizing committee, said at the show that evaluation of a replacement for the country's Dassault Mirage 2000s is continuing, and there is no indication the Typhoon has been ruled out. Neither is there any sign of a contract for the 30 new F-16 Block 61s the UAE told the U.S. about a year ago it intended to acquire.

Underscoring Eurofighter's UAE hopes, the partner nations chose IDEX to sign a ministerial-level agreement to integrate the MBDA Brimstone 2 on the Typhoon. Used by Royal Air Force Panavia Tornados in attacks on Islamic State forces in Syria, the missile is a centerpiece of the Typhoon Phase 3 Enhancements (P3E) package. The €200 million ($227 million) upgrade includes software improvements for the MBDA Storm Shadow cruise missile, Raytheon Paveway IV precision-guided bomb and air-to-air weapons.

P3E has been accelerated to deliver Brimstone capability on the Typhoon in 2017, which means it could reach Royal Air Force frontline units in 2018, a year before the Tornado retires. It is the latest in a series of upgrade contracts awarded since last summer, including integration of Storm Shadow and devel-

opment of the Captor-E AESA.

Brimstone integration has gained importance as more Middle East nations find themselves engaged in counterinsurgency operations, sometimes over distances requiring fighters rather than light-attack types (see page 28). Combat has shown that such operations require precise, short-time-of-flight weapons with low-yield warheads—the need Brimstone 2 was developed to meet. The Rafale has previously had an advantage in this area, carrying the Sagem Hammer laser-guided glide bomb.

Unmanned Chic

Piaggio makes progress with HammerHead UAV, but is it enough to combat Reaper and Predator as the U.S. loosens UAV restrictions?

Tony Osborne Abu Dhabi

With an order under its belt and the considerable clout of Emirati cash, Piaggio Aerospace has been able to push forward with flight tests for its Hammerhead unmanned reconnaissance aircraft.

A development of its P.180 Avanti executive twin-turboprop, the first fully representative prototype P.1HH HammerHead made its first flight from Trapani air base, Sicily, on Dec. 22, but the manufacturer—now 98% owned by United Arab Emirates' (UAE's) Mubadala Development Co.—kept the milestone under wraps until the IDEX defense showcase here, where the project was initially disclosed two years ago.

And now the Italian air force has affirmed its commitment to the system with an order for six aircraft and three ground control stations; deliveries are slated to start in early 2016.

Previously the air arm said it would like to purchase as many as 10.

PIAGGIO AEROSPACE

Piaggio's first fully configured P.1HH HammerHead UAV made its first flight in Sicily on Dec. 22 last year.

HammerHead is being certified with Italian military airworthiness agency Armaereo. The flight-test program and qualification campaigns for the production configuration will be phased progressively, with initial operating capabilities coming in steps before a final operating capability later.

A second prototype is in assembly and should be ready to fly in the summer.

HammerHead has a longer wingspan—15.6 meters (51 ft.) compared to the Avanti's 14 meters—to improve low-speed loiter capability and high-altitude performance. Until now, Piaggio has been flying a demonstrator aircraft, essentially a stripped down Avanti fitted with Selex ES's flight-control system.

Arriving at the first flight phase has been a challenge because 2014 brought significant changes to the company. Mubadala bought out Tata's stake in May and replaced the management team, with Carlo Logli, former CEO of SuperJet International, taking over as CEO. The new owners streamlined operations from two plants to a single new facility at Villanova d'Albenga, which created difficulties with workers unions, as the new plant was "70 km [43 mi.] from one site and 20 km from the other," says Logli.

One of Logli's aims is to speed up the HammerHead's entry into an already crowded medium-altitude, long-endurance market, but he claims the aircraft has advantages, such as a cruise speed of up to 320 kt., while the longer wing brings high-altitude loiter speed down to 135 kt. Piaggio also says the aircraft is capable of flying in all weather because it is based on a civil-certified aircraft—while the twin-engine configuration provides additional safety. The P.1HH will have a 16-hr. endurance with a sensor payload.

Even though the mission system is largely free of International Traffic in Arms Regulations export restrictions, HammerHead is powered by Pratt & Whitney Canada turboprops, which could give the U.S. leverage over potential sales.

The Italian air force order is a significant step forward, but HammerHead's market may be further eroded as the U.S. softens its stance on overseas UAV sales, particularly for the Predator XP export version of the General Atomics MQ-1. The U.S. State Department has cleared the XP for sale to India, and approval to sell the UAE a specialized version, dubbed "Emirati Predator" or EP, is expected shortly, according to UAE air force officials.

In addition to HammerHead, Piaggio is developing its manned Multirole Patrol Aircraft, an Avanti derivative with even longer wings—21.4-meter span—as well as larger canards and vertical stabilizer. Expected to fly in 2014, the aircraft is now due to fly in the summer and debut at the Dubai air show in November.

NORTH STAR AVIATION

Projecting Economically

Low-cost reconnaissance/attack aircraft show their worth in the Middle East

Tony Osborne and Bill Sweetman Abu Dhabi

Middle Eastern air arms may not be on budgets as tight as their compatriots' in Europe, yet they are increasingly looking for more cost-effective means of delivering the effects of air power.

The United Arab Emirates (UAE) has spent billions of dollars on Lockheed Martin F-16 Block 60s, so it seems odd that a country that prides itself on buying advanced weaponry is also investing in rather more austere platforms—partly for its own special-operations units but also to support its near neighbors. It is a trend that is beginning to be noticed.

The UAE's purchase of Air Tractor AT-802s is a prime example. Developed mainly as an agricultural and fire-fighting aircraft, the AT-802's ability to lift roughly half its weight in payload has made it an ideal aircraft for border patrol and counterinsurgency in the UAE's eyes.

The country's Special Forces Command ordered 24 aircraft and was first to adapt the AT-802 for the armed mission. Since then, six of the UAE's aircraft have been handed to Jordan. This has prompted interest in the aircraft's capabilities from other nations, say program officials. Lebanon and Mali have expressed interest in the AT-802, but both are countries to which the U.S. is reluctant to sell equipment that has the potential to be armed.

Where the AT-802 cannot go, however, alternatives such as the Advanced High-performance Reconnaissance Light Aircraft (Ahrlac) can. Designed and developed in four years by South Africa's Paramount Group, it appears the company already has orders for the Ahrlac and is preparing to start deliveries in around two years.

Paramount Chairman Ivor Ichikowitz does not confirm that there is a launch customer and says none of the nations in negotiations wants to be identified. But in reply to the suggestion the company either has an order or is so close to a deal it makes no difference, he says: "That would be about right."

The Ahrlac experimental demonstrator has logged 65 hr. since its first flight in July 2014, including short-runway and rough-field tests, and was ready to retract its landing gear and start high-speed testing at the end of February. A cruise speed of 330-350 kt. is expected. So far, flight testing has not shown the need for any substantial changes in the twin-boom pusher design, which has a slightly swept-forward wing and helicopter-like view for the two crew.

Major airframe components have been fabricated for the first of two preproduction model (PPM) aircraft, which is "within six months" of flying and will fully conform to production standards. The aircraft will be used to test mission systems: Ahrlac has a lower-fuselage bay that accommodates a payload pallet, allowing the aircraft to switch quickly between roles.

The UAE's Northstar-developed 407MRH is a commercial Bell 407 equipped with a military mission system and armament.

The PPM aircraft will also test armament, including an internal 20-mm gun from South Africa's Denel and guided weapons such as Denel's Hellfire-equivalent Mokopa missile, and will be fitted with new Martin-Baker Mk. 17 lightweight ejection seats.

Other than the Pratt & Whitney Canada PT6A, five-blade pusher propeller and ejection seats, 98% of components are built in-house, Ichikowitz says. This includes the mission computer, from Paramount company ATE, so it controls the avionics source code. The aircraft components are designed so they can be made on widely available commercial machine tools, and assembly is "jigless," with self-aligning airframe parts.

Ichikowitz says the company's next project could be an attack helicopter smaller and less costly than the Boeing AH-64 Apache or AgustaWestland AW129 but "larger than a [Bell] JetRanger." That lower end, however, is where UAE-based Northstar Aviation aimed in taking a certified commercial light helicopter and giving it a precision attack capability with Hellfire missiles.

The Bell 407MRH has a price tag that is a fraction of an AH-64's. Northstar buys 407GX helicopters from Bell and retrofits a new avionics suite, mission computer and weapon pylon system capable of carrying Hellfire, guided and unguided rockets as well as forward-firing guns. The aircraft, which made its public debut at IDEX, can be quickly switched to a new role to carry four passengers in the rear cabin.

While NorthStar has not named its primary customer, the UAE armed forces have purchased 30 407MRHs, with around a dozen already in service. "The aircraft has been very well-received by the customer," says Adam Gunn, technical director at NorthStar. "We can fit a full weapons load and fill it with fuel up to the maximum takeoff weight . . . and it will operate comfortably on the hottest days here in the UAE."

Wedding Ring

Indian navy order should become a pioneering Japanese sale of finished military equipment

Jay Menon and Bradley Perrett Bengaluru

As India moves toward ordering Japanese amphibious aircraft, it probably helps that the two countries are becoming closer diplomatically. Each is disconcerted by the rise of China, which is friendly with neither. And in international relations, partners—existing and potential—tend to put a lot of emphasis on trade in defense equipment.

India is likely to order nine ShinMaywa US-2 amphibious aircraft this year, officials say, filling a navy search-and-rescue requirement and handing Japan its first aircraft export contract under Tokyo's relaxed arms sales regime.

SHINMAYWA

The US-2 may pioneer exports under Japan's new arms sales policy.

A private local partner is expected to help build the aircraft for the Indian navy, and perhaps make parts for export. Local content is the key issue to be settled before a contract, industry and government officials say. Deliveries should begin by 2018, maybe next year if the contract is signed soon enough.

The Indian air force and coast guard are also keenly interested in the 43-metric-ton (95,000-lb.) aircraft, says Sujeet Samaddar, the head of ShinMaywa's Indian subsidiary.

For the navy, India may take its first six aircraft, under the designation US-2i, directly from ShinMaywa. At first, two aircraft a year should be delivered. The first US-2i to be assembled in India is expected to roll out within five years of the order being placed.

"The acquisition process of the US-2i was discussed as part of the Services Capital Acquisition Plan for 2015, and the deal is likely to be finalized during the visit of Japanese premier Shinzo Abe later this year," a government official familiar with the acquisition process tells Aviation Week.

India chose the US-2 over the Bombardier 415 MP and Beriev Be-200 amphibious aircraft. Only the US-2 came close to meeting the navy's requirements, the official says. Although unarmed, it will be the first finished military product in decades to be exported by Japan, which in 2014 relaxed its self-imposed ban on selling arms abroad.

"With a coastline which runs nearly 7,500 km (4,660 mi.), it won't be surprising if the navy increases its requirement to over 15 such aircraft," says a Japanese government official at the Aero India exhibition in Bengaluru (Bangalore). Air force and coast guard purchases could increase India's US-2i fleet to 20 or more.

After Abe met Indian Prime Minister Narendra Modi in Tokyo last year, the two countries declared that they were elevating their relationship to a "special strategic and global partnership." That understanding should at least help ShinMaywa overcome India's tendency to drag out defense equipment orders. The Indian defense ministry may see reasons to defer, as it often does, but the foreign ministry and prime minister's office should be keen to get the US-2 deal done. In years to come, it may be seen as an Indo-Japanese wedding ring.

Of more importance to India, the key feature of the US-2 is its ability to land and take off on water surfaces with 3-meter (10-ft.) waves. Contributing to this capability is an unusual engine configuration: four Rolls-Royce AE2100J engines for propulsion, and one Rolls-Royce and Honeywell CTS800 driving a compressor that blows air over the flaps, rudder and elevators for extra low-speed lift and control.

It is not a cheap aircraft, however. India's will cost $90-115 million each, depending on configuration, part of a program cost of around $3 billion.

Difficulties in achieving the required 30% local content are obvious, especially if the initial six aircraft are built in Japan and the total order reaches only nine. ShinMaywa needs an Indian partner that can build parts of a large aircraft to the required level of quality. A US-2 project engineer suggests that a simpler structure, such as the tail, may be the best choice for transfer to India.

The program highlights India's difficulty in expecting large local content from orders that cover small unit volumes. ShinMaywa already builds the US-2 far more slowly than is normal, with a production rate less than 0.5 a year. But the Indian order would not offer more than a faster production run offset by the transfer of work that is already supported by skills and equipment in Japan. And the Indian requirement, while bigger than Japan's own, is far from economically large. Exports would improve the efficiency of the prospective two-country production setup but are surely a hit-and-miss prospect for so specialized and costly an aircraft.

The challenge is not just on the Indian side. ShinMaywa, like the rest of the Japanese arms industry, does not know much about outward technology transfer. "Everything we are doing is new," says the engineer. That includes marketing to foreign militaries by setting up a stand at the Bengaluru air show.

Still, if Japan is to become an arms exporter, it must begin somewhere, and ShinMaywa and the US-2 appear to be the pioneers.

Ready For Launch

Indian fighter designers freeze AMCA configuration, now seek funding

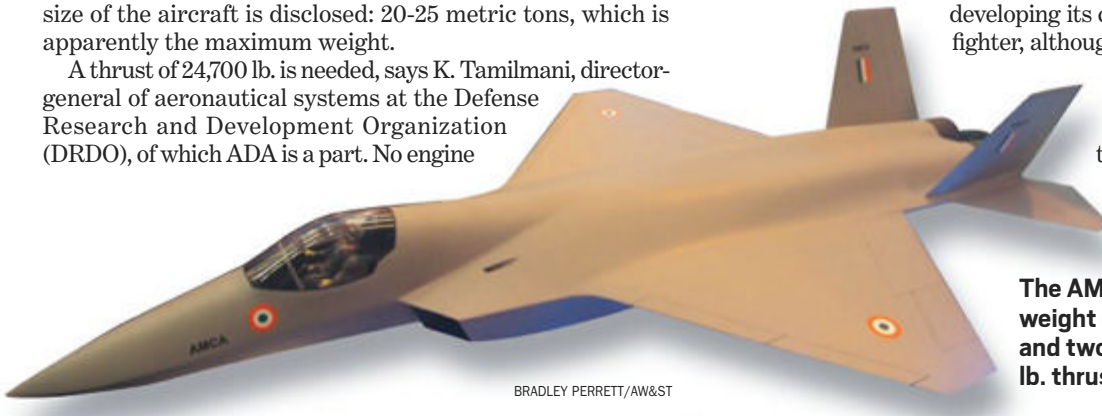
Jay Menon and Bradley Perrett Bengaluru

India is lining up three aircraft to replace its aging fighter fleet in the next decade. One is Russian, one is French and one, the Defense Ministry's technologists hope, will be Indian.

The designers have now frozen the configuration of a proposed medium-weight Indian fighter that they expect to fly early in the 2020s. General Electric is the preferred supplier of propulsion for the twin-engine, stealthy Advanced Medium Combat Aircraft (AMCA), but the defense organization that is handling the project, the Aeronautical Development Agency (ADA), has opened negotiations with other suppliers.

Although an ADA official who is closely associated with the project tells Aviation Week the preliminary design and therefore configuration will not now change, only an approximate size of the aircraft is disclosed: 20-25 metric tons, which is apparently the maximum weight.

A thrust of 24,700 lb. is needed, says K. Tamilmani, director-general of aeronautical systems at the Defense Research and Development Organization (DRDO), of which ADA is a part. No engine with that afterburning rating is available, Tamilmani said, so a powerplant will have to be upgraded. Based on sea-level static thrust, the General Electric F414 has the closest rating, which helps explain the preference for GE. Also, the U.S. company has been working with ADA and the Indian industry on propulsion for the Hindustan Aeronautics Ltd. (HAL) Tejas. Its Mk.1 uses the GE F404, and the Mk.2 the F414.



BRADLEY PERRETT/AW&ST

The AMCA would have a gross weight of 20-25 metric tons and two engines of 25,000 lb. thrust each.

ADA hopes GE can provide the engine, says the agency official. But Eurojet Chief Executive Clemens Linden says his organization, a consortium of European engine makers, remains interested in the program. A GE official declined to comment.

The agency needs an Indian industrial partner to build the AMCA, says the ADA official, notably failing to assume that only HAL, which is part of the Defense Ministry, could be qualified. Although private Indian companies make aerostructures and systems, none has experience in detailed design and integration of jet aircraft, let alone a stealth fighter.

Indian content of the AMCA is supposed to be 80%, so manufacturing of the engines probably will have to be licensed. That presents a stark contrast with another Indian fighter program, one based on the Sukhoi T-50. This has been presented as a joint project, but India would get only a 13% share despite paying half of the development cost, according to *The Times of India*. DRDO would have minimal participation, says the ADA official. After three years of negotiations, India and Russia have been unable to agree on proceeding with joint development.

Apart from India's opportunity to develop and receive technology in the T-50 effort, the two sides have not agreed on delivery timeframes, engine selection and weapons integration (*AW&ST* Feb. 12, p. 56). In India, the project has been called the Fifth Generation Fighter Aircraft or the Prospective Multi-Role Fighter, a name that sounds noncommittal.

Building of the first AMCA prototype is expected to begin in 2-3 years, integration of the engine in the second half of 2019 and a rollout in 2021. Allowing time for ground-testing, first flight could occur by 2022. The target for entry into service has not been disclosed, but the Tejas was not ready for service until 22 years after ADA and HAL began full-scale development.

If India does not agree to buy the T-50, and if the AMCA falls far behind schedule, then the air force should be able to rely on HAL-built Dassault Rafales to replace old fighters. But negotiations underway since 2012 have failed to produce a contract for the French fighters. If that project fails to proceed, then India will be left with little choice but to upgrade its Sukhoi Su-30s for production into the 2020s.

ADA estimates the cost of AMCA development at more than 200 billion rupees ($3.2 billion). The figure is remarkably low: South Korea expects to spend 8.8 trillion won ($7.92 billion) on developing its comparable KF-X stealth fighter, although Lockheed Martin said in 2009 the program would cost $12.4 billion.

Project definition of the AMCA has begun, says the ADA official. The next step will be seeking government approval to proceed with an initial design and development phase costing 40 billion-50 billion rupees, reports *The Times of India*.

ADA's AMCA design includes a faceted body, a trapezoidal wing with a forward-swept trailing edge, and aft-mounted horizontal stabilizers. Advanced features intended for the aircraft include supersonic cruise without afterburning, thrust vectoring, internal weapons carriage, advanced integrated avionics and sensors, and shared sensor apertures including conformal antennas, integrated flight and propulsion control.

ADA is planning stealthy and non-stealthy versions. The agency may be following the plan proposed for the KF-X, which would have a stealthy shape but initially would not have the detail engineering necessary for low signatures.

Like most modern fighters, the AMCA would be designed for many missions, including air-to-air, strike, suppression of enemy air defenses and maritime attack. A maximum weight of 20-25 metric tons would compare with 29.9 metric tons for the Boeing F/A-18E/F Super Hornet, for which the F414-GE-400 generates 22,000 lb. static, sea-level thrust. Accordingly, ADA appears to be aiming at a somewhat lower thrust loading. In the area of propulsion, the ADA official compared the AMCA with such aircraft as the Lockheed Martin F-16.

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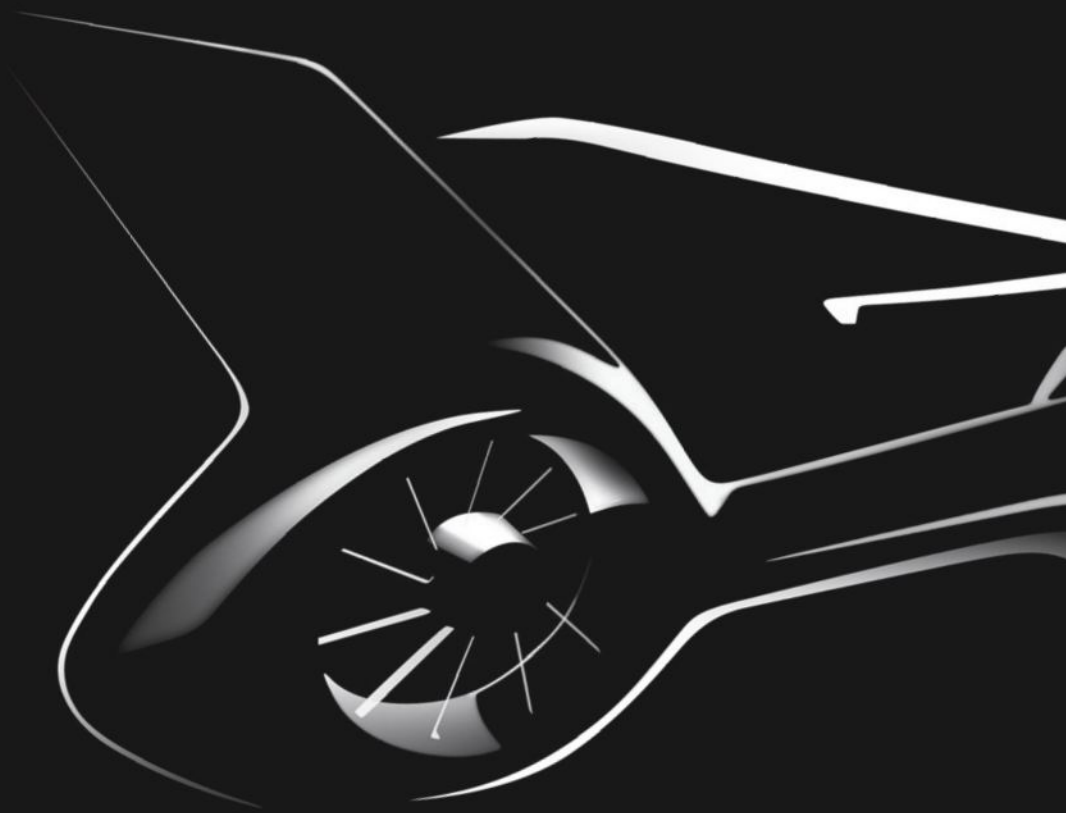

AIRBUS
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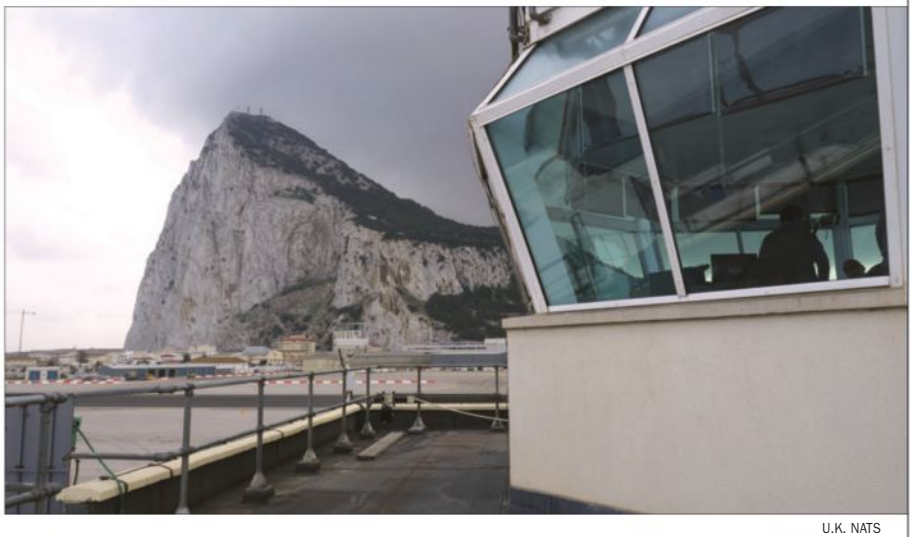
Ambition vs. Decision

After more than 10 years of talks, a single airspace in Europe is no closer to reality

Cathy Buyck Brussels



U.K. NATS

The Single European Sky initiative is aimed at streamlining and upgrading the air traffic management (ATM) hodgepodge that bedevils the 28-nation bloc. The inefficient and fragmented ATM system is badly in need of an overhaul, but the ambitious project has deviated and is now on a zigzag path itself. This has airlines wondering if the approach should be changed.

"I think we failed to provide evidence and prove that it is a concept that can work. Maybe we should be a bit more pragmatic and less political and institutional and explain *why* it would work," says Athar Husain Khan, CEO of the Association of European Airlines. "Maybe we should have a bottom-up approach, work with a couple of airline representatives, a couple of willing air navigation service providers [ANSPs], a couple of willing airports and a couple of willing regulators. We have to stop the confrontation and find common ground," he asserts.

The European Commission (EC) remains convinced of the need to transform Europe's air traffic management. "With 28,000 air traffic movements a day, we are approaching the limit of what our systems can manage," warns Violeta Bulc, the new European Union (EU) commissioner for transport. "We are approaching gridlock in the skies; a dire threat for the growth of our economy, the competitiveness of airlines and airports, the mobility and opportunity enjoyed by our citizens. The EU has enough economic problems—I don't want us to add one more."

But the EC's ambitions do not mesh with the decisions of member states and ANSPs.

There is no impetus for moving ahead with implementation of the Functional Airspace Blocks (FABs). With the goal of improving traffic flow while saving costs and flight time, FABs establish common airspace blocks arranged around traffic flows rather than state boundaries. European airspace has been divided into nine FABs and EU members should have implemented their FABs by Dec. 4, 2012.

EU members have been sued by the commission for noncompliance, and there is no agreement on the reduction of air navigation charges for the second five-year reference period (RP2), which started Jan. 1. The ongoing spat between Spain and the U.K. over Gibraltar could delay further efforts on setting an EU-wide cost-efficiency target for RP2 and, more important, the bitter dispute is raising questions on the legality of the—already overdue—endorsement of the Single European Sky (SES) 2+ legislative proposals by Europe's transport ministers last December.

Last year the EC sent letters of formal notice to all 28 EU members regarding the long delay in making their respective FABs fully operational.

There has been an exchange of views and some corrective measures have been taken, an official of the EC's Directorate-General for Mobility and Transport (DG Move) says. Yet only two FABs—the Danish-Swedish bloc and the North European airspace bloc covering Estonia, Finland, Latvia and Norway—have fulfilled all criteria and infringement proceedings have been stopped.

The U.K./Spain dispute over Gibraltar is outside the purview of the EC's transport policy, but affects all major proposals, including the SES.

The timing of the infringement proceeding was "extremely unfortunate," believes Husain Khan. National authorities were reviewing the SES 2+ legislative proposals, which the EC introduced in June 2013 to speed up reforms that were planned under the initial SES legislation (adopted in 2004) and the SES 2 package (adopted in 2009) and adapt them to demands by member states to slow the speed of reform. "The court action put the member states even more on the defensive and made them even more adamantly opposed to the SES, sending the performance scheme in the wrong direction," Husain Kahn says.

On the other hand, he adds, "we need to be fair [about] the EC. A lot of frustration had been building up over the last decade because member states for whatever reason, and there are many, failed to comply, failed to meet deadlines, failed to implement, failed to find any way to constructively deal with the SES. It had a legal tool to react and it used it."

The EU members reached a compromise on EU-wide cost-efficiency targets for RP2 in the second half of last year, and a reduction of just over 3% each year for five years, year-on-year, was scheduled to go forward to the Single Sky Committee meeting in January. Germany, however, changed its mind and its state-owned ANSP—DFS—submitted a last-minute proposal to increase charges to airlines by 30% for air traffic control services as of Jan. 1, 2015, to cover previously unaccounted for provisions in controller pensions.

After strong protest from airlines

including Lufthansa and Air Berlin, the largest users of German airspace, and the promise of the German government to partly subsidize the pension plan, DFS settled for a 16.6% increase. "It is a clear case of a monopoly service provider abusing its dominant position," Europe's main airline associations aver.

Germany has been the most flagrant in increasing, rather than decreasing, charges, but other European countries also have chosen to boost their ATM fees. DG Move has rejected the 2015-19 performance plans of seven other member states—France, the Netherlands, Luxembourg, Italy, Belgium, Austria and Slovakia—at the Single Sky Committee meeting in January.

Margus Rahuoja, the EC's director for Aviation and International Transport Affairs, admits the performance plan is an issue. "[It is] not working. Very simply, the challenge for the EC is to make it work," he told delegates at the EU ATM Master Plan conference in Brussels last December. DG Move intends to have an agreement on the RP2 and the SES 2+ package by summer, although it is not clear how it will foster a deal. It has no legal power to enforce cost efficiencies on ANSPs, most of which are state-owned in Europe, or force member states to agree on the legislative proposals (which were endorsed by European Parliament in March 2014).

In the meantime, airlines are paying the higher charges.

"The analysis of the figures shows that for 2012 and 2013 airlines will have paid an additional €900 million [$1.09 million] compared with the [RFP1] targets adopted for the EU states," notes International Air Carrier Association Director General Sylviane Lust. "We fear that RP2 will be even worse. It is time the states accept that the SES regulation was meant to lower charges to airlines and not to further increase ANSPs' profits."

Yet a top official of DG Move, who spoke to Aviation Week but may not be named under the new Juncker Commission's external communications policy, believes it is not all bad news. He contends that significant progress has been made and that the SES is a reality viewed in a wider context. "Military involvement and sovereignty are sensitive issues. Today we have a flexible use of airspace in Europe; that is a mind shift. We have a network manager, we have Sesar [Single European Sky ATM Research] moving into the deployment phase, we have a performance scheme not just for cost efficiency but also for safety, capacity and the environment."

Others appreciate the successes of the SES more than the participants themselves, the official says, noting that a number of regions "such as Asean [Association of Southeast Asian Nations] admire what we have achieved and would love to have the same level of progress in creating more cooperation between independent nations." Within Europe the SES project gets a lot of criticism, especially from airspace users, the official says. "Their criticism is focused, they want to pay less."

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Resisting the Obvious

Irish government puts forward more demands ahead of an agreement to sell Aer Lingus to IAG

Cathy Buyck Brussels

To its management, the takeover of Aer Lingus by International Airlines Group (IAG) seems like a "no-brainer" that benefits all stakeholders. But the Irish government is yet to be convinced that it should give up control of the national airline as unions continue to oppose the proposed deal. And Ryanair, the largest single Aer Lingus shareholder, remains silent about its intentions.

On Feb. 24 Ireland's Minister for Transport Paschal Donohoe said the government could not give an "irrevocable commitment to accept an offer to dispose of its 25% shareholding, should one be made by IAG, based on the information and commitments that have been provided to date."

But the government did not totally close the door, and noted it remains open "to considering any improved proposal which IAG may bring."

Dublin said it wants more precision on IAG's and Aer Lingus's statements that the deal will create new jobs, specifically on the "timeframe within which net additional employment would be created," and how exactly the acquisition by IAG will grow traffic and connectivity from its regional airports at Cork and Shannon.

Aer Lingus's total passenger numbers, including on its regional services, have passed the 11 million mark for the first time.

Another key sticking point for the Irish government is Aer Lingus's Heathrow slot portfolio. IAG CEO Willie Walsh has offered to continue using the slots for short-haul connections with Ireland for five years, but the government has now officially confirmed it requires a longer period.

The Aer Lingus board is still strongly in favor of the IAG deal, and outgoing-CEO Christoph Mueller even warned that the Irish airline's long-term growth prospects, especially on transatlantic routes, could be at risk if it is rejected.

Mueller recognizes that politicians, unions, Aer Lingus employees and its constituencies in the regions are worried that the acquisition of Aer Lingus by IAG will have a negative effect on

employment and connectivity. But "IAG and also our management team and our board are engaged on a daily basis to remove these concerns in a very intensive dialogue with all parties concerned. I'm quite convinced that we will complete that process," he told analysts and journalists during a call discussing Aer Lingus Group results for 2014.

Currently, the visibility of management and board "is already pretty advanced, and we have now reached a point where basically one single question needs to be asked: On which ground can the deal be rejected? We do not see any strong argument any longer to refuse this deal, because it will improve the connectivity of Ireland, it will increase the employment of Aer Lingus and we believe it would be also in the benefit of shareholders," Mueller said.

He emphasized that scale is one of the biggest benefits of the deal: a combination with IAG and the group's airlines, British Airways, Iberia and Vueling. "Whether it is just the acquisition of aircraft or general procurement benefits, I think this is a no-brainer," says Mueller, who is leaving Aer Lingus at the end of the month to lead Malaysia Airlines' restructuring.

Yet an outright sale to IAG might not be the only way to grow Aer Lingus's transatlantic business. The airline has analyzed possibly joining one of the joint ventures on transatlantic routes, CEO-designate Stephen Kavanagh revealed. "We had come to the conclusion that entering a joint venture on the North Atlantic was very relevant for the next phase of development of Aer Lingus," he said. Aer Lingus has not identified which immunized joint venture was of most interest, and the IAG proposal came about "before we could open dialogue in that event."

He admitted that two of its current code-share partners on transatlantic routes, United Airlines and Air Canada, were not thrilled about IAG's approach. But he insisted: "We con-

Growth Opportunity?

U.S. airlines plan to expand into Cuba, despite potential hurdles

Brian Sumers Los Angeles

With the Obama administration loosening Cuban travel restrictions, several U.S. carriers signaled they plan to add scheduled service as soon as they are permitted. But it could take a decade—or perhaps longer—until such a strategy leads to major success.

In the short term, at least two factors will keep U.S. airlines from Cuban expansion. First, although the U.S. Department of Transportation said in January it will negotiate a bilateral agreement that should allow scheduled flights, it gave no time frame for when a deal might be reached. And second, the Obama administration has not approved allowing U.S. tourists to visit Cuba, so the pool of potential travelers remains small.

Both restrictions should disappear relatively soon. But there are long-term challenges too, and many analysts say they are skeptical U.S. airlines will profit greatly from the shift in policy, at least within five years. Assuming tourism is permitted, a major problem is a lack of hotel rooms. There are barely enough now during peak season to accommodate Canadian and European tourists, and they are generally at lower-quality resorts than many Americans prefer.

"Cuba, in my mind, isn't an airline problem but a tourism and general economic development problem," says Hubert Horan, an independent consultant and former executive with Swissair, America West and Northwest Airlines. "The viable airline market in countries like these is limited by the size of tourist infrastructure."

Eventually, that might change. Cuba probably would need to invest in roads and airports and build more upscale hotels. With its current tourist infrastructure, the country is already proving to be a bit problematic for WestJet Airlines, which flies from Toronto to Veradero. The country has about 60,000 hotel rooms, according to recent estimates.

"I don't perceive there to be a ton of capacity, hotel room-wise," says Bob Cummings, WestJet's executive vice president for sales, marketing and guest experience. "There are obviously peaks and off-peaks, but it will be interesting to see how capacity ramps up on the Cuba end with respect to the U.S. guys."

Those factors have some analysts questioning why United Airlines announced in January that it plans to serve Havana from two hubs—Houston and Newark, New Jersey—as soon possible. Routing passengers through Southern and Northeastern hubs works for established beach destinations, but analyst Mike Boyd says it is not the right strategy for the newly opened Cuba. He does not expect U.S. travelers in most of the country will want to visit the island.

"There is no demand," Boyd says. "You hear this all the time: 'People want to go.' What people? You aren't going to get mainline tourism anytime soon. I don't know what United is say-

U.S. passengers disembark from an American Airlines charter flight at Havana's Jose Marti International Airport in January.

GETTY IMAGES FILE PHOTO

tinue to trade well with our partners. Obviously the ongoing situation needs clarification in the short term before we can proceed on the logical next steps with our partners and joining an immunized joint venture."

Aer Lingus has quite successfully grown its transatlantic business on a stand-alone basis. "We profitably expanded our long-haul network utilizing our cost advantage and favorable geographic position and helped establish Dublin as the seventh-largest European hub for transatlantic connections," Mueller said.

The airline increased transatlantic capacity expressed in available seat-kilometers (ASK) by 23.8% in 2014, and long-haul performance "was particularly strong," it noted, with revenue up 28.4% to €490 million ($556 million), passenger numbers up 20.6% to 1.3 million and load factor up 0.6 points to 83.7%. Average long-haul fare per passenger rose 6.5%, to €370.

Kavanagh said Aer Lingus "is not seeing some of the pricing pressures a number of the other long-haul airlines have spoken about in their recent guidance. We have seen particularly solid growth in the key period that drives our profitability."

The airline's short-haul business "was resilient in a highly competitive environment," he said, with average fare per seat up 2.5%, to €69.60, on steady load factors of 75.5%. Short-haul revenue in 2014 was €791 million compared to €789 million in the previous year. Capacity in terms of ASKs was reduced by 1.5%.

Aer Lingus reported operating profits before net exceptional items of €72 million for the year to the end of December, up almost 18% from 2013. However, the group incurred a net loss of €95.8 million, reversed from a €34 million profit in 2013, when a €190 million provision for pension costs is included. Total revenue for 2014 rose by 9.2%, to €1.56 billion.

ing when it says it is going to fly from Newark and Houston. I don't know who is going to be on those airplanes."

In an update of his 2009 report, "Cuba: What's next? Normalization of Relations, Mirage, Myth or Opportunity," Boyd argues it is too early for airlines to rush into Cuba, which he expects will see only a slight increase in "visiting friends and relatives" (VFR) traffic. Most will come from Miami-Dade and Broward Counties in South Florida, Boyd says, home to about 700,000 Cuban Americans, rather than New York or Houston, which have far smaller Cuban-American populations.

So American Airlines, JetBlue Airways and Spirit Airlines—all with robust South Florida operations—probably stand to gain most in the near future, although in some cases airlines will simply replace charter flights with scheduled service. Even Delta Air Lines, with its slightly out-of-the-way Atlanta hub, might not be able to profit as much as airlines with strong Florida bases.

"Miami-Havana will take off first," says Robert Gordon, professor of economics at Northwestern University. "I would think for the first five years or so, the overwhelming amount of travel will be VFR."

Boyd estimates Cuba could eventually represent 1.4-1.8 million annual passengers from the U.S., but suggests those numbers will be far in the future—after the hotels are built. Beyond Havana, he suggests that 5-7 other Cuban destinations, including Camaguey, Cienfuegos and Holguin, someday will support service, although only from Florida.

The country, Boyd asserts, will probably be a strong beach market once infrastructure improves, perhaps better than Cancun, Mexico, or San Juan, Puerto Rico, although he is not sure how much business travel will materialize. But, he says, carriers should see how the market develops before rushing to add capacity. He does not envision the first airlines into Cuba reaping any long-term rewards.

Southwest Airlines seems to be taking a cautious approach; CEO Gary Kelly recently told investment analysts that Cuba is just one of more than 50 potential markets the airline is considering.

"You can do it at any time," Boyd said. "The fact is Cuba will be a pretty good market if it ever really opens up. But it will still be a spoke out of Chicago or Charlotte. It's not going to be a shuttle from New York. There won't be a dominant carrier."

Melting Measures

Anti-core icing strategies emerge as FAA relaxes restrictions on GEnx-powered 747-8 and 787

Guy Norris Los Angeles

General Electric is introducing a final series of software and hardware improvements to mitigate the threat of core icing on its GE90 and GEnx engines, and is using lessons learned from the modifications to ensure no ice-related surprises occur with the GE9X in development for Boeing's 777X.

Solutions range from improved software for faster ice-crystal-icing (ICI) detection in the GEnx to hardware changes that reduce exposure to engine-icing issues in the GE90-94 by rehousing temperature sensors. The software change is particularly important for the GEnx-1B-powered 787 and GEnx-2B-powered 747-8 because it clears operators to resume flying at higher, more economical altitudes in areas of known icing.

Lessons from the CF6, GE90, GEnx experiences are being fed into the design of GE9X as GE and NASA continue anti-icing research

Core icing remains a relatively little understood phenomenon that chiefly affects aircraft flying at high altitudes between 38,000-41,000 ft. in the vicinity of intense convective activity such as large thunderstorms or tropical storms. Several aircraft, particularly 747-8s have suffered uncommanded

thrust loss, and even damage, after ice particles accreted to areas behind the fan before breaking off in slabs to be ingested by the compressor.

The ice particles, which are usually encountered at such altitudes only in the moisture-laden atmosphere of the tropics, measure around 40 microns in diameter and have a reflectivity of only 5% of a raindrop, making them hard to detect using standard weather radar. Following several incidents, the FAA issued an airworthiness directive to 747-8 and 787 operators in November 2013 prohibiting operation in moderate and severe icing. In the presence of known ICI conditions, crews were directed to detour 50 nm around convective cells or reduce altitude to a maximum of 30,000 ft.

That same month, Japan Airlines reacted by replacing 787s with 767s on routes from Tokyo to several destinations including New Delhi and Singapore, and suspended plans to use 787s between Tokyo and Sydney. The revised software, which Boeing flight tested earlier this year on a leased Ethiopian Airlines 787, will allow operators to increase operating altitudes in ICI conditions to 35,000 ft. for 747-8s and 37,500 ft. for 787s. GE is leading much of the industry research in this area and posits that the varying susceptibility between the engines is probably related to configuration differences. The GEnx-1B has one additional low-pressure compressor and turbine stage compared to the -2B. The 787 engine therefore operates at a slightly higher rpm and temperature than the 747 engine, making it harder for ice to form.

Boeing says: "These revisions allow our customers greater flexibility in fleet planning and flying more direct routes. We remain dedicated to working with GE and our customers to remove remaining flight restrictions. Only a small number of GEnx engines have experienced [ICI] inflight and none since 2013."

GE certified and installed the initial software modification to the entire GEnx-1B and -2B fleets in mid-2014. "With the modification, there have been no further incidents. However, as we've continued to ground test for icing conditions both here and in Canada [at GE's Winnipeg ice test facility], we refined the software logic for various operational nuances," GE states.

The new software senses the presence of ice particles and automatically activates the inward-opening variable bypass valves (VBV) situated between the booster and high-pressure compressor, ejecting ice into the bypass duct. Although this is the same basic solution developed earlier by GE, the engine company says this latest load includes revisions to improve detection and VBV operation in various flight modes. Final operability and aircraft-level certification follow the completion of 787 flight tests; baseline software validation was conducted by GE on full GEnx engines—using a special device that produced ice crystals—during ground tests at Winnipeg. The company also conducted rig tests at the University of Dayton Research Institute in Ohio, and at NASA Glenn Research Center in Cleveland using a full GEnx booster.

The FAA has also certificated an anti-icing upgrade to the GE90-94, which involved the introduction of the first part for a GE large commercial engine to be created using additive manufacturing. The new part is the housing for the Goodrich-made PT25 temperature sensor located in the "gooseneck" between the fan and booster section and the inlet to the high-pressure compressor. The change is only being made to the GE90-94 because the larger GE90-115 does not appear to be vulnerable to the high-altitude icing threat.

The modification is the final step in a three-phase anti-core icing mitigation redesign for the engine, says Bill Millhaem, general manager of the GE90 and GE9X programs. "We previously released an improved stage 1 compressor blade, which was more robust, and we modified the variable geometry inlet guide vanes into the high-pressure compressor to reduce accretion onto those," he says. "The third step is the PT25 sensor, which we have repositioned and given a new geometry to reduce accretion. The sensor used to be stuck in the flow path right in the gooseneck transition location of where ice builds up and then sheds into the compressor," Millhaem adds.

GE chose to make the part using three-dimensional (3-D) printing or additive manufacturing techniques because "it happened to be the quickest way to put it out to the fleet. It also allowed us the flexibility to continue to iterate small design changes. That's the great thing about 3-D printing. You can design, print it and run it in a couple of week. Traditionally it would take nine months to be able to do a simple design iteration, now it is two to three weeks, depending on the complexity, to do that," says Millhaem.

Lessons learned from the CF6, GE90 and GEnx experiences are being fed into the design of the GE9X as GE continues anti-icing research with ongoing runs of the GEnx booster section at NASA Glenn. "With the -9X we are in the process of understanding the accretion process and tweaking the design to avoid parts [on which ice is prone to accumulate and then shed], as well as how we can use variable geometry to mitigate this," adds Millhaem.

Updated engine control software was cleared on this leased Ethiopian Airlines 787-8, pictured returning to Boeing Field after a test flight in January.

JOE WALKER

Facing Fact$

Ex-UTC executive takes the helm as Bombardier tries to reposition

Graham Warwick Washington

In 2012, when the CSeries was planned to cost $3.4 billion to develop, Bombardier had $5.7 billion in debt and $670 million in earnings. Now the cost of developing its all-new narrowbody airliner has risen to $5.4 billion, and the company has $8.4 billion in debt and losses of $570 million in 2014. With analysts concerned it could run out of cash, the company announced a new financing plan and chief executive.

United Technologies Corp. aerospace executive Alain Bellemare has replaced Pierre Beaudoin as CEO, with an initial focus on improving program execution. Beaudoin has become executive chairman, replacing his father, Laurent Beaudoin, who has retired after 50 years. Pierre Beaudoin says his initial focus will be the financing plan, which aims to raise up to $600 million in equity and $1.5 billion in debt.

Bombardier's problem is the CSeries, which will continue to consume development dollars into 2016. And even if deliveries begin in the second half of this year, as the company maintains, the aircraft will sell at a loss because of launch prices until production ramps up. Beaudoin now says entry into service of the initial 110-seat CS100 will be "more toward the end of the second half."

The growth in CSeries development cost is revealed in Bombardier's 2014 financial results. The increase of almost 24%, to $5.39 billion, is due in part to last year's 100-day grounding of the CSeries after an engine failure during ground testing. But for the first time, the total also includes $325 million in vendor development costs that Bombardier must repay to suppliers from sales of the CSeries.

Program costs have been on the increase since the CSeries first flew in September 2013, when development costs were projected to be $3.4 billion, plus another $500 million in capitalized borrowing expenses. The objective then was to keep the total program cost below $4 billion, Bombardier Commercial Aircraft President Mike Arcamone said at the first flight.

By the end of 2013, $3.31 billion had been spent on CSeries, and an estimated $1.05 billion in development and borrowing costs lay ahead, for a total of $4.36 billion. A year later, the company has spent almost $3.99 billion and is estimating another $1.4 billion to come—$850 million for development, $225 million for borrowing and the $325 million to repay suppliers.

Against this background of rising development expenditure, Bombardier's cash reserves have dwindled. The company ended 2013 with $4.84 billion in available short-term capital. By the end of 2014, this had declined to $3.85 billion, including $2.49 billion in cash, despite Bombardier raising $500 million in additional liquidity in April. And the Aerospace sector continues to spend more cash than it generates.

Bombardier moved to husband its resources in January, when it halted development of the Learjet 85 midsize business jet. But the Business Aircraft division is still expected to spend around $1 billion in 2015 on development, mainly of the long-range Global 7000/8000, while Commercial Aircraft is to spend another $900 million on the CSeries. Combined free cashflow is expected to be only around $1-1.4 billion.

Bombardier says the additional equity and debt will give it the financial flexibility to "explore other initiatives such as certain business activities' potential participation in industry consolidation." On a Feb. 12 conference call with analysts, neither Beaudoin nor CFO Pierre Alary would elaborate, although Beaudoin says Bombardier must decide how to respond to the $26 billion merger in December of China's largest train makers if it is to remain a leader in that industry.

Analysts have suggested the company sell its Aerostructures unit, formed in July when Beaudoin split its Aerospace sector into discrete business, commercial and manufacturing units to streamline management. But 75% of Aerostructures' business, expected to total $1.8 billion in 2015, is producing wings, fuselages, cockpits and nacelles for Bombardier aircraft.

Analysts have also suggested finding a partner for its commercial aircraft business. The company already has sold off its business-jet fractional ownership and military-pilot training units, but "participating in consolidation . . . does not necessarily mean selling," says Alary. "It's not that there is a business unit for sale today," says Beaudoin. "It's about positioning the company to lead in every market. If the industry is changing, we want to participate so we can continue to lead."

Even with new financing in place, the company will continue to be controlled by the Bombardier family, of which Beaudoin is a member. Through so-called supervoting shares, the family controls 54% and will participate in the new equity issue "in a significant way," says Beaudoin.

BOMBARDIER

All five Bombardier CS100 development aircraft and the first CS300 have been handed over to flight test.

Bombardier has gone outside the company for its CEO before, appointing railway executive Paul Tellier to the position in December 2002 in a restructuring that saw the sale of its recreational products and non-core capital businesses. But Tellier departed early in December 2004, Laurent Beaudoin retaking the helm. Pierre Beaudoin then took over as CEO in June 2008; his first major action was launching the CSeries.

Beaudoin says he approached fellow French Canadian Bellemare after the January announcement that he was leaving UTC, where he was president of the Aerospace & Propulsion business, which includes Pratt & Whitney, Sikorsky and United Technologies Aerospace Systems. Previously he was president of Hamilton Sundstrand and before that of Pratt & Whitney Canada in Montreal, across town from Bombardier.

Check 6 *Aviation Week Editors discuss Bombardier's performance and leadership.* **AviationWeek.com/podcast**

Survival Skills

Greece's uncertain financial outlook and eurozone position may thwart Aegean's plans to grow

Cathy Buyck Athens and Brussels

Aegean Airlines could be facing one of its biggest challenges since beginning operations as a scheduled passenger airline in 1999, if its home country leaves the eurozone and a substantially devalued Greek drachma reemerges. Greece's new government opposes the harsh austerity measures imposed as part of the country's €250 billion ($285 billion) bailout by the Troika: the European Central Bank, International Monetary Fund and European Commission (EC). And it is unclear how Greece will secure further financial assistance if it refuses to meet the demands of international lenders.

On the bright side, Aegean has a proven track record of operating in tough conditions. It braved 23 consecutive months of deep recession in Greece and used the downturn as an opportunity to convince the European competition authorities to allow it to buy smaller, struggling competitor Olympic Air at the end of 2013. Aegean also used the economic crisis to decrease its unit costs and improve efficiencies.

Now the privately owned Athens-based carrier is attempting to profit from the market vacuum left by the grounding of neighboring Cyprus Airways.

The Cypriot government suspended its flag carrier's operations on Jan. 9 after the EC ruled that the more than €100 million the government gave the airline in 2012 and 2013 constituted illegal state aid that provided the carrier with an undue advantage over its competitors. The EC decreed that more than half of the €100 million, plus interest, would have to be repaid. Cyprus Airways has received large quantities of public money since 2007 "but was unable to restructure and become viable without continued state support," European Union (EU) Competition Commissioner Margrethe Vestager says. "Therefore, injecting additional public money would only have prolonged the struggle without achieving a turnaround."

Aegean last year expressed interest in taking over Cyprus Airways in the government's privatization effort, but it now can strengthen its leading market position in the region without having to buy assets and invest time and money in bringing the heavily loss-making Cypriot airline back to profitability. On Jan. 13, four days after Cyprus Airways ceased operations, Aegean revealed plans to increase the size of its base at Larnaca International Airport to four Airbus A320s serving 14 destinations this summer, including new routes to these airports: Paris Charles de Gaulle, Milan Malpensa, Munich, Rome Fiumicino, Tel Aviv, Beirut, London Heathrow and Kiev, Ukraine.

Aegean also will increase the frequency of its Athens-Larnaca services to six a day to improve the connectivity with its expanding European network via the Greek capital.

Last year Aegean added 15 international destinations from Athens, and it aims to add 14 this year, to bring its route portfolio from the capital to 61 international and 30 domestic points. The bulk of the new routes are within Europe, but Kuwait, Iran, Saudi Arabia and Armenia are also on the map as part of Aegean's expansion strategy toward the Middle East and Russia/Commonwealth of Independent States. "Athens is again a focal point as we are rebalancing our capacity growth," says Managing Director Dimitrios Gerogiannis.

When the crisis emerged in Greece, domestic traffic collapsed due to the erosion of disposable income. International traffic to Athens dropped because of the negative perception of the Greek capital, with its many strikes and talks about a possible "Grexit" from the eurozone. International passenger throughput (of all airlines) at Athens airport and Greek domestic traffic fell 23% in 2008-13. Aegean's revenue on domestic routes decreased by half in the five-year period, 25% due to declining traffic and 25% due to lower yields.

JOEPRESAVIATION.NET

With two to three A320 lease expirations per year, Aegean Airlines has a high degree of flexibility to adapt to market changes.

To counter crisis-induced developments, Aegean shifted capacity away from Athens and expanded bases with several new international routes from secondary Greek airports: Thessaloniki, Heraklion, Rhodes, Corfu, Chania, Kos and Kalamata. "We decided not to decrease capacity," notes Gerogiannis. The company was able to maintain its size "and not shrink because we were in a healthy financial state," he says. "It was a deliberate decision; we wanted to protect our international expansion strategy and be in a good position to grow once the economic recovery started. However, it cost us two and a half years of losses."

The risk paid off. The secondary bases have been performing well, and Aegean achieved a profit again in 2013, reporting net earnings of €66.3 million on revenues of €682.7 million. In the first nine months of 2014, net profit for

the group rose 31%, to €78.56 million, compared to the same period the preceding year (on a pro-forma basis including Olympic) on a 10% increase in revenue. Operating margin in the first nine months of last year was 14.9%, making Aegean one of Europe's financially best-performing airline groups and placing it well ahead of the much larger Lufthansa, Air-France-KLM and International Airlines Group.

"We successfully restructured in spite of the Greek GDP loss, the high unemployment and the rapid growth of low-cost carriers," Gerogiannis points out. Load factor increased to 79% in the first nine months of last year, compared to 66% in 2009, and the cost per available seat kilometer (CASK) excluding fuel decreased to 4.7 eurocents from 5.2 for the combined airlines.

Top 10 Carriers Serving Greece

2010 Seats		2014 Seats	
Aegean Airlines	8,857,966	Aegean Airlines	11,485,253
Olympic Air	6,520,596	Ryanair	3,928,176
EasyJet	1,668,378	EasyJet	2,331,828
Thomson Airways	1,376,760	Thomson Airways	1,412,776
Air Berlin	1,286,999	Air Berlin	1,010,432
Lufthansa	812,342	TUIfly	917,595
Cyprus Airways	775,734	Olympic Air	860,786
TUIfly	750,960	Condor Flugdienst	812,953
Athens Airways	669,322	Thomas Cook Airlines	811,925
Alitalia	646,808	Lufthansa	745,700
Other	11,076,226	Other	13,681,182
Total:	34,442,091	Total:	37,998,606

Source: OAG

Aegean plans to offer 15 million seats this year—7.7 million on international flights to 100 destinations and 7.3 million on domestic flights to 34 destinations—an increase of 15% from 2014. The airline will operate to 42 countries, 10 more than in 2014.

To support the planned expansion, Aegean is introducing seven Airbus A320s on top of the five it added in 2014. Aegean currently operates an all-Airbus single-aisle fleet—one A319, 25 A320s and four A321s—all powered by IAE V2500 engines. Olympic operates 14 Bombardier Dash-8s, 10 Q400s and four Q100s for short-runway flights.

Greece's largest carrier last year reactivated an order for five A320-200s and topped up the purchase with two more of the type. Six new A320s are scheduled to be delivered this year and one in early 2016. They will be equipped with sharklets and V2500 engines.

Aegean does not intend to retrofit its other Airbus narrowbodies with sharklets. "The fuel savings of the sharklets are minimal for flight segments of less than 2-3 hr., which represent the majority of our network," Gerogiannis says. "Seven aircraft equipped with sharklets are sufficient for our route portfolio." Aegean has only four aircraft on its balance sheet. "Flexibility is key for us; we want to be able to adjust to the market. We have on average two to three lease expirations per year," he says. The average age of its fleet is six years.

"It's very good to operate a young fleet," says Gerogiannis. "There are less technical issues, there are less aircraft-on-ground incidents, reliability is higher, and maintenance expenses are lower." Fuel burn is also lower, although this might be of less importance, given the drop in fuel prices.

Management has started to look at Aegean's fleet needs past 2020 and has begun preliminary talks with Airbus and Boeing about their reengined narrowbodies, the A320neo and 737 MAX. Gerogiannis says Aegean is "happy" with this kind of 174-200-seat narrowbody. Bombardier's CSeries is not being considered, he says.

The upcoming summer schedule should allow Aegean to gain the full benefits of the Olympic acquisition, with improved connectivity and shorter transfer times for passengers. The integration of administrative, commercial and support services was completed in early 2014. Now the frequencies and capacity of Olympic and Aegean have been aligned to facilitate integrated hub operations at Athens and Rhodes and "best capture the domestic-to-international connectivity potential," Gerogiannis says.

All Olympic flights now carry Aegean's A3 flight code to increase their visibility in booking systems. Olympic will retain its brand and aircraft operator's certificate (AOC), Gerogiannis says, noting that to use the brand, the airline has to have its own AOC. This was a requirement set by the Greek state when it privatized Olympic.

But why keep a brand that is widely associated with downfall and bad service, while the Aegean brand stands for service, quality and friendliness? "In Greece, the Olympic name and logo have an emotional value," Gerogiannis points out. "Using the brand does not hinder us from integrating the airlines' operations."

He emphasizes that the gains of the Olympic acquisition are very clear: It adds a comprehensive public service obligation (PSO) network and a domestic/regional route portfolio that is best served with turboprops. When Aegean evolved toward a single-type fleet of Airbus narrowbodies and phased out its Avro RJ100s in 2011, it had to withdraw from several domestic routes because either the airports could not handle A320 operations or traffic was too thin. Olympic has contracts for 20 PSO routes.

Aegean and Olympic jointly increased passenger numbers by 14% in the first nine months of 2014 to 7.9 million, of which 4.1 million traveled on domestic routes and 3.9 million on international routes.

The combination provides Greece's largest domestic airline by far, accounting for 81% of seat capacity, according to OAG data for 2014. In 2010, Aegean-Olympic's joint share of the Greek domestic market was 89%. This dominant market share explains the EC's initial objection to their proposed merger.

However, the Greek market is fragmented on international routes and system-wide. Aegean is the largest airline on international routes, with only a 19% capacity share, and the largest airline overall, with a 30% share. But as in most European markets, low-cost carriers (LCC) are gaining ground, and Ryanair is now Greece's second-largest airline, followed by EasyJet, OAG data shows. Budget operators increased their capacity share to 25% last year—still relatively low—from 15% in 2010.

Aegean, which launched operations in 1999, is not intimidated by the rise of the LCCs. "We have them all—Ryanair, Transavia, EasyJet, Norwegian, Wizz Air, Germanwings, Pegasus, etc. We have had LCCs here since 2003, and we have managed to live with them. Previously, we competed effectively with the charter airlines," Gerogiannis says. "We have always been a very operationally efficient airline with a lean management structure—very technology-driven [with] a strong balance sheet."

Butting Heads

Japanese LCCs Peach and Jetstar target rivals' hubs

Adrian Schofield Auckland

Competition in Japan's nascent low-cost carrier sector is heating up dramatically, as the main players push further into each other's home bases to find new growth opportunities.

True LCCs are such a recent phenomenon in Japan's domestic market that they initially had little network overlap. However, the latest moves by Jetstar Japan and Peach highlight their increasingly head-to-head rivalry. While Peach plans to open a new hub in Jetstar's main base at Tokyo Narita Airport, Jetstar is launching its first international service from Peach's stronghold at Osaka Kansai International Airport.

Jetstar Japan and Peach have emerged as the largest of the handful of LCCs launched in this market since 2012. While initially selecting different hubs, it was inevitable they would compete more vigorously on the same routes.

Peach already has flights between Kansai and Narita, but now intends to up the ante by introducing flights from Narita to other domestic destinations. Like Jetstar Japan, smaller LCCs Spring Airlines Japan and Vanilla Air are also based at Narita.

Daily flights from Narita to Sapporo and twice-daily service from Narita to Fukuoka are scheduled to be launched by Peach, on March 29. Fukuoka is a key route for Jetstar Japan, while Narita-Sapporo is one of Vanilla's largest markets.

Airline executives describe the new routes as "a first step in making Narita a Peach hub," with further expansion from this airport to follow. However, the carrier is not yet planning to base any of its A320s overnight at Narita, and it is also electing not to use the airport's new LCC terminal.

While the Peach foray is a shot across the bow of Jetstar Japan, another intriguing facet is the challenge to Vanilla Air. All Nippon Airways owns Vanilla and also has a major stake in Peach. It has always been assumed that ANA's two proxies in the LCC market could co-exist because they focus on different hubs, but that dynamic is changing.

Peach now operates 14 A320s, and expects to add one or two more during the six months starting April 1—its fiscal first half. In its upcoming summer season, starting March 29, the carrier will operate 12 domestic and seven international routes.

Narita will be the third hub for Peach, as the carrier already has four routes from Okinawa's Naha Airport and an aircraft base there. Peach is also considering further secondary hubs after Narita. While it is not revealing its target cities, the carrier says it is exploring hub opportunities in other countries as well as in Japan.

Entry into Tokyo's downtown Haneda Airport could be in the cards, too. Aviation authorities are encouraging LCCs to apply for nighttime international slots at Haneda and are offering reduced landing fees. Peach confirms it is considering this option and is believed to be targeting a route to Taipei, Taiwan.

Despite Peach's latest Narita move, it was actually Jetstar Japan that made the first major foray into a rival hub. Last year, Jetstar began basing aircraft at Kansai, to support the six routes the airline operates from that airport.

Jetstar Japan has now increased its challenge by choosing Kansai rather than Narita to launch its first international flight. So far, Jetstar has focused on domestic routes, but the entry into the international arena is seen as crucial to strengthening its financial performance.

The route in question is a daily service to Hong Kong, beginning Feb. 28. Peach already serves this route, as do some full-service carriers such as Cathay Pacific Airways and ANA. Singapore-based Jetstar Asia flies to Hong Kong, and the Jetstar group is also attempting to gain regulatory approval for a Hong Kong-based joint venture.

Jetstar Japan now operates almost 20 routes, all domestic apart from Hong Kong. The carrier—a joint venture between Qantas Airways and Japan Airlines—took delivery of its 20th A320 in December.

Not all of Japan's new LCCs are growing, however. Vanilla Air, for example, has opted to take a hiatus from its expansion in order to strengthen the performance of its existing network.

The carrier has increased its Narita-Hong Kong flights from daily to twice daily, beginning Feb. 21. Beyond that, it will not be adding flights during the remainder of its fiscal year, which runs through March. Further, it has no plans to launch new flights in the upcoming fiscal year beginning April 1.

Vanilla aims to improve its load factors and move toward profitability during this period, a spokesman says. The carrier expects to resume its network expansion efforts in its fiscal year beginning April 1, 2016.

Due to the slowdown, Vanilla has scaled back its fleet plan. The airline took delivery of its seventh A320 in January and its eighth in February. It previously planned to receive two more aircraft during fiscal 2015, but now will leave its fleet unchanged. Vanilla leases all of its A320s.

Vanilla now has four international and three domestic routes out of Tokyo. The carrier has been focusing on its international network recently, and its strategic plan calls for 70% of its revenue to come from international services.

Peach is entering new markets with its fleet of Airbus A320s.

PEACH

On Autopilot

A Ghent University study reveals poor work conditions for crews at European low-cost airlines

John Croft Washington
and Jens Flottau Frankfurt

The European airline industry is undergoing a profound transformation and one element of the shift from traditional business models often has deeply negative effects for the work conditions of pilots and cabin crew, says a new report— "Atypical Employment in Aviation."

An extensive study was commissioned by the European Commission's European Social Dialogue Committee (ESDC), and the resulting 300-page report warns of possible exploitation of pilots and flight attendants by low-cost carriers (LCC) in Europe, and lapses in safety culture that could follow. It also highlights the reality of working for some of the carriers with frequent roster and base changes that make "planning your life impossible," as one pilot puts it.

Members of the ESDC include the European Cockpit Association, European Transport Workers' Federation and the Association of European Airlines. The study was

A new study criticizes the practice of European low-cost carriers, including Norwegian, of using agencies and freelance pilots to meet their staffing demands.

funded in part by the EC and carried out by Ghent University in Belgium.

European legacy carriers have been stagnating at best, and many are downsizing both fleets and workforce to survive. When there are new jobs for pilots or cabin crew, they are mostly with LCCs. That air transport segment is growing fast, but some LCCs are trying to undermine the traditional employer-employee relationship to keep staff costs low.

According to the report, there is an "increased risk of bogus self-employment" within the low-fare sector in Europe, as well as a trend for employers increasingly to demand that pilots finance their own training or reimburse the airline for the training provided. In some cases, junior pilots are paying the airline to fly in order to gain flight hours.

The information in large part came from an anonymous online survey in which 6,633 pilots responded, 45% of whom work for network airlines and 22% for LCCs. While 79% of the respondents reported having traditional "direct" contracts with their airline employers, 70% reported flying for LCCs under nontraditional agreements, including self-employment via a cooperation agreement with an airline, working for an airline via a company, or other means.

The researchers say "alleged self-employment workers are de facto 'disguised' employees, which is also known as bogus self-employment," a means to reduce labor costs for tax reasons and "avoid payment of high social security contributions."

The responses represent more than 10% of the known population of European professional pilots, which, researchers say, "makes it possible to give a clear overview of the current aviation sector."

Fueling changes in the employment model has been the progressive liberalization of the European aviation market with which labor legislation has not kept up. This has left loopholes that companies are using to their advantage. "Aviation law is not up to speed with the new emerging business models," the report concludes. "In some cases, this results in social and fiscal engineering and social dumping through flags of convenience and crews of convenience practices involving third countries with crewmembers being home-based outside the EU." The situation should raise "an intense sense of urgency."

While self-employment, fixed-term work, temporary agencies, zero-hour contracts and pay-to-fly scenarios may well be legal, the researchers say there is "rising concern that workers may be subject to potential abuse in the areas of fair competition and workers' rights," and that aviation law in the European Union has to catch up with the new paradigm.

Of particular concern are junior pilots entering the job market through the nontraditional arrangements, which could put them further in debt and at risk for exploitation. In the study, 20-30-year-old pilots reported predominantly working for LCCs versus network carriers, charters, regionals, cargo or business aviation companies.

NORWEGIAN AIR SHUTTLE

Not every low-cost carrier is the same in terms of employee treatment. Of pilots flying for LCCs including Germanwings, EasyJet and Monarch Airlines, more than 50% said they have direct contracts with the carriers. The opposite was true at Wizz Air, Ryanair, Norwegian Air Shuttle and Air Berlin. For Ryanair, 34% of the 650 pilots who responded have direct contracts; 27% are self-employed; 18% work for the airline via "a company," and 10% through a temporary work agency. Of the 193 respondents flying for Norwegian, 30% reported being directly employed, while 63% have a contract via a temporary work agency.

The European Cockpit Association has been a vocal opponent of Norwegian's Ireland-based Norwegian Air International (NAI) unit's efforts to gain approval to fly to and from the U.S. with crews based in other parts of the world. The campaign against NAI is also supported by major airlines in Europe such as Lufthansa and SAS Scandinavian Airlines, and in the U.S. Delta Air Lines, United Airlines and American Airlines have been vocal opponents. The Air Line Pilots Association, International has made the fight against NAI one of its key priorities.

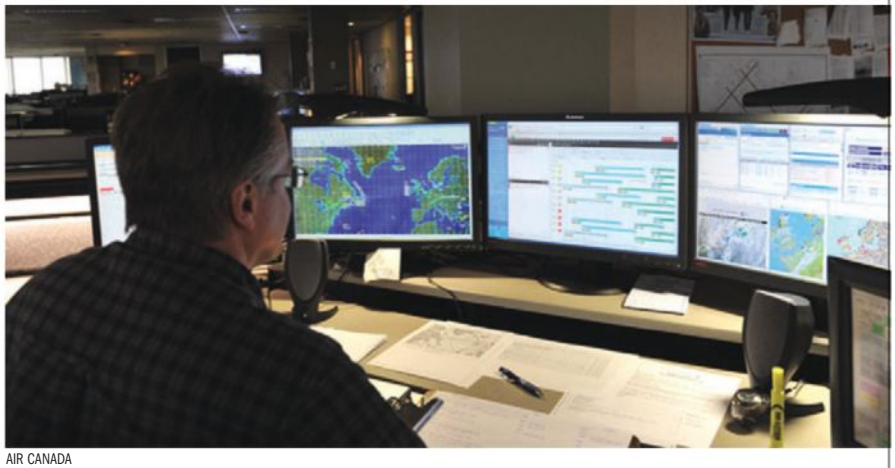
Recommendations to help newly licensed pilots in the workplace include establishing mandatory internships with airlines and prohibiting pay-to-fly arrangements or European systems to finance flight training.

On Track?

Industry is united on tracking, but operational control and cost concerns linger

John Croft **Washington**

One year after the disappearance of Malaysia Airlines Flight 370 (MH370), airlines and the commercial air transport industry continue to strongly support international calls for high-fidelity tracking of aircraft flying in oceanic and remote areas starting next year—but there is a catch. How exactly to implement the tracking solution, and more fundamentally, whether the cost-benefit case makes sense for airlines are crucial questions that will either define or derail the movement.



AIR CANADA

An Air Canada dispatcher plans a flight across the North Atlantic. Canada, like the U.S., requires dispatchers to take a more active role in the health and monitoring of a flight.

"Because we know so little about what happened [with MH370], I think we've got to be cautious about either drawing conclusions or jumping to conclusions about what it tells us in terms of the way the system operates," says Andrew Herdman, executive director of the Association of Asia-Pacific Airlines. "It's an anomaly amongst anomalies."

Public astonishment that a Boeing 777-200ER with 227 passengers and 12 crewmembers could vanish prompted the industry, through the International Civil Aviation Organization (ICAO), to develop a multilayered global tracking concept called the Global Aeronautical Distress and Safety System (Gadss).

Gadss does not address whether portions of the system must be made tamperproof, a protection that may turn out to be of primary importance in the disappearance of MH370 if surveillance systems were manually disabled while the aircraft was in radar coverage in the transition between two adjacent air navigation service providers (ANSP). That position came in part through an International Air Transport Association (IATA) task force that contributed to the Gadss plan. "We had manufacturers and the International Federation of Airline Pilot Association [on the task force], and they felt strongly that the pilot should still be part of the overall system of what happens on that aircraft," says Kevin Hiatt, senior vice president for safety and flight operations for IATA.

Emirates Airline President Tim Clark has been publicly skeptical of that position, saying that someone with specific knowledge boarded MH370 and disabled three separate systems. "Whoever was clever enough to interdict the system will be able to interdict this one as well," he told Aviation Week in June. The U.S. NTSB is recommending that airlines flying extended overwater operations outside of radar coverage have a "tamper-resistant" method of broadcasting position that can pinpoint an accident site.

Crafted by several working groups and agreed upon by member states at an ICAO high-level safety meeting in February, Gadss will require all airlines to actively track their aircraft at 15-min. intervals, with position reports accurate to 1 nm during "normal" operations by November 2016. This will be followed in later years by higher reporting rates for "distress" flight tracking during anomalies and implementing methods to more quickly retrieve the flight data recorders or the information therein.

ICAO and industry are refining the concept of operation and proposed standards and recommended practices in the next six months, as well as testing the proposals through August as part of an implementation pilot project. Singapore and several other countries have offered to host the trials, now being defined, with the goal of producing guidance materials for airlines to use in implementing tracking procedures.

Active tracking via position reports is already common for some nations, including the U.S., Canada and China, which practice a "shared responsibility" model wherein airline dispatchers and the pilot-in-command are jointly responsible for the safety of a flight from gate to gate. That practice is not commonly used elsewhere in the world, where a dispatcher's duties can end after sending a flight plan to the cockpit before takeoff, after which the pilot-in-command remains the sole authority for the mission. ICAO, which allows for both forms of control, did not address changes to those standards at the safety conference, although the International Federation of Airline Dispatchers Associations has asked that operational control and flight supervision be made the norm even for carriers not required to use dispatchers.

Joe Miceli, president of the Airline Dispatchers Federation, says the Gadss plan "falls short" by not requiring shared responsibility between dispatchers and the pilot-in-command: "The case can be made that had an aircraft dispatcher been following [MH370] with the U.S. system in place, they would have noticed the turn and

that the aircraft was off the course and would have called for assistance." Initial reports on MH370 showed mass confusion when the aircraft went missing, with Malaysia Airlines' operations center believing the aircraft was in "normal condition" more than 1 hr. after communications and surveillance were lost.

Herdman cautions that today's operational methodology "works" considering the safety performance of the industry and the trend of continuous improvement: "You can always think of initiatives which might improve safety, but before you apply them, you have to look at the cost-benefit, and you certainly have to look at the possible unintended consequences that might jeopardize the extraordinary level of safety that we take for granted in modern aviation."

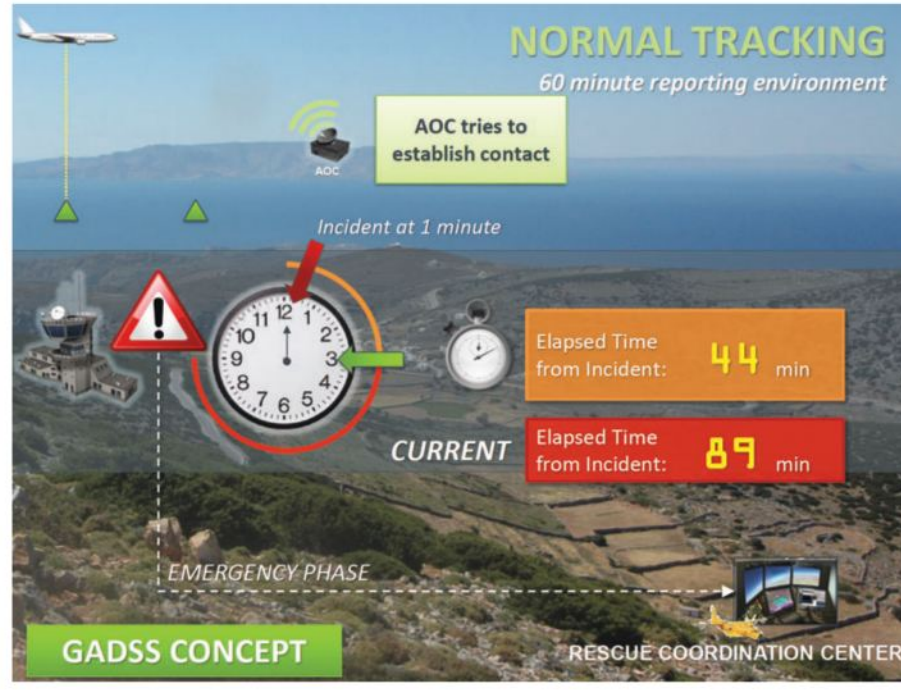
Today in oceanic airspace, pilots at a minimum report their position and other information at certain waypoints via various media, including high-frequency (HF) radio reports, or digitally via data link over HF links or satellite networks. Those reports go to air traffic control (ATC) for separation services, or separately to dispatchers in an airline operations center (AOC) but can be as sparse as 60-90 min., depending on geographic location. While approximately 80% of widebody aircraft flying oceanic are equipped with Automatic Dependent Surveillance-Contract (ADS-C), which sends position reports to ATC at 10-15 min. intervals for reduced separation and more efficient routes, airlines do not have to use the system, and even if they do, AOCs do not typically receive copies of those reports.

"When it comes to interaction between ANSP and AOC systems, there has not been a requirement for these to be interoperable at a technical level," says a spokesman for the Civil Air Navigation Services Organization. "As a result, these systems have developed in relative isolation from each other, and the exact level (or lack) of interoperability has not been fully assessed."

The near-term ICAO plan for 15-min. tracking would have airlines themselves putting procedures and communications links in place to track the aircraft and contact the appropriate ANSPs if an aircraft misses its 15-min. reporting interval.

ICAO says the action will accelerate the response time for emergency services launch from approximately 90 min. today to 44 min., assuming an aircraft goes out of communication 1 min. after its most recent report. There is a 30-min. lag built into the system to help identify false alarms before rescue services launch.

Part of the internal assessment for how much the new tracking requirements will cost airlines comes down to: Can existing equipment can be used? What data "pipes" are available? Can position data already being captured



Gadss calls for 15-min. position updates in normal operations. Longer term, the system must have a higher rate distress-tracking capability, including an autonomous backup mode and a deployable flight data recorder or the equivalent.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Digital Extra *Read more about the ongoing sea search for MH370:* **AviationWeek.com/MH370**

Video For a video recap of the global tracking discussion at ICAO's High Level Safety Meeting—tap here in the digital edition or go to **AviationWeek.com/MH370**

by ANSPs be sent directly to the AOC? And what tools must be available in the AOC to do the tracking? For position information, carriers see great promise with the planned arrival in 2017 of Aireon's space-based ADS-B, a surveillance network that would provide high-rate position updates for any aircraft operating the ADS-B transponders already required by a variety of mandates globally. "We do see that there is a viable solution coming up with space-based ADS-B," says Hiatt. "What our airlines want to avoid is doing something that is a stopgap or an unnecessary measure to prepare for what we think is going to be the ultimate solution."

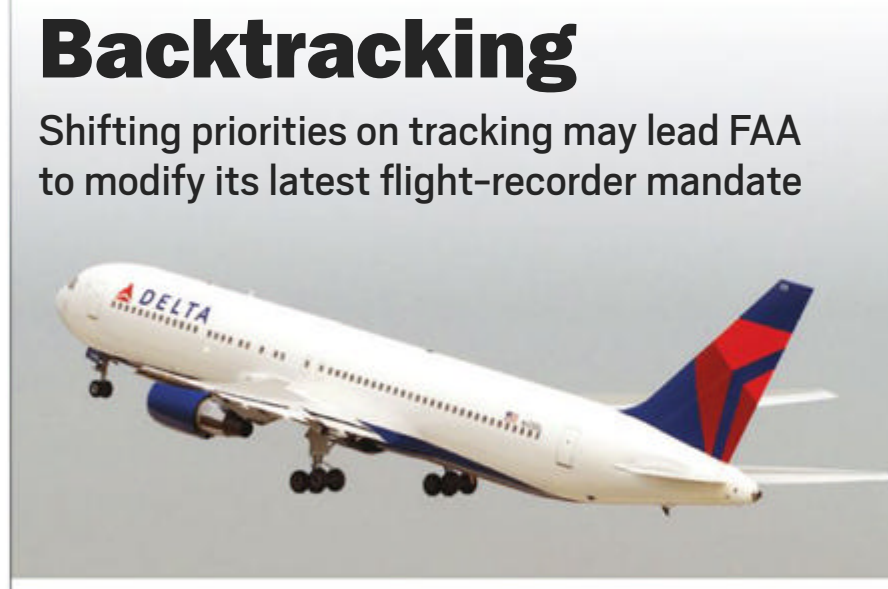
Solutions, however, will need to be in place next year, which is why the airline industry's two main data services providers, Rockwell Collins's Arinc and SITA, have both launched new products to help airlines piece together the required reporting elements at the minimum cost, including processes to obtain copies of data already going to ATC (see page 45).

Philip Clinch, SITA's vice president for Aircom Services, cautions airlines that focusing on the 15-min. reporting interval is a distraction. "The key factor is that if airlines don't have a [flight tracking system], sending reports every 10-15 min. will be useless," he says. "If it doesn't go somewhere to a system that's looking at the information and checking whether the aircraft is doing what it is supposed to, then it's of no use." While agreeing that the new standards will have more of an impact for airlines that "haven't had the tradition" of flight following, "I think to some extent that can be explained by geography in that it's always been relatively easy for U.S. carriers to track their aircraft within the U.S.," he says. Operators in other countries must track aircraft that overfly many different countries, he notes. In the U.S., surveillance feeds from the FAA for areas in radar coverage are provided via ground links at no cost.

Hiatt says one-year on, global tracking is "still high, if not the highest" item on the airlines' to-do list. "We're doing everything we can to continue to make it that way," he says. "That's why we are actively working with ICAO to help shape the performance-based objectives to get the solutions so the flying public can have a comfort factor of knowing that [airlines] know where the aircraft are."

Backtracking

Shifting priorities on tracking may lead FAA to modify its latest flight-recorder mandate



DELTA AIR LINES

Sean Broderick Washington

Removing the data link recording mandate would make upgrading older aircraft FANS less expensive.

Industry's growing emphasis on leveraging existing technology to enable flight tracking as soon and as broadly as possible could prompt the FAA to remove a significant financial hurdle keeping thousands of aircraft from being equipped with capabilities that would support the tracking initiative.

The issue stems from a 2008 FAA rule mandating changes to, among other things, cockpit voice recorders (CVR). Among the many requirements is a mandate to include message recording capability for data link—text-messaging systems known as controller pilot data link communications (CPDLC)—that is part of a Future Air Navigation Systems (FANS) installation. In most cases, this requires a CVR upgrade.

The rule included a forward-fit deadline of April 2010 for new aircraft, while those in service were considered retrofit candidates. Aircraft delivered since the deadline have CVRs that can capture data link messages. At issue are the retrofit requirements, which essentially mandate a CVR upgrade if FANS is added or an existing FANS installation is modified—including activation of an already installed system.

FAA reasoned that, from a safety standpoint, recording data link messages—which replace voice transmissions between air traffic controllers and flight crews—is just as important for incident investigations as recording cockpit discussions. If messages cannot not be recorded, data link should not be used. The FAA's approach differs from others, including the European Aviation Safety Agency, which has only a forward-fit rule.

"The implementation of the recording requirement cannot be further delayed in favor of some generalized benefit of lessened environmental operational impact and eventual international harmonization," the FAA said in the 2008 rule's preamble.

FANS includes two parts: data link and Automatic Dependent Surveillance-Contract (ADS-C). Together, they deliver text messages and automated position reports to controllers, which help keep aircraft safely spaced in areas without radar coverage. While the 2008 rule focuses on data link, the automated position reporting that ADS-C provides offers significant safety-enhancing potential.

The FAA's original rationale viewed FANS as an operations-enhancing, cost-saving tool that would allow aircraft to be spaced closer together over routes not covered by ground surveillance. FANS is mandatory on the most efficient—and crowded—North Atlantic routes, and the amount of mandated FANS airspace is increasing in phases, in part to handle demand. But FANS remains a supported option in most oceanic airspace.

As a nice-to-have feature, the FAA wanted to ensure its use would not hinder accident investigations. "The FAA

has again concluded that any future benefit of using data link equipment alone is outweighed by the risk of not having the communications recorded," the agency explained in 2008, emphasizing that data link is not mandatory.

But now FANS is seen as more of a safety benefit, and operators are using FANS capability as a means of global tracking. The International Civil Aviation Organization (ICAO), prompted by last March's disappearance of Malaysia Airlines Flight 370 (MH370), is recommending that aircraft during normal operations over oceanic and remote areas broadcast their position at least every 15 min. (see page 42).

"The standard proposed, specifically the ADS-C position reporting, is a FANS function hosted in the aircraft [flight management computer]," explains Anthony Rios, vice president of sales for Avionica, which counts FANS systems among its specialties. "Any U.S. operator intending to implement this would be subject to the data link recording rule as well."

The FAA's requirement has left more than 7,400 aircraft that could benefit from FANS installations flying without them, in large part because of the costly CVR upgrade. The new CVR hardware costs less than $50,000, but the labor costs of routing new wires throughout an airframe doubles the total outlay, and in some cases, alternate hardware is needed to integrate the new CVR.

The FAA's Performance-based Operations Aviation Rulemaking Committee (PARC) began to look at the issue before MH370 disappeared. The group's conclusion: Data link's benefits—and by extension FANS benefits—are now heavily tilted toward safety. Factoring in the flight-tracking push, the working group determined that changing the retrofit requirements to drop the CVR upgrade would be prudent.

"The PARC believes that because operators are opting not to install the FANS 1/A capability because of the costs to install the data link recording capability, the FAA's data link recording rule is compromising these improvement areas that are taking advantage of FANS 1/A capabilities to support a global aeronautical distress and safety system," the PARC said in a November report to the FAA.

The hesitancy is evident in both large and small operators. Rios says one Avionica customer, a major U.S. carrier, upgraded its aircraft that fly the North Atlantic, because operating outside the designated FANS routes burns about 15% more fuel. But the carrier is holding up on upgrading about 40 more aircraft because of the recording-capability costs.

"It's correct to say it's not mandatory, but how can you make a living burning that much fuel?" Rios says.

The PARC found that about 2,100 air transport aircraft that entered service before the 2010 forward-fit cutoff date have not upgraded to full FANS, nor have approximately 5,300 business or "high-end" general aviation aircraft. The group's recommendation to the FAA: Either issue guidance clarifying that data link messages do not have to be recorded on full FANS retrofits or modifications, or change the rule.

"In the end, operators that desire to install Cpdlc on retrofit aircraft or modify existing Cpdld installations likely will not proceed with the installation or modification owing to the additional significant costs to include data link recording capability," the PARC said.

The FAA acknowledges it is considering the recommendation, but says it has no timeline for making a decision.

Bridge Work

Airlines address missing links as global tracking goes mainstream

John Croft **Annapolis, Maryland**

The drive for cost-effective near-term flight-tracking solutions ahead of forthcoming international standards and rules has the airline industry's two main cockpit data services providers reinventing and evolving legacy products and services to suit. Rockwell Collins Arinc and SITA have both developed new packages that will allow airlines in many cases to cost-effectively transition from what had been passive, infrequent flight following to active tracking.

The International Civil Aviation Organization (ICAO) and industry continue to debate the final form and concept of operations for required tracking (see page 42), but the initial move calls for airlines to obtain position data every 15 min. for aircraft in the near term and, eventually, increased rates and other requirements when certain problems are encountered. For the U.S., Canada, China and several other countries where dispatchers are jointly responsible for a flight and are already required to actively track their assets, the change could merely mean an update in frequency of the reports airlines already receive in oceanic and remote areas. For other parts of the world where operational oversight is much less stringent, the upgrades will require a paradigm shift in operations. In either case, airlines are keen to maximize the use of existing avionics and data streams while minimizing the costs of any new measures.

"What we have seen since the disappearance of Air France Flight 447 in 2009 is that there is always a desire to find a single 'silver bullet' solution," says Tim Ryan, director of Programs and Services Management for Information Management Services at Rockwell Collins. "And if we've learned anything over those years, we've learned that a single solution, while it can be fashioned, doesn't meet the equally important facet of cost-effectiveness."

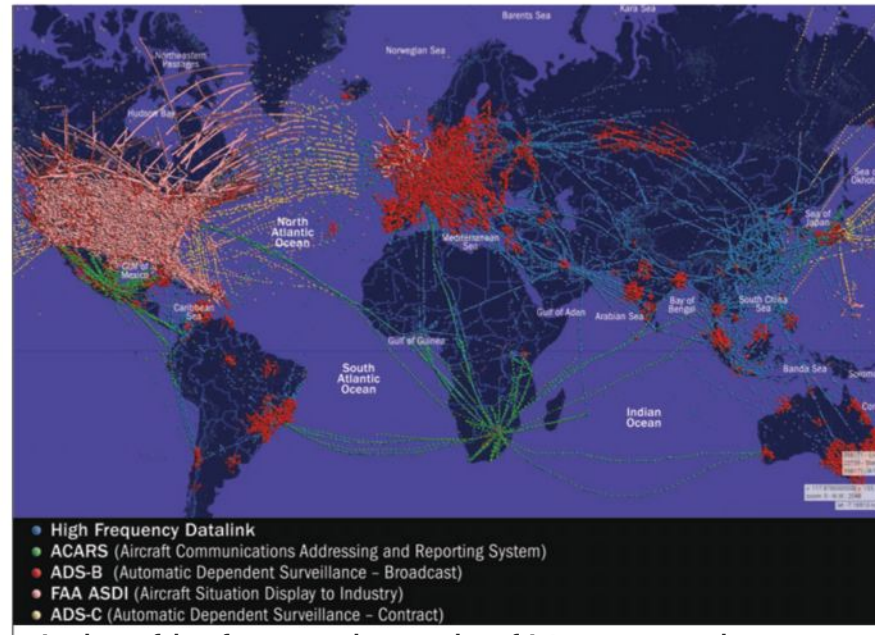
While surveillance in populated areas may be provided by the air navigation service providers using radar or other technologies that result in position updates multiple times per minute, the same is not true in oceanic and remote regions where aircraft-provided position reports can be 1 hr. or more apart. For those zones, both Arinc and SITA can provide higher-frequency surveillance data from equipped aircraft to air traffic control or an airline's operations center (AOC) using automatic dependent surveillance contract (ADS-C), part of the Future Air Navigation Sys-

tem (FANS) suite of avionics, or the Aircraft Communications Addressing and Reporting System (ACARS). Approximately 80% of the widebody fleet already have FANS, which gives the aircraft the ability to send ADS-C position updates to air traffic control (ATC) at certain intervals, typically 10-15 min., in return for lower separation standards and more efficient routes with less fuel burned. The data are generally sent from the aircraft to the ground via Inmarsat and Iridium satellite constellations or through Arinc's ground-based high-frequency data link (HFDL) network.

Separate from ATC, airlines generally communicate with an aircraft over the same data pipes using the onboard ACARS to send and receive operational data, fuel status and position reports, a process that can be redundant and costly when the same position reports are already being sent to ATC using ADS-C. Airlines historically have not attempted to access ADS-C data because it requires decoding.

However, with the impending new tracking standards and the potential rulemaking that could follow, airlines are revisiting processes and procedures to proactively seek out the most cost-effective solutions from the avionics and data streams already available.

Arinc has been working with as many as five non-U.S. airlines on a new tracking service that will be part of its "GlobaLink" family of services. To be officially unveiled in March, the Flight Tracking Solutions will include working with individual airlines to map gaps in route structures where more frequent position reports will be needed to meet ICAO's proposed standards, expected later this year, and determine how to achieve the most cost-efficient mix of data transmission methods. Along with data feeds from the FAA for U.S. and U.K. domestic airspace and decoded ADS-C position reports from ATC, the flight tracker will also include Arinc-vetted position reports provided by FlightAware's network of crowd-sourced automatic dependent surveillance broadcast (ADS-B) receivers as "situational awareness" input, as well as a new "back channel" position service derived from Arinc's HFDL network. The flight-tracker upgrade can be installed as a software upgrade to the 130 airline customer using either the OpCenter or Hermes dispatch tools.



ROCKWELL COLLINS

A subset of data from a one-day snapshot of Arinc customers shows geographical distribution of the most common position data sources for tracking.

Future third-party data sources, which could include position data from Aireon's space-based ADS-B data or possibly inflight entertainment syst7ems, would be considered in the cost-benefit analysis. Aireon, a joint venture between Iridium, Nav Canada and the air navigation service providers of Ireland, Italy and Denmark, plans to have its space-based ADS-B network in place in late 2017 for ATC uses, particularly in the North Atlantic where update rates will allow for reduced separation. Aireon also is designing a free "alert" aircraft tracking service whereby vetted users can obtain tracking information on any aircraft transmitting ADS-B signals anywhere on the globe.

For Arinc, perhaps most intriguing is the new offer of "no additional cost" position data from HFDL, which is collected as part of a continuously operating diagnostic check of the system. While voice communications over HF, used as a backup to VHF and satellite communications, are associated with high noise levels, the same network is less noisy for data transmissions, which are a lower-cost-per-data packet than satellite services. Peter Grogan, Arinc's senior director of GlobaLink data services, says the system today transmits position reports as often as every 10-20 min., but rates can be increased regionally if needed.

"We believe there is some untapped connectivity solution around HFDL that has embedded position information, but a lot will depend on equipage," says Jeff Standerski, senior vice president for Rockwell Collins's Information Management Services. "It would be great if every aircraft had HFDL radios, but every aircraft does not have HFDL."

All of Rockwell Collins's customer airlines do have HFDL, however, and retrofit installations can be accomplished overnight at a "fraction of the cost" of a satellite communications system, according to Ryan. He says a gap study may show it is cheaper to install HFDL on a fleet of long-haul aircraft rather than using position data solutions coming across the satellite links.

Ryan says the airlines Arinc has been working with have not tested the tracking solution directly in their operations. "We want to provide them with a user interface that they can use to exercise the data and provide some feedback as to how this might work within their operations," he says.

Competitor SITA has called out a beta version of a flight tracker with Singapore Airlines and Malaysia Airlines, both of which will receive the first operational version via software upgrade in March, says Philip Clinch, vice president for Aircom Services for SITA. Called Aircom Server Flight Tracker, the system takes maximum advantage of existing surveillance data onboard, as well as the means to decode ADS-C position reports already

being received by ATC, to avoid costly upgrades to the aircraft. "We offer [airlines] the ability to comply with the requirements for a tracking system that is proactive and doesn't simply wait for position reports to come in or extrapolate where it thinks the aircraft might be," says Clinch. "It actively goes out and seeks the information in order to identify when the aircraft isn't sending it anymore, which is something that does not seem to have been done by most airlines up to now."

Data feeds include Inmarsat, Iridium, HFDL for airlines that have contracted for the service through Arinc, and ADS-B information from FlightAware. The Flight Tracker software can either reside within the Aircom Server, in place at the dispatch centers for approximately half of SITA's 160 ACARS customers, or can be accessed by others via a cloud-hosted system. SITA has traditionally been the provider of ACARS services to airlines outside North America, but does have airline customers within the U.S. and Canada, including Delta Air Lines, JetBlue, Virgin America and WestJet. "They wouldn't have to change anything in their dispatch centers immediately," he says of the cloud-based-version customers. "They might have a separate standalone system for the flight tracking to begin with and see how that develops."

Like Arinc, SITA is providing its customers with the means to decode ADS-C messages from ATC to lower the cost of obtaining tracking data already being provided. Clinch points out that in regions where air navigation service providers have not yet implemented ADS-C capability, the software allows an airline to request the surveillance data directly from the aircraft. "But we do differentiate between the different areas where ATC is already requesting the position, and we do not request it additionally—we send a copy to the airlines," he says.

The system goes beyond merely following flights by making the airline an active partner in the progress of the flight. Clinch says the software can "watch out for position reports and has a timer that—if it hasn't received a position report within a certain time, which is selectable by the airline—can request its own information." He notes the initial trials looked at only "basic tracking" features that did not include higher rates of transmission when certain triggers are exceeded.

By mid-2015, Clinch says, two new capabilities "that go beyond" basic tracking will be added: Decoding of pilot-controller data link communications to determine ATC instructions to a pilot to determine if movements are planned or unplanned, and monitoring FANS handovers between adjacent providers to identify when an aircraft does not connect to the correct system.

"One of the things that is going to be the most challenging in identifying when an aircraft is in a situation it shouldn't be in is identifying when ATC told the aircraft to change course or not," says Clinch. "Traditionally when ATC has been using voice radio, it is practically impossible to know that without asking the pilot."

Unmanned Allies

Can smaller, cheaper cooperating unmanned vehicles help larger manned platforms survive?

Graham Warwick Washington

Development of unmanned systems that can help manned platforms survive in high-threat environments is a key feature of programs planned by the Defense Advanced Research Projects Agency (Darpa) and previewed in its fiscal 2016 budget request.

"We have done some modeling and simulation looking at low-cost air vehicles and how you distribute those in a system-of-systems approach to compete certain missions," says Darpa Deputy Director Steven Walker. "We've seen some pretty good effect in doing that and confusing the enemy."

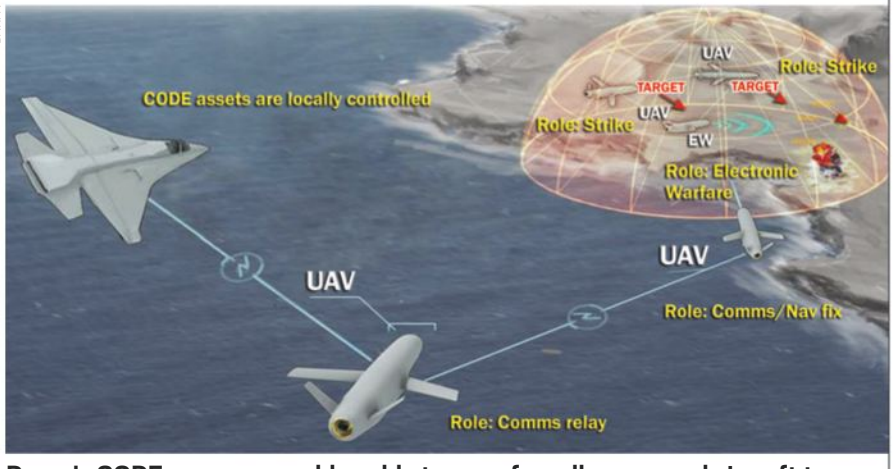
Advances in microsystems and precision navigation and timing technologies mean "as things get smaller and cheaper and we can synchronize things better, we can do similar missions with many, many small vehicles as you can with larger ones," he says. "The problem we always run into is if you want to fly ranges that are relevant, you've got to get the small vehicles there to begin with."

The Gremlin program, for which an initial $8 million is sought in 2016, is set to develop small unmanned aircraft systems (UAS) that can be launched in volleys from "commodity platforms," likely transport aircraft. They would fly into contested airspace, conduct moderate-duration missions and be recovered by the launch platform.

Increasing the lethality, survivability, payload and reach of combat aircraft by teaming them with unmanned wingmen is the objective of the TEAM-US (Technology for Enriching and Augmenting Manned-Unmanned Systems) program, which would be funded at an initial $12 million in 2016.

UAS tailored to specific missions—including surveillance, electronic attack and weapons delivery—would work with "less survivable, but decision-making manned platforms" to gain access to contested airspace, with swarming UAS supporting missions against network-integrated air defenses.

DARPA



Darpa's CODE program would enable teams of small unmanned aircraft to find and engage targets under a single mission commander.

Using existing manned aircraft for command, control and battle management would make "these fourth- and fifth-generation platforms viable participants in future anti-access, area-denial scenarios where they may have limited survivability," states Darpa.

"Whereas we see potential in high numbers of low-cost things, and we would like to explore that more with the [U.S.] Air Force potentially in a joint program, we do still believe there is a place for the high-end system and for getting to the fight when you need go long ranges," Walker says.

Darpa is to lead the Air Force and Navy in a program dubbed the Aerospace Innovation Initiative, which would conduct an X-plane technology demo for the next generation of U.S. fighter, to enter service after 2030. There is no evidence of a program in Darpa's 2016 request, but Walker says it is in the classified budget.

Offboarding sensors and weapons to unmanned "wingmen" would be valuable for a sixth-generation fighter, "if we can make it work," acknowledges Walker. Darpa's Collaborative Operations in a Denied Environment program is "looking at how to have multiple UAVs cooperate in a more active way . . . and get to the point where one person controls six UAVs and the UAVs do most of the work," he says.

In the maritime domain, meanwhile, unmanned vessels that can deploy to significant ranges to provide offboard multispectral early warning of anti-ship cruise-missile attacks is the objective of the Multi-Axis Protection of Surface Ships program, to be funded at an initial $11 million in 2016.

The Mobility Infantry program, at $6 million in 2016, is set to explore development of a mixed team of soldiers and semi-autonomous off-road vehicles—similar to those used by special forces—that, unmanned, can act as mobile, extended-range fire-support platforms.

At an initial $8 million in 2016, the Strategic Mobility program is to identify sea-based platform, aerial delivery, and automated logistics and distribution technologies that could enable deployment of a brigade in just days.

The Multi-Domain Unmanned System (UxS) program, for which $7 million is requested in 2016, is to develop a design that can morph to cross physical domains—ground-air, ground-sea or air-sea. The goal is to build a prototype capable of operating in one domain then being modified for another.

New space programs planned for 2016 are to develop technologies to enable small, low-cost satellites to replace today's large, expensive spacecraft. Demonstration of a deployable antenna for a cubesat, and electro-optical/infrared (EO/IR) sensors and inter-satellite links for under-100-lb. spacecraft are among the slated projects.

Other programs planned for 2016 include development of microelectro mechanical-systems inertial sensors for GPS-free munitions guidance and low-cost EO/IR seekers for air-launched weapons able to engage fixed and moving targets with minimal external support in a GPS-denied environment.

Domino Effect

USAF tries to reset close-air-support discussion as congressional reluctance to retire the A-10 threatens F-35 ops

Amy Butler Orlando, Florida, and Nellis AFB, Nevada

Few procurement issues—with the exception of the unsuccessful fight to continue F-22 production—spark the kind of impassioned pleas among U.S. Air Force officers as the unsuccessful struggle to retire the A-10 to make way for the Lockheed Martin F-35.

Generally, when the service wants to retire an aircraft, there is a disappointed cadre of officers loath to let it go. But there is usually a direct replacement being delivered, giving those officers a future.

Not so in the case of the A-10. The Air Force is for the second year pushing to quickly retire the fleet, in part because it is a single-mission aircraft designed to provide close air support (CAS). Amid the budget crunch, the Air Force is shedding single-mission fleets.

Yet the focus of its mission is exactly what has congealed support for the aptly named Warthog. The A-10 has been a visible savior for ground troops for decades and especially so in recent fights in Iraq and Afghanistan. But it is being replaced by the multimission, single-engine, stealthy F-35. A-10 boosters fear the CAS mission will be lost if it is only one among a host of missions to be handled by the F-35, which is also replacing F-16s in the Air Force. Some say the Air Force has lost its way on the CAS mission.

"That's a ridiculous statement," says Air Force Chief of Staff Gen. Mark Welsh, bristling at the notion during a roundtable discussion with reporters Feb. 13 at the annual Air Force Association symposium in Orlando. "Guess how many CAS sorties we've flown? It's about 20,000 a year. When is a little bit of credit given for that? . . . Let's not change the facts to match whatever story we're trying to tell." Welsh also notes that CAS is "all the Marine Corps is buying [the F-35B] for—to replace the Harrier."

There are also lawmakers who want to save the A-10 for parochial reasons—that is, to keep iron on the ramp at bases in their districts.

So the Air Force has been in a quagmire, frustrated by emotional pleas to keep the A-10—pleas exacerbated by developmental performance problems of the F-35 and that have bred a vocal band of critics regardless of its progress. USAF's lack of a clear message about the F-35's capabilities as it gets closer to being fielded has not helped.

Now the Air Force is on the offense, reaching out to officers in its sister services to outline the future of CAS in an attempt to reshape the discussion away from a binary A-10 versus F-35 fight.

Air Combat Command chief Gen. Herbert "Hawk" Carlisle is hosting a week-long, multiservice summit on CAS early in March. Topics include conducting CAS in a "contested" environment, a term referring to airspace that is defended, though not with high-end integrated defenses seen in anti-access area-denied (A2AD) situations. An example would be if the Islamic State posed a strong threat to allied jets in Iraq and Syria; although the A-10 has an armored cockpit, it would be susceptible to such a threat and CAS sorties would be forced to fly higher and to use different tactics.

The summit will address CAS as it stands today, as well as when the F-35 enters service, Carlisle told reporters at the annual symposium. Among the alternatives, already in use for years, are precision-guided munitions deployed from a host of aircraft—B-1s, B-52s, F-16s, F-15Es and others—to provide support for troops in the midst of a fight. The F-35, however, will bring stealth to the table. "We just have to get to the point where the services all understand what the future looks like in this arena because there is a thread of conversation going on that really has become a little ridiculous," Welsh, an A-10 pilot himself, said. The F-35 "will be a good CAS platform. It will take us a while to get to the point we want it to be, [as with] every other airplane [with which] we've fought, including the A-10."

The U.S. Air Force recently began employing the A-10 against so-called Islamic State targets in Syria.

U.S. CENTRAL COMMAND

Some observers suggest USAF should employ a low-cost system for CAS where possible. Doing so would require purchase of a new platform—a thorny path amid budget pressure.

"A follow-on may be something we need to think about," Carlisle said, acknowledging that a new system may be considered. "Nothing is off the table."

The Air Force is also working to maintain pockets of CAS experience within future units in Air Combat Command to ensure the "culture" is not eroded. "We are looking at squadrons in the active and Reserve component where we can put a higher percentage

of pilots who come out of the A-10 as they transition. We kind of create places where the CAS culture has a home."

Training is key to maintaining a CAS focus, according to instructors at the Air Force's weapons school.

"It has long loiter time. It [the A-10] is designed for an outside visual search, and can carry a lot of different weapons. But really what makes a difference with the CAS is the focused training of the pilots," Maj. Sean Hall, an A-10 instructor pilot, told Aviation Week during a recent interview at Nellis AFB, Nevada, where the service houses its advanced tactics and training school. "I personally believe the F-35 can be highly effective at CAS if the aircrew get focused CAS training."

In parallel, the Air Force is also in a tactical fight with Congress. Lawmakers are balking at a plan for the second year in a row to retire the A-10s, a step needed to free up maintainers to help establish F-35 squadrons.

Last year, USAF Lt. Gen. Christopher Bogdan, program executive officer for the F-35, said a lack of trained F-35 maintainers was the largest hurdle to declaring initial operational capability (IOC) by December 2016 with the first F-35A squadron. Bogdan said 800-1,000 maintainers will be called for then. Of those, 300-400 are needed for the first squadron at Hill AFB, Utah, Carlisle said. Training an experienced maintainer takes 9-12 months, Bogdan said, while training a "green" student requires more time.

Despite the shortfall, Welsh is adamant that the service will declare IOC for the F-35A on time. As a backup plan, Lockheed Martin has submit-

Flexible Count

India's military may be lucky if it can buy half the helicopters it needs in the next five years

REUTERS/LANDOV

An Indian air force light-combat helicopter, being developed by Hindustan Aeronautics Ltd., performed at AeroIndia in Bengaluru Feb. 18.

Jay Menon and Bradley Perrett Bengaluru

Here is a number to catch the attention of the rotorcraft industry: India needs 1,000 helicopters by 2020, says the country's defense minister.

It is not likely to get even 500 in that time, industry officials say. But the sheer scale of its requirements has contributed to an extraordinary array of helicopter programs that have not yet reached production contracts. For four programs, still subject to competition, a total of 434 helicopters is required. In three other programs covering 53 helicopters, the competitions are over, but the U.S. suppliers are awaiting orders. And India's Hindustan Aeronautics Ltd. (HAL) is meanwhile developing two types whose total production is slated to exceed 500.

India's notorious prevarication when it comes to defense procurement explains why so many programs have become bunched up. For example, one program, the Reconnaissance and Surveillance Helicopter (RSH), has twice reached the type-selection phase, only to be halted and sent back for another round of bidding. Boeing has been waiting so long for intended orders for 15 CH-47F Chinooks and 22 AH-64D Apaches that its price offer is expected to expire within weeks, which would prompt the government to hold another competition.

And now another factor is complicating the programs further: The government's "Make in India" policy now mandates minimum local share in production, which in the past may have been more negotiable. Moreover, these demands for additional helicopter manufacturing in India are coming just as the only local company with all-round rotorcraft skills, HAL, is heavily loaded with its own programs, notably production of the Dhruv utility helicopter and the two development efforts.

So foreign suppliers are forced to look for partners among India's mostly immature private aerospace companies. At least one of those newbies is likely to become a familiar name in rotorcraft manufacturing in the decades ahead, elevated by foreign technology and domestic demand.

The risk for India is that more than one private company will become such a winner, thanks to several foreign companies each choosing a different local partner. In the long term, "there is room for two Indian manufacturers, including HAL," says a foreign industry official. But dividing the Indian helicopter market among three or more companies would undermine the ability of all of them to achieve strong skills and low costs.

The Japanese experience is instructive. Japan's armed

ted pricing data and timelines to the Air Force for providing maintenance services; the service ultimately wants blue-suit (USAF) F-35 maintenance. Bogdan said last year that contractor maintenance was cost-prohibitive, but Carlisle notes that the Air Force is looking into it nonetheless.

Carlisle says the service also may temporarily move some experienced maintainers from Luke AFB, Arizona, to Hill to help stand the unit up. Jets are already arriving at Luke, which will be the international training location for the F-35 pilots globally. "We'll take interim measures because the advice we offered on how to best do this has not been accepted, which is fine," Welsh says. "We have to do that with the Congress, with our partners, with everybody. We'll get there from here."

Welsh says the CAS discussion is intended to reset the mindset about the mission to allow for new operational concepts and technologies, including the next-generation of CAS weapons. "How do you just change our mindset? Let's have gun pods with bullets this long and put 50,000 of them in the pod instead of everybody trying to get 1,000 or 600 out of the airplane during a CAS sortie," he says. "There are just different ways to look at this problem that technology can help us solve. . . . None of this is new. We've just got to energize it."

Carlisle notes his concerns lie beyond declaring IOC for the first F-35 squadron. "Then what?" he asks. He adds that deliveries of the jets are speeding up, but not the pipeline for maintainers.. "We're not going to get airplanes, park them on the ramp and not fly them."

forces and civil authorities also have a large helicopter fleet, but the government splits production between three companies, with the result that not one, after more than 50 years of production, is a force in the global rotorcraft industry. Admittedly, India's habit of deferring and canceling defense procurement programs could well spread out the current logjam, giving a chance for the strongest private company to take on successive development and production efforts.

About 1,000 helicopters are covered by the nine programs that have not yet reached the production-contract stage (see table). But these are not the same 1,000 that Defense Minister Manohar Parrikar says are needed by 2020. Many of the helicopters due over the next six years will come from current production programs, such as the Dhruv.

Among the open competitions, the closest to selection is the coast guard helicopter. India's choice for the 14 aircraft it needs is between the Airbus EC725 Caracal and Sikorsky S-92. The two bidders expect a decision in the middle of the year.

Next up is the Naval Utility Helicopter for antiterrorism operations and for such missions as enforcing India's exclusive economic zone. India wants 100 such rotorcraft. Bell expects to offer its Model 429 and Airbus the Panther when the request for proposals appears, probably this year. Sikorsky's nearest product is the S-76D, but the company, noting that the helicopter is larger than its competitors and therefore at a cost disadvantage from the start, says it may not bid.

The industry expects the defense ministry to issue a request for information for the RSH requirement in the next few months and a request for proposals by the end of the year. Airbus will offer the Fennec, which was previously selected. Bell expects to propose the Model 407, which now has an armed variant developed at company expense, says Sameer Rehman, Bell's managing director for commercial business-Asia Pacific.

Russian Helicopters says it will offer the Kamov Ka-226T for RSH, but it declines to comment on its proposals for other requirements. The Ka-226T has excellent characteristics in high-altitude operations, Russian Helicopters says. India needs an aircraft that can operate from fields at 6,000 meters (19,700 ft.) altitude; the Ka-226T can manage 7,250 meters. India's current procurement policy gives no credit for exceeding specifications, however. Instead, the ministry will simply choose the cheapest option that meets the requirement.

While the program for 197 RSHs looks big by almost any standard, Airbus's Rainer Farid suspects production will eventually run to 300 or even 400. He adds that HAL is a possible partner, despite the pressure of work that it is handling.

Indian Helicopter Programs[1]

PROGRAM NAME	WEIGHT (metric tons[2])	QUANTITY	TYPE	STATUS
Light Utility Helicopter (LUH)	3	384	HAL[3] LUH	In development
Light Combat Helicopter (LCH)	5.5	179	HAL LCH	In development
Attack Helicopter	7.3	22	Boeing AH-64D	Selected
Heavy-Lift Helicopter	22.7	15	Boeing CH-47F	Selected
Multirole Helicopter	9.9	16	Sikorsky S-70B	Selected
Coast Guard Helicopter	11-12	14	Undecided	Selection mid-2015
Naval Utility Helicopter	3.4-4.5	100	Undecided	RFI issued, RFP likely 2015
Recce, Surveillance Helicopter	2.3-3.6	197	Undecided	RFI and RFP likely 2015
Naval Multirole Helicopter	9.9-12	123	Undecided	RFP likely 2016

[1]Excluding those contracted for production. [2]Based on weights of candidate or chosen types. [3]Hindustan Aeronautics Ltd. RFI = Request for Information, RFP = Request for Proposals. Sources: Indian government, companies and industry officials.

Furthest out, at least for now, is the Naval Multirole Helicopter Program. Sikorsky's Robert Kokorda expects it to be similar to an earlier requirement his company won with the S-70B. If so, the S-70B should be well placed, but an advanced version of the type, the MH-60R, may also be suitable. India needs the aircraft to provide utility transport, a problem for the equipment-packed MH-60R, but other options are the S-70B and the more voluminous S-92, which would need to be fitted with a combat system.

Eurocopter is offering the EC725 for this requirement. It would have to develop a combat system for it, says Farid.

AgustaWestland is notably absent; the company was accused of paying bribes to win a contract in 2010 for AW101s that were to serve as ministerial transports. The government has banned AgustaWestland from new programs. It is unclear how long the ban will last, but given India's tendency to take its time with orders, AgustaWestland could one day reemerge as a contender for the current requirements.

Gearing Up

Helicopter manufacturers preparing for a busy 2015, introducing important new models

Tony Osborne London and Paris

No less than four new-generation medium and medium-heavy helicopters are set to fly in 2015, in what looks to be a critical year for rotorcraft makers, both large and small.

The Airbus Helicopters X4 and Bell's Model 525 Relentless are perhaps the most eagerly awaited. The X4, having been shrouded in secrecy since details of the project were released back in 2011, will fly this year, company CEO Guillaume Faury told journalists in January. The first prototype of Bell's fly-by-wire 525 did not fly as planned at the end of 2014, and is now likely to take to the air in the early spring.

Also significant are planned first flights in Russia and China for Kamov's much-delayed Ka-62 medium helicopter and the Chinese version of the Airbus EC175, the AC352. Both aircraft are due to fly with Turbomeca's Ardidien 3 engine in the spring or early summer.

But it is Airbus's X4 that is arguably the most eagerly awaited. Due to be unveiled March 3, it will also be the first model to be branded with a new Airbus designation.

But the X4 will not be the technological marvel that former Eurocopter CEO Lutz Bertling promised back in 2011. At the time, he pledged the X4 would represent the same technological leap that Airbus's A320 airliner represented with its fly-by-wire and side-stick controls in the late 1980s.

The next-generation cockpit displays and fly-by-wire technologies Bertling envisaged have since been shelved.

Instead, the aircraft will have the Airbus-developed Helionix avionics suite common to the EC145 T2 and EC175, but it still will feature some significant new technologies. Teaser videos in the run-up to the Heli-Expo show reveal the use of the company's Blue Edge blade technology, which along with the fenestron-shrouded anti-torque system will help to reduce external noise.

The helicopter will replace both the AS365 Dauphin and EC155 helicopter family and will likely be targeted at the medium segment, challenging AgustaWestland's highly successful AW139 and perhaps that company's smaller AW169. Sikorsky's S-76 and Bell's Model 412 will also be fair game for the X4.

For Bell, development of the Model 525 represents a significant gamble. As the largest commercial helicopter it has built, Bell is hoping the addition of fly-by-wire controls can set it apart from the already strongly established competition that includes AgustaWestland's AW189 and the EC175.

But Bell is also hoping to steal some market share from heavier machines such as the EC225 and Sikorsky S-92, by promising the ability to shuttle eight passengers up to 250 nm offshore, combined with lower operating economics.

The company is currently conducting what it calls "safety of flight" tests, ahead of first flight and assembly of the first of five prototypes, FTV1, which is close to completion. Despite a slight delay of the first flight, Bell still hopes to achieve FAA certification in the middle or third quarter of 2016, CEO John Garrison told Aviation Week.

The second prototype, FTV2, is also in final assembly process, and Garri-

Tilting Times

AgustaWestland's AW609 tiltrotor finally moving forward

Tony Osborne London

AgustaWestland is making steady progress with its AW609 commercial tiltrotor, assembling the third prototype—AC3—to pave the way for deicing system tests toward the end of this year.

Engineers are assembling the aircraft in Italy, where it will undergo shakedown flights during the early summer before being dismantled and sent to Philadelphia in preparation for testing of the deicing system in Minnesota toward the end of the year. These tests will also involve the use of the U.S. Army's Helicopter Icing Spray System CH-47 Chinook test helicopter.

This aircraft will embody many of the improvements already developed by engineers on the AW609 program, including rematched engines bringing them closer to the specifications of the production Pratt & Whitney Canada PT6C-67A powerplants. It will also feature the latest software block of avionics, which includes a training mode, as well as a new pitot static system. These are on top of changes introduced in late 2013, which include new aerodynamic modifications to reduce drag.

Studies are underway to improve the payload performance during so-called Category A operations—in which the aircraft will be able to land or takeoff safely with one engine inoperative.

The company believes it already has achieved improvements in performance, up to 730 nm with standard fuel, but the addition of auxiliary underwing fuel tanks under development to be positioned on the wing near the engine nacelles could allow the tiltrotor to fly up to 1,100 nm.

The work was prompted by interest from customers who

BELL HELICOPTER

son says certification will be followed by a handful of orders before the end of that year.

"Our goal of a safe successful first flight is just around the corner," he explained. "The progress is very encouraging . . . we set very aggressive timelines, and we are really just a couple of months off the timeline."

At the opposite end of the scale, Bell is returning to its roots with its development of the Model 505 JetRanger X, in an attempt to repeat the success it had with the Model 206 JetRanger back in the 1960s.

The JetRanger X flew for the first time Nov. 10 at the company's Mirabel facility near Montreal and has generated significant interest in the market,

Bell had hoped to fly the first prototype Model 525 last year, but a maiden flight this spring now looks more likely.

with Bell positioning the aircraft with a price only slightly higher than that of its prime competitors, the Robinson R66 and Enstrom-built turbines.

Bell has already taken 300 letters of interest for the aircraft, and market analysts suggest sales of the Robinson R66 fell by almost 50% during 2014.

Conceived in 20 months prior to first flight, the Model 505 uses the dynamic gear from the Model 206 LongRanger but features a new modern airframe, modern avionics and—for the first time in a Bell-produced aircraft—a Turbomeca engine.

Construction of the company's factory in Lafayette, Louisiana, is well underway, and will be critical in keeping the aircraft's price competitive, with the local government providing tax breaks and incentive packages.

Type certification with Transport Canada is expected before the end of 2015, and the company believes it could build as many as 200 a year.

Several independent manufacturers are also looking to move into the single-engine turbine market to compete with the 505 and the R66. New Zealand-based Composite Helicopters International (CHI) was little known until it posted an Internet video of an accident involving one of its experimental prototypes.

The video recorded the moment when a rod end component sheared from the upper swash plate of the rotor head, resulting in a dramatic loss of main rotor control. However, the test pilots said later that the aircraft's composite structure saved them from serious injury.

CHI is currently developing three products. The five-seat KC630 is fitted with a Rolls-Royce RR300 engine. The KC650, designed for hot-and-high performance, has a six-seat configuration and is fitted with a Honeywell LTS101 engine. The company is also proposing the KC640, fitted with the RR250 C20B engine. Type certification of the KC630 is expected in late 2017 with the KC650 and KC640 in 2018.

Independent manufacturer, Marenco Swisshelicopter is continuing its development of its SKYe SH09 helicopter, after its first flight in October.

The Honeywell HTS900-powered aircraft is targeting Airbus Helicopters' AS350 Ecureuil and the Bell 407, as well as some of the light twin-helicopters and has already generated some 50 orders. However, progress has been slow, with 10 months between the rollout of the first prototype in November 2013 and the maiden flight. The company is now focusing its efforts on assembly of the second prototype.

Gallery *See the engines being developed for the many helicopters entering service and in the pipeline:* **AviationWeek.com/HeloEngines**

Digital Extra *Rockwell Collins is preparing its Pro Line Fusion integrated avionics for the helicopter market:* **AviationWeek.com/ProLineFusionHelo**

AGUSTAWESTLAND

The third prototype of the long-delayed AW609 should get airborne this summer, ready for a winter of de-icing system trials.

want to be able to fly their AW609s from helipads in New York to Bermuda. "Customers also want to be able to fly to Paris or London from pads in Monte Carlo," Clive Scott, the AW609 program manager, told Aviation Week.

The most significant changes will come in the fourth prototype (AC4), which is due to fly in 2016.

This aircraft will embody many of the manufacturing improvements developed by AgustaWestland engineers during 2013. They have been working on reducing the cost of production, but also ownership. These include new hydraulic systems and lightweight wiring, as well as new inertial reference systems for the flight control system.

One of the reasons behind these changes is that the first prototype, AC1, has now been flying for 12 years, and many components and systems are now out of production or obsolete.

AC4 will also feature production standard engines and the Rockwell Collins Fusion avionics suite, which will replace the Pro Line 21 currently installed on the aircraft.

A test rig for the Fusion system is being installed in Italy, and should go active in early summer. Scott also says many of the suppliers for the aircraft have now been selected. Only a supplier for the landing gear has yet to be chosen.

Scott said the company is still on track to achieve certification in the FAA's Powered Lift category during 2017.

Bigger the Better

Increasingly, helicopter makers are focusing on larger, more profitable models

Tony Osborne London

It is a fact: Helicopter manufacturers like producing large helicopters.

On the whole, larger aircraft make more money, fewer have to be produced to register a decent return, and demand for them is unlikely to disappear given the need for oil and gas support helicopters, not to mention military variants that carry troops or hunt submarines.

But the current wave of commercial heavy helicopters produced in the West and in the 10-metric-ton-plus category are now at least 15 years old and are based on designs that date back to the 1960s or '70s.

But there are signs that a new generation of heavy helicopters may now be beginning to creep onto the drawing board, particularly in Europe.

Sikorsky's S-92 first flew back in 1998—yet the aircraft has its roots in the company's highly successful S-70 Black Hawk/Seahawk model, using many of the dynamic components from that aircraft.

Then there is Airbus Helicopters' EC225, which made its first flight back in 2000, but even a quick glance will tell you it is an another iteration of the Super Puma family that has its roots in Aerospatiale's SA330 Puma, which made its maiden flight back in 1965.

The EC225 was actually born from a French air force desire for a new combat search-and-rescue aircraft. Eurocopter at the time was faced with a dilemma—it didn't have the development resources to fund a whole new aircraft, so it was either a new platform kitted out with the running gear and avionics of the Super Pumas before it, or a new-generation Super Puma with new avionics and improved performance.

Airbus selected the latter option, and despite the ditching incidents in 2012 has not looked back, with strong sales sustained by a busy oil and gas industry.

China also has developed a commercial helicopter in this class, but the AC313 is actually a development of France's Aerospatiale Super Frelon, a design that also dates back to the late 1950s. In fact, only Russia has produced a new-build helicopter in this category, the Mi-38, but its development has been dogged by delays and a lack of funding with only a series of prototypes to show for an aircraft that has been flying since 2003. Indeed, customers of Russian Helicopters show more interest in the type the Mi-38 was supposed to replace, the Mi-8/17 family, which have been progressively upgraded.

So far, Airbus has been reluctant to talk about its future developments, especially as it prepares to unveil its new X4 helicopter March 3, but it is an open secret that one of its other X-programs—the X6—is a new-generation heavy helicopter almost certainly slated to replace the EC225 and Super Puma families toward the end of this decade.

The X6 program has been going on in secret for some time, but will likely follow the company's new family identity. Both the EC175 and the X4 will share a similar design philosophy. Details are scarce, but engine manufacturer Turbomeca may provide some clues; it is in the process of working on its Tech3000 demonstrator program, which will develop technologies for an engine in the 2,500-3,000-shp range. The company plans to complete development work by the end of 2016. By then, CEO Oliver Andries says Airbus shall be "ready to engage into a contractually binding product development."

AgustaWestland already has a relatively modern product in this category, the three-engined AW101, and had been considering re-certifying the type in its current configuration for commercial use. But those plans have now been shelved, and the company is now exploring alternative configurations including a twin-engine aircraft in the 10-ton class.

"The investment we would need to bring a civil certification to the current production variant [of the AW101] is such that this plus the number of aircraft we could sell at the time do not converge into a strong business case for the time being," explained Roberto Garavaglia, the company's senior vice president for strategy and business development.

Garavaglia says a 10-ton aircraft is being considered but adds that "what shape this [aircraft] will take isn't clear." Such a development is, however, seen as a priority by AgustaWestland's owner's Finmeccanica, which identified a new heavy-lift helicopter as one of the objectives of the parent's restructuring between 2015 and 2019.

China also has ambitions in the development of a new Advanced Heavy Lifter in cooperation with Russia, although this would be significantly larger than the 10-ton machines being developed in the West, with an all-up weight of 40 tons, which would make it the second-largest helicopter after the Mil Mi-26.

AGUSTAWESTLAND

AgustaWestland has shelved plans for civil certification of its three-engine AW101 as it looks to a new 10-ton helicopter.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Safety First

North Sea crashes prompt reviews, but have things really changed?

Tony Osborne London

The offshore helicopter industry is still healing from wounds inflicted by five accidents—two of which were fatal—over just four years in the North Sea.

Despite the helicopter being a vital tool in the efficient operation of oil platforms across the world, confidence in rotary-wing transport suffered significantly after the second fatal accident in August 2013, this time involving a CHC Scotia-operated AS332L2 Airbus Helicopters Super Puma as it made its final approach to Sumburgh in the Shetland Islands.

The crash prompted significant soul-searching by the operators, regulators and government, and a series of reviews probing every aspect of offshore helicopter operations, even questioning the cultural differences between operations in the U.K. and in Norway, where the frequency of fatal accidents per 100,000 flying hours is one-third lower than in Britain.

PA PHOTOS/LANDOV FILE PHOTO

Wreckage from the August 2013 crash of a CHC-operated Super Puma is a somber reminder of the dangers of helicopter operations in the North Sea.

But now the community is looking ahead, confident that it has been able to turn a significant corner by fostering closer cooperation, as well as information and data-sharing.

Four different bodies set up reviews into North Sea operations following the Super Puma crash, but it is those carried out by the regulator, the U.K. Civil Aviation Authority (CAA), and a joint review carried out by the operators themselves that are likely to result in the most radical changes, those in the community believe.

The most significant of these was the publishing of the CAA's CAP1145 document in February. Managers at the main oil and gas operators had plenty of time to contemplate the document as they made the long flight to Los Angeles for the Heli-Expo convention.

Initially the document caused angst in the industry. While it outlined important changes to improve passenger survivability, pilot training and safety management, operators were concerned that it had the potential to negatively impact operations and bring additional risk to their operations. However, many of those fears were quickly overcome.

CAA officials have admitted that the CAP1145 study was actually a two-year-long review squeezed into just six months and the regulator admits it didn't have time to consult.

"We had to do it fast, and we had to get it out there," said the CAA's director for safety and airspace regulation Mark Swan, speaking at a Royal Aeronautical Society event last July.

But a review into the CAP1145 actions and recommendations published by the CAA in January states that there is now a strong collective commitment to change. The report points to how the industry managed to train 57,000 oil workers in six weeks to use new standard emergency breathing systems in order to improve survival in the event of a ditching or accident. Indeed, 14 of CAP1145's 32 mandated actions have been completed and a further six are on track, the report says. The rest are subject to revised delivery schedules, largely because more reviews were needed before other action could be taken.

"It is strongly intended that the momentum built over this year should continue," the report states.

"In particular, the working relationships established between helicopter operators, regulators and manufacturers should lead to further safety improvements and the embedding of a stronger safety culture across the offshore helicopter industry."

Some of this momentum has been generated by the creation of HeliOffshore in October last year, prompted by the joint operators' review started by Bond Offshore, Bristow and CHC. These founding companies—along with U.S. operators Era and PHi—have since been joined by a further 50 operators, manufacturers and associated businesses working toward safety improvements.

Gretchen Haskins, CEO of HeliOffshore, the new international offshore helicopter industry association, says the operators are now working together in ways not seen before and influencing operators worldwide, not just in the North Sea.

"The companies don't want compete on safety," says Haskins. "Through their activities with HeliOffshore, the operators are working together on a number of work streams."

Work streams for the association include automation, the use of pilot-monitoring systems, stabilized approaches, and health and usage monitoring systems, as well as greater information-sharing on incident reporting.

The latter is where HeliOffshore has already produced results, according to Haskins, who says several operators already have benefitted from using procedures adopted by other operators because of data-sharing in areas that didn't happen before.

Another success has been to prompt helicopter manufacturers to produce standard Flight Crew Operating Manuals (FCOMs), commonplace in commercial fixed-wing aviation but unusual for helicopters, where it is usually up to operators to write their own operating manuals, based on the interpretation of training given to instructors by the manufacturer.

Airbus Helicopters has already delivered on its work to develop a standard FCOM for the EC225, and it will deliver a similar document for the EC175. AgustaWestland will follow for its AW189 and Sikorsky for its S-92, and Bell has promised the same for its Model 525.

The challenge for operators and regulators will be to maintain this strong start even as oil and gas companies are facing a downturn in revenues from declining oil prices.

New Thrust

With its sole-source status waning, ULA shifts to a commercial development and sales model

Amy Butler Washington and Orlando, Florida

The United Launch Alliance's (ULA) plan to field a new rocket engine with startup Blue Origin called the BE-4 is only one step of a larger strategic plan to take the company from a sole-source monopoly mentality to competing in a burgeoning commercial market.

With that plan, ULA's current launchers—the Atlas V (developed originally by Lockheed Martin) and Delta IV (originally developed by Boeing)—will likely be supplanted by a new, yet-to-be-named rocket design within the next decade. The Atlas V and Delta IV are the workhorse rockets for the Defense Department, and have been since the early 2000s. But both now have a limited future.

Last year, former ULA Chief Executive Officer Mike Gass said the per-unit cost of an Atlas V 401 mission was $164 million; a Delta IV heavy mission was priced at $350 million. These prices are averages for the 36-core deal signed between ULA and the U.S. Air Force.

Atlas V, the Pentagon's rocket of choice for price and performance, is now compromised due to tensions between Washington and Moscow over the latter's ambitions in Ukraine. Russia supplies the RD180 engine for it and Congress has mandated that no Atlas engines can be purchased to be used for national security missions. Delta IV has a stellar launch record but is more expensive; its heavy variant, however, is one-of-a-kind and is the driving reason why the family will remain active into the future.

That is until ULA—or another company—can build a replacement. ULA CEO Tory Bruno, who took over that position last August, abruptly replacing Gass, says the company is also developing a new upper stage to take the place of the legacy RL-10, built by Aerojet Rocketdyne, which now mates with the Atlas V and Delta IV.

Bruno is also reducing the company's infrastructure from five launch pads—supporting both launch vehicle types—to two. One will be on each coast, and each will support operations for the Next-Generation Launch System (NGLS) as well as support flyout of the last Atlas V and Delta IV missions, he told Aviation Week during a Feb. 17 interview. The company announced in 2008 it would drop one of its Delta II pads, leaving five pads in its infrastructure. The company oversees that many pads because it inherited both launch fleets, supporting the Air Force's policy of maintaining two launch vehicles for assured access to space. The company plans to eventually go to two pads "just a couple of years after we introduce the Next-Generation Launch System," which is slated to be flight tested in 2019. "We'll be ramping up the new rocket and we'll be ramping down the Atlas and Delta, so it'll be just a couple of years . . . before we can retire the other pads and be completely dependent on the new pads," Bruno adds.

The assumption is that future national policy will include two competing launch companies—not a single company managing two different rocket fleets.

In September, ULA's Bruno, and Blue Origin—a secretive Seattle-based startup funded by Amazon.com founder Jeff Bezos—announced a partnership to develop the BE-4 a liquefied natural gas engine designed to both replace the RD180 in the Atlas V and to support the NGLS design. The BE-4 design was originally intended for Blue Origin's New Shepard Launch Vehicle, and the companies are scaling it up to produce about 550,000 lb. of thrust for Atlas V and NGLS—as much as 15% more thrust than the RD180, Bruno says. "It is not a major amount of work having to be done over again in order to scale," he says. Two of the engines would be needed for the thrust required by the Air Force.

The NGLS will be capable—when coupled with the new upper stage—to take over heavy payload missions now handled exclusively by the Delta IV Heavy, Bruno says. Air Force certification for the engine is expected to take about one or two flights to achieve, Bruno notes, adding that up to one year will likely be necessary to allow the Air Force to review and qualify the hardware.

BLUE ORIGIN

ULA says the new BE-4 engine will be ready for a flight test on the Atlas V in 2019.

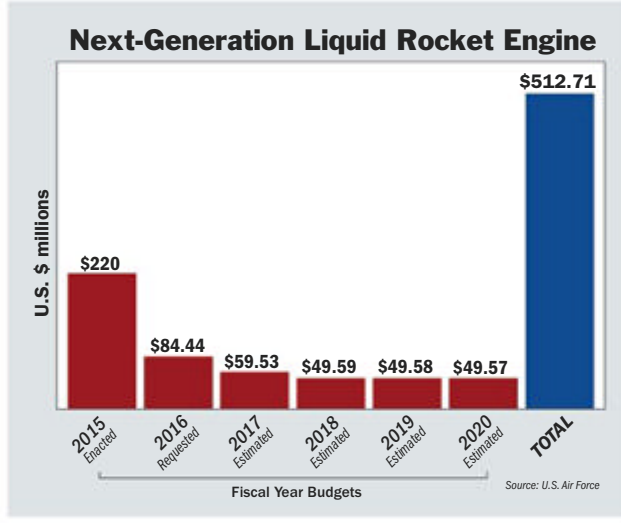
The company expects to require less time than SpaceX needed to certify its Falcon 9 v1.1, in part because it has already included the Air Force in its design-review process and because the new system will rely on legacy processes already approved for the EELV program. The Air Force and SpaceX signed the cooperative research and development agreement on its Falcon 9 certification in June 2013. Maj. Gen. Roger Teague, director of space procurement for the secretary of the Air Force, says certification is likely in the summer of this year.

The near-term priority for ULA is to field the BE-4. The team is now testing components for it, and "they are right where I expected them to be" in development, Bruno says. Full-scale engine firings are slated for the 2017 timeframe.

Bruno says ULA has a cost target for NGLS but he declined to provide it.

Meanwhile, the Air Force is scrambling to devise an acquisition strategy to take advantage of both advances in the commercial market—SpaceX is also pushing for an upgraded Merlin engine and Aerojet Rocketdyne is developing the AR-1 as an RD180 replacement—as well as new funding provided by Congress. Lawmakers set aside $220 million in fiscal 2015 to begin a next-generation rocket engine program, but the Air Force did not include a procurement strategy in its fiscal 2016 budget request sent to Congress Feb. 2. Experts estimate that a new engine will cost at least $1 billion to develop, and the Air Force's fiscal 2016 request includes only $514 million through fiscal 2020 (see chart on opposite page). This is in part because the fiscal 2015 appropriation arrived so late that it gave the Air Force little time to plan to use the funding, Teague explains.

Air Force Space Command chief Gen. John Hyten says the



acquisition strategy should be ready in the spring or summer. It will ultimately call on industry for a large portion of the investment, Hyten told Aviation Week during a Feb. 12 interview at the annual Air Force Association Air Warfare Symposium in Orlando. "It is clear the Congress wants a competition as soon as possible," he said, adding that the Air Force wants to continue to purchase launch services rather than developing its own engine to be handed to industry as government-furnished equipment. "There are some very interesting engine development programs going on right now, so the first thing we have to do is to explore the public-private partnerships that can take advantage of the work that is already going on in industry. . . . We want to use our investment dollars to continue to explore those engine technologies. If we can't work those things out, we have to basically figure out how to build an engine that can be used by anybody and get off the RD180."

Bruno, meanwhile, says ULA's partnership with Aerojet Rocketdyne to develop the AR-1 is a "back-up plan" to the BE-4. The AR-1 is a kerosene engine also being designed as an RD180 replacement by Dynetics and Aerojet Rocketdyne. NASA has invested about $50 million in risk-reduction work for this engine and advocates are hoping the Air Force will carry on the development, according to an industry source. Thus far, the team is conducting risk reduction for main injector stability, the source says. The Air Force recently signed a memorandum of understanding with NASA Marshall Space Flight Center allowing for the risk-reduction work to continue with Air Force oversight and funding. AR-1 advocates are arguing that the Air Force should build an engine directly for its own use and not simply contract for launch services. The Air Force could do this using NASA as its technical overseer, they contend.

Meanwhile, ULA is also planning to buy long-lead parts for "white tail" rockets beyond the 36-core deal funded as a bulk buy by the Air Force in anticipation of moving further into the NASA market as well as the commercial market.

"We intend to go aggressively now after NASA commercial activities—cargo and crew—as well as pursuing the commercial market place, which is largely comsats in [geostationary] orbit," Bruno says. "Some of these customers don't order so far in advance that it would be earlier than the long-lead part requirement, so that forces us to act like the commercial company that we are and anticipate the need and place those long-lead orders having confidence that we will sell them later."

The concept of building white tails— rockets not yet sold—was anathema to ULA only a year or so ago, as the company was in the luxurious position of being the monopoly launch services provider to the Pentagon for large national security missions. Now, however, Bruno notes that the market has changed substantially, driving ULA to change with it.

Redundant No More

Europe's final ATV mission leaves ISS vulnerable to Russia

Amy Svitak Paris

The five nations that make up the International Space Station (ISS) partnership bid farewell to Europe's fifth and final Automated Transfer Vehicle (ATV-5) with a fiery atmospheric reentry over the Pacific Ocean Feb. 15, leaving Russia's Progress freighter the only vessel capable of refueling, boosting and ultimately retiring the orbiting outpost.

"There is no 1:1 replacement to the ATV," says European Space Agency (ESA) ATV-5 mission manager Massimo Cislaghi. "Rather, there will be a redistribution of its capabilities among the rest of the ISS servicing fleet," which, in addition to Progress, consists of the SpaceX Dragon, Orbital Sciences Corp. Cygnus and Japanese H-II Transfer Vehicle (HTV).

However, Cislaghi says Russia's Progress is, "to my knowledge, the only one capable of performing ISS reboost and refueling."

For now, with Moscow and Kiev still at odds over an ongoing crisis in eastern Ukraine, Western relations with Russia remain precarious. Mere days into a newly signed peace accord, both sides violated the agreement, and it remains to be seen whether and how the crisis will affect the ISS partnership.

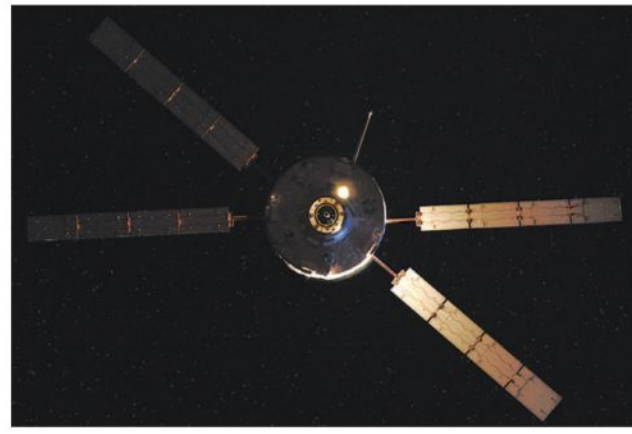
In the meantime, ATV prime contractor Airbus Defense and Space says it may be possible to produce a sixth ATV to de-orbit the ISS, if a plan to use two Progress vehicles for this purpose becomes untenable. But such a development would come at considerable cost to the partnership.

"Should we be asked to do it now, we would do our best, but it makes it extremely difficult, because we do not have spares for every piece of the ATV," says Gilles Debas, head of the ATV program at Airbus Defense and Space. "It's something we could imagine, but to make it quick and inexpensive would be a challenge. It would take time and quite a strong investment to restore the capabilities after having ramped ATV down a few years ago."

With the final ATV mission—dubbed "Georges LeMaitre" after the Belgian cosmologist and father of the Big Bang theory—the ISS partnership has closed the door on what has been the largest and most sophisticated space vehicle ever built in Europe, a space freighter renowned for its reliability and precision. The largest of the current fleet of cargo delivery vehicles, ATV is the only ISS capsule capable of operating with a high degree of independence. It is able to

navigate autonomously and rendezvous with the station to an accuracy equivalent to the width of a €1 coin.

The first ATV, "Jules Verne," was launched March 9, 2008, and spent 155 days docked to the ISS. It was followed three years later by ATV-2 "Johannes Kepler," lofted on Feb. 16, 2011, and it remained at the space station for 116 days. The third was the "Edoardo Amaldi," which was launched March 23, 2012, and spent 184 days at the ISS. It was followed by "Albert Einstein," sent to space June 5, 2013, to spend 135 days at the station.



ROSCOSMOS/O. ARTEMYEV

A prototype "black box for spacecraft" running inside ESA's ATV as it broke up in the atmosphere returned data to the ground, but the images it took were lost in transit.

In all, the ATVs accumulated 776 days of docked operations at the orbiting outpost, to which they delivered a total of nearly 32 metric tons (70,547 lb.) of cargo and payload.

ATV-5 was launched July 29 by European consortium Arianespace atop an Ariane 5 ES launch vehicle from Kourou, French Guiana. It weighed 19,926 kg (44,000 lb.) at liftoff, loaded with fuel, food, water and supplies on its final mission to the ISS. The vessel rendezvoused and docked with the orbiting outpost Aug. 12, where it remained a pressurized part of the station for the past six months.

During its 186-day stay in space, ATV-5 regularly raised the station's orbit to compensate for the effects of drag in the upper atmosphere. In all, teams at the Toulouse Space Center in France conducted five attitude-control, three orbit-reboost and two debris-avoidance maneuvers—a first in the history of European spaceflight.

The ATV series of space freighters is part of Europe's barter contribution toward the cost of ISS operations, in exchange for which European astronauts and experiments are flown on the station. In March 2011, ESA member-states decided to cap the ATV program at five vehicles, to focus on new developments, rather than continue ATV production.

ESA and Airbus Defense and Space are now applying ATV technologies in support of NASA's Orion spacecraft being built by Lockheed Martin Space Systems to fly astronauts to deep space.

Dubbed the European Service Module, ATV's technical successor is a follow-on barter arrangement with NASA through 2020 and represents a critical piece of the Orion development that will supply power, air and propulsion during the test flight in 2018.

Small UAS, Big Step

Long-awaited proposed rule on small UAS welcomed, but FAA urged to finalize regulations quickly

Graham Warwick Washington

Reaction to the FAA's long-awaited proposed rules for small unmanned aircraft has been guardedly positive, with advocates welcoming the relaxed certification standards but concerned that the operating restrictions could hinder commercial use.

Associations representing manufacturers, general aviation and airlines welcomed the proposed regulations, but urged the FAA to expedite the final rule, which some estimate could take up to three years because of the large volume of public comments expected.

Unmanned aircraft under 55 lb. will not require airworthiness certificates, and operators will not need pilots' licenses under the notice of proposed rulemaking (NPRM) for small unmanned aircraft systems (SUAS). But operations will be restricted to daylight, under 87 kt. (100 mph) and 500 ft., and within unaided visual line-of-sight of the operator.

Limiting small UAS to visual line-of-sight operations will limit commercial uses, proponents argue.

Small UAS will not be allowed to fly over people not directly involved in their operation. The proposed rule does not allow the commercial carriage of cargo such as the package delivery services envisioned by Amazon and Google, but the FAA is seeking comments on whether such operations should be allowed—within the other constraints of the rule.

The proposed rule "addresses two basic safety issues: keeping UAS well clear of other aircraft and mitigating the risk to people and property on the ground," says Transportation Secretary Anthony Foxx. "The proposed rule offers a very flexible framework that provides for the safe use [of small UAS] while also accommodating future innovation in the industry," says FAA Administrator Michael Huerta.

The FAA is also seeking comments on whether it should create a separate "micro-UAS" classification for vehicles weighing no more than 4.4 lb. Limits being considered include a maximum speed of 30 kt, altitude of 400 ft., distance from the operator of 1,500 ft. and that the vehicle should be made of frangible materials to minimize collision damage. "We are asking the public if such a category, and special rules to govern [micro unmanned aircraft], should be in the final rule," says Huerta.

Small UAS up to 55 lb. will be allowed to operate in Class G uncontrolled airspace, but be barred from Class A controlled airspace above 18,000 ft. and require permission from air traffic control to operate in Class B, C, D and E controlled airspace, including around airports. Micro-UAS operations, meanwhile, would be limited to Class G low-altitude airspace.

A private or commercial pilot's license will not be required to fly a small UAS, nor will a medical examination. Instead, the FAA proposes creating an unmanned-aircraft operator certificate with a small UAS rating. This would allow the operator to fly any small UAS meeting the rules. "This is fundamentally different [from] being a private pilot," says Huerta. "A number of requirements . . . simply don't apply. But what does apply is the ability to operate within airspace with other aircraft."

The unmanned-aircraft operator would have to pass an aeronautical knowledge test focused on airspace "rules of the air," be vetted by the Transportation Security Agency, and to obtain an operator's certificate that would have to be renewed every two years by taking a written proficiency test. Huerta says the FAA would work with testing organizations to make the exams widely available.

Although small UAS will not require airworthiness certification—Huerta says such approval could take manufacturers 3-5 years to obtain, and notes the pace of innovation means their UAS could be outdated by the time they are certified—operators will have to conduct a preflight inspection before every mission.

"The pilot qualification requirements look reasonable and I am pleased that there is no airworthiness certification requirement, contrary to what the FAA suggested in its November 2013 UAS Roadmap. However, some of the operating restrictions will curtail useful applications," says New York lawyer Brendan Schulman, who specializes in UAS cases.

SKYCATCH

"For example, the line-of-sight requirement would seem to prohibit building inspections that involve flying around and behind a smokestack," he says. "There is a restriction on night operations which could pose a problem for search-and-rescue operations. And the 500-ft. ceiling doesn't make much sense in parts of the country that are very remote or where the minimum safe altitude for manned aircraft is 1,000 ft."

Huerta says an "aggressive" research program is underway on beyond-line-of-sight operation, which requires a see-and-avoid system. Also, the so-called Section 333 exemption process provides a way for the agency to "consider specific uses people want to put forward as the regulatory framework evolves. This is not the final word on the full scope of UAS operations. It's an extremely important first step."

The possible limits on micro-UAS are based in part on rules already in place in Canada. "It seems possible that they might be amenable to a larger weight and even fewer restrictions than we proposed," says Schulman, who in December petitioned the FAA to create a special category for micro-UAS under 3 lb. The petition was filed on behalf of the UAS America Fund, which was set up to help the commercial UAS sector.

"What we are laying out is a flexible regulatory roadmap that can provide a clear roadmap for how this very large class of UAS can operate in the national airspace system," says Huerta. "As the rules become finalized, they are going to provide probably the most flexible regulations for aircraft under 55 lb. that exist anywhere in the world."

Expect the Unexpected

The lower price of fuel may change industry dynamics over time and the benefits may be smaller than many believe

Jens Flottau Frankfurt, Sean Broderick Washington, Madhu Unnikrishnan San Francisco and Adrian Schofield Auckland

Much as the meteoric rise in fuel prices dramatically changed the equation of airline business models and caused unprecedented demand for more-efficient aircraft, the recent steep fall in jet fuel prices has the potential to change the equation again. While short-term financial benefits for many airlines are undisputed, there is increasing concern that the new shift may prove a mixed blessing for airlines and aircraft manufacturers over time.

Estimates by rating agency Moody's show what a hugely positive financial impact the lower fuel prices will have on the airline industry's costs. Moody's analysts believe airlines globally will spend around $70 billion less on fuel in 2015 than in 2014, equivalent to a reduction of one-third. But given that the once-favorable hedging contracts are binding and scheduled to be in place for some time, and that the U.S. dollar has strengthened against several important currencies, the net effect will be more like $35 billion. Moody's believes that the seven U.S. airlines it is rating alone will end up paying $15 billion less for fuel this year.

But executives at many airlines insist that while low fuel prices are changing balance sheets, big-picture strategy—notably fleet planning and capacity—remains largely unaffected for now. In the U.S. United Airlines this year will take delivery of two used Boeing 737-700s—aircraft acquired due in part to their more favorable economics thanks to fuel prices of around $50 per barrel, about 50% lower than six months ago. Beyond that, however, the carrier says its fleet plans are not being reworked to cash in on cheaper gas.

"These are assets that we fly for 25 to 30 years," Chief Revenue Officer Jim Compton says. "If we are so fortunate that fuel prices remain at this level for years to come, we might adjust our view on what fuel prices we use when we make these fleet investment decisions. But for right now, we are still assuming the same fuel prices that we've used or seen over the last few years, which is $120-125 [per barrel]."

Delta Air Lines, which stands to gain $2 billion in savings from lower fuel costs in 2015 net of its hedges, has not changed plans due to the fuel price drops. The carrier's move to phase out its 16 747-400s from 2014-17 remains on track. "Planning with a low fuel price will only disappoint," CEO Richard Anderson says. "And planning with a high fuel price, if you end up being wrong and the fuel price is lower, you will be pleased."

On the other side of the Atlantic, the picture is similar. Lufthansa says it will spend around €900 million ($10.2 million) less on fuel in 2015 than it did last year when fuel costs amounted to €6.7 billion. The airline is sticking to its policy to keep capacity flat in terms of aircraft units and grow only by way of increasing seating capacity.

An even more substantial effect on bottom lines will only be seen when the current fuel-hedging contracts expire and are replaced with ones that mirror current market prices. Low-fare carrier Ryanair is among the carriers that, from today's point of view, hedged at the wrong time—at prices that turned out to be too high. Moody's warns that unhedged airlines might use the opportunity to wage fare wars in an attempt to boost market share. However, since there are few unhedged airlines in Europe, the potential of widespread near-term fare reductions does not loom large.

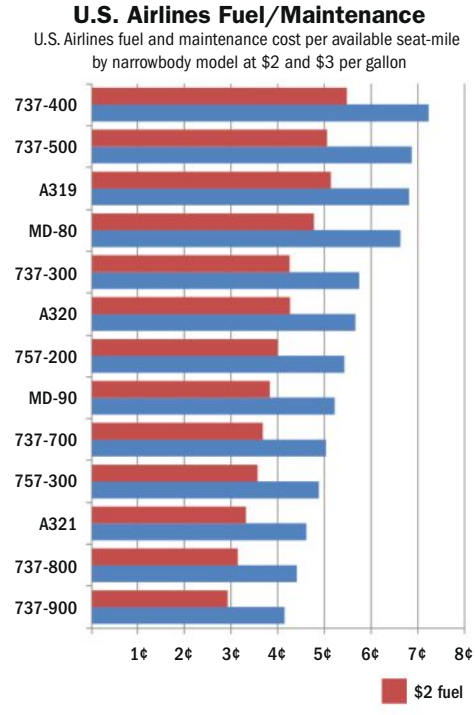
There are significant exceptions that can change company fortunes and distort current market dynamics: The drop in fuel prices will, at least in the short term, widen the cost gap between European and most U.S. carriers on the one side and Gulf carriers on the other. Emirates is completely unhedged, thus is one of the large airlines in the world to see immediate benefits. Etihad Airways ended its hedging program in late 2014 when prices had already declined significantly.

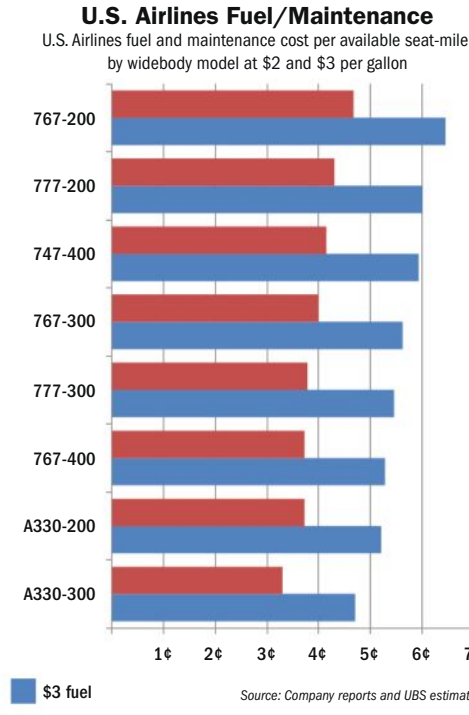
Other major airlines that are not hedged include American Airlines, Air China, China Southern Airlines and China Eastern Airlines. Many other Asian carriers have little hedging so are enjoying immediate benefits. Air Asia and Asiana Airlines hedged approximately 10% of its requirements in 2015, Japan Airlines (JAL) is at 20%, All Nippon Airways (ANA) at 45% and Cathay Pacific at 50%, according to French bank BNP Paribas.

One question confronting all airlines is how to continue or resume hedging

Will airlines raise capacity faster now that they may be able to afford it? Analysts are split.

Airlines are seeing a substantial unit cost reduction as a consequence of the fuel price decrease.





given the current price levels.

Beyond the obvious near-term positive impact on balance sheets, future consequences may not be as obvious. Brian Pearce, chief economist at the International Air Transport Association, believes the impact of lower fuel is "more complex than people say." He does not go along with the prediction that a drop in fuel prices necessarily translates into an equivalent increase in airline profits. In fact, Pearce argues, because of several different factors that will crop up in the next 1-2 years, the bottom-line benefit for airlines will be much lower.

He even wonders whether cheap oil is actually that good for the industry when all the follow-on ramifications are taken into account. For starters, Pearce points out, "profits have increased with rising fuel" over the past few years. That airlines would ever be able to be profitable given the massive increase in fuel costs over and above the historic trend, was totally unexpected. In fact, many analysts have predicted record numbers of mass-bankruptcies and consolidation.

Although there have been market exits, the number of actual bankruptcies has been fairly low and consolidations have occurred in different regions at different paces, but not in record numbers.

What seems to be the major factor for airlines' financial performance improvement in recent years has been capacity control. Carriers simply could not afford to continue to fly all the marginal routes they had put in place—in spite of ongoing losses—for "strategic reasons" to improve network quality. Improved quality (meaning more destinations) takes a backseat when in survival mode.

Pearce is concerned that some of the discipline may soon be lost, although in general he believes that the "mindset change among airline CEOs is probably here to stay." Some airlines may continue to use older aircraft rather than retiring them. And he expects a "delay in some of the industry restructuring that has been happening in Europe. Some players had been expected to exit, but will not." Also, it is still relatively easy to start a new airline, particularly if business plans can be based on lower fuel costs.

Therefore it will be "all the more difficult for airlines" to continue to post profits at the current levels, Pearce argues.

Moody's believes airlines will use "this windfall for debt reduction, aircraft purchases, and shareholder returns, rather than significantly grow their fleets to wage market-share battles." But it also believes that the

FRAPORT

ability to increase yields on a global basis will be "limited" due to the reduced price of oil.

In fact, airlines are being pressured to waive the fuel surcharges they introduced when prices first started to rise. Many carriers are citing fuel hedges for the lag in eliminating surcharges, but this defense will not work for much longer if low fuel prices continue.

Some airlines are aiming at a soft landing by starting to absorb canceled fuel surcharges into higher base fares, thereby removing an increasingly unpopular fee without taking much of a revenue hit.

In the Asia-Pacific region in particular, actions on fuel surcharges have varied greatly. Some airlines such as AirAsia, Cebu Pacific and Philippine Airlines (PAL) have dropped the surcharge altogether, while several others such as JAL, ANA, Singapore Airlines and Cathay Pacific have reduced the surcharge level.

Some carriers have ditched these fees as a result of regulatory directives. For example, on Jan. 8 the Philippines Civil Aeronautics Board revoked airlines' authority to add a separate fuel surcharge. This affected 27 carriers, not just locally based operators such as PAL and Cebu but also a number of foreign airlines serving the Philippines.

Australia's two major carriers—Qantas and Virgin Australia—have eliminated fuel surcharges, although the effect on total ticket prices will be minimal. Qantas will raise its base fares to compensate for the loss.

Lufthansa has already redefined its surcharge to include airport and security fees to counter demands for reduced overall fares.

"Airlines will behave in a rational way if they are under threat," says Adam Pilarski, senior vice president of Avitas consulting firm. But now that the most immediate threat has disappeared, he is convinced they will start lowering fares, thus weakening their own position.

"Fuel prices were way too high and should not have been," Pilarski says. He has bucked the mainstream, predicting this fall in prices far ahead of other analysts. Now the big question for him is: Will [prices] stay or hover at this low rate? If so (and that still includes prices of $80-90 per barrel as compared to the current level of below $50) the development would represent a "permanent structural shift that has tremendous impact."

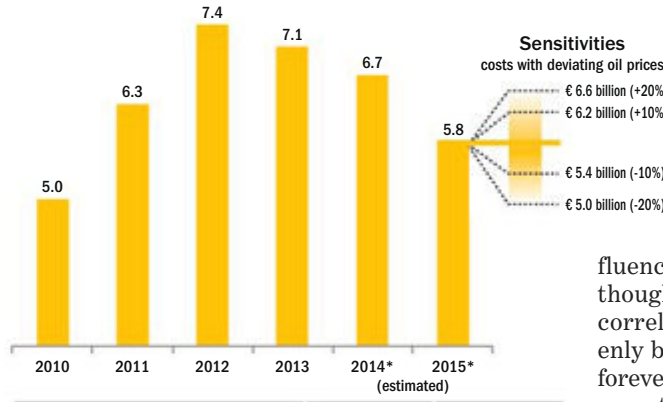
The impact of the new fuel price environment could extend well beyond airline economics per se, to have a strong influence on aircraft production, even though Airbus and Boeing deny the correlation for now. "People mistakenly believed [fuel prices] will be up forever," Pilarski says. Therefore they were trying to get access to as many fuel-efficient aircraft as possible as a kind of a life insurance—the only way to be protected in relative terms vis-a-vis the competition and, in effect, "an expensive form of hedging." That is what caused the strong demand for and launch of Airbus's A320neo and A330neo and Boeing's 737 MAX. Now the main argument for ordering these aircraft becomes less important. "Obviously you don't have an immediate impact, it will take time for reality to sink in," he says.

But in consequence, Pilarski warns that there is "still a huge overhang" in orders. He points to the fact that both Airbus and Boeing hold orders for twice as many aircraft as they have produced for two consecutive years, and he predicts the ratio will be "below one" in 2015.

"From an aerospace and defense industry perspective, falling oil prices and the increasingly likely 'lower for longer' outlook elevate the risk of aircraft order deferral and/or cancellation as the value proposition for airline carriers in terms of reduced cost of ownership for new/next-generation equipment relative to existing/current-generation equipment is markedly reduced," says widely followed Moody's analyst Russell Solomon.

"The massive orderbooks continue to mitigate this rising risk, nonetheless, particularly in that a significant component is earmarked for emerging market growth, which is clearly not without risk itself, but we believe is less exposed to oil price declines than developed markets, for which fleet re-

Lufthansa Group Fuel Expenses After Hedging (€ billions)

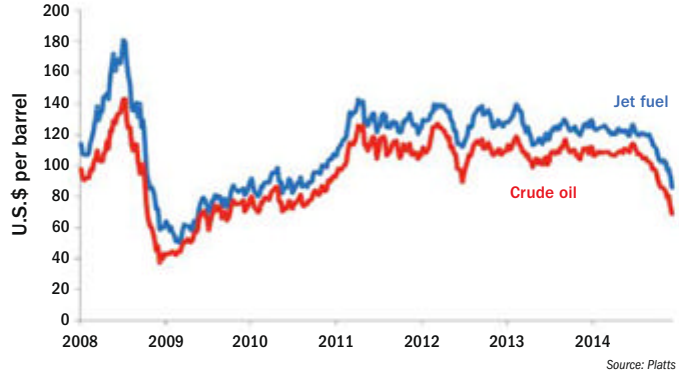


Assumptions	Fiscal 2014	Fiscal 2015
Current fuel hedging levels	79%	73%
Expected volume (metric tons)	8.9	9.0
Brent forward (U.S.$ per barrel)	—	68
Euro/U.S. dollar exchange rate	—	1.24

* Estimated Source: Lufthansa Group

Lufthansa saw a €1.6 billion swing in its fuel costs in 2010-13. Hedging is delaying further benefits.

Jet Fuel and Oil Price Fluctuation Since 2008



Source: Platts

Airlines operated with fuel prices well in excess of $100 per barrel for several years, but now they can adjust to much lower levels.

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placement can more easily be delayed if jet fuel costs continue to decline and stay relatively low," he says.

OEMs such as Airbus Group, Boeing and others could see more pressure on the orderbooks sooner than they expected. "The lingering issue of the OEMs having to fill their skylines for both narrowbody and widebody programs, as new variants are scheduled to be introduced over the next few years, will likely prove more challenging in the current environment," Solomon says, "with margins likely coming under increasing [beyond normal course] pressure as last-off-the-line models are sold."

Pilarski has no doubt that there has been an order bubble. "The question is how will we deflate the bubble? With a sharp needle or will there be slow leaking?" In the sharp-needle scenario, airlines would cancel a great number of existing orders. If the bubble only has a small leak, the industry may simply have to endure a few years with considerably fewer orders. "It does not have to become a disaster," Pilarski concedes.

In *The Airline Monitor*, Ed Greenslet agrees and disagrees. He believes the number of orders for new aircraft will likely come down. But, he says, "There is no evidence in history" of a correlation between oil prices and orders. If orders do go down it is because "they must drop to an average over time. They have been at a peak for four years; it's just the way the beast works—in cycles."

Greenslet points out that the price of fuel almost tripled between 2004-14, but deliveries increased by 67% over the same time. And no new aircraft types were available that would have been more fuel efficient than those in service before the rise in fuel. So while new orders may fall at a time of plummeting oil prices, he argues that there is no link between the two. To him, it is just a coincidence.

Airlines will become more profitable in the short term, Greenslet avers, and fares will be lowered when the current hedging contracts that bind them to fuel prices higher than the current market level expire. "The airlines will bank it in the short term, but then will use [the cash] to build market share or build a business. This industry has a long history of irrational behavior."

But would it be irrational to just take advantage of the situation and lease some good, mid-price, mid-age aircraft? "We take it as a given that fuel prices in the current range make it more attractive to retain, and acquire, 10- to 15-year-old airplanes instead of growing the fleet with new types," Greenslet concedes. However, he sees "two problems with that strategy." Most of the new aircraft on order are intended for growth, not replacement. And there "is no way the used aircraft market could supply the more than 1,000 new single-aisle types now being delivered each year, particularly if the airlines are at the same time retaining the older types they have." Second, before a significant part of the airline industry gives up on orders, it would have to be convinced that fuel stays low for 10 years or so. "The fear of being on the wrong side of the fuel price trends, when significantly better products are available, is a risk most airlines would probably wish to avoid."

Swiss bank UBS, by contrast, warns there could be a negative effect for carriers. UBS has calculated that at current fuel prices 10-15-year-old used narrowbodies are 10-15% more cost effective than new current-generation aircraft and 5-10% cheaper to own and operate than next-generation aircraft such as the A320neo or 737 MAX. "However, we think the main impact of $2.00 [fuel] is that the probability of very high $4.00+ jet fuel that the airlines have had to guard against and plan for at $3.00 is now much lower. At $4.00, the used 10-15-year-old aircraft would no longer be economical compared with new models, UBS analysts argue.

Therefore UBS sees "the potential for airlines to extend the lives of older aircraft and increase their utilization benefiting the engine manufacturers, aerospace aftermarket and lessors with significant near-term lease expirations." The analysts warn that airlines could "begin to look to defer current generation aircraft on order if fuel remains at these lower levels for 6-12 months." UBS believes that Boeing is more at risk than Airbus because "it has a much larger gap to try to bridge to its next-generation models."

But lessors do not (yet) see a major change in airline behavior, even though industry profitability is improving across the board. Aengus Kelly, CEO of leasing giant AerCap, says his company was able to extend leases for seven Airbus A340s and two Boeing 747-400s by several more years; it had been expected to scrap the aircraft. He cautions that airlines are only extending contracts by a finite time until the next major engine and airframe overhauls. At that point, keeping the aircraft will still be uneconomical in spite of the much lower direct operating costs, Kelly argues, noting: "Airlines are doing this at the margin, there is not a big capacity change. The aircraft are still on the way out."

2015 Estimated Earnings-Per-Share Sensitivity to Changes in Jet Fuel

	AIRLINES					
	AMERICAN	ALASKA	DELTA	JETBLUE	SOUTHWEST	UNITED
$3.15	$3.34	$3.46	$3.58	$0.72	$1.86	$1.43
3.05	3.94	3.68	3.81	0.83	2.00	2.39
2.95	4.55	3.90	4.04	0.95	2.15	3.34
2.85	5.16	4.13	4.27	1.06	2.30	4.30
2.75	5.76	4.35	4.49	1.18	2.44	5.25
2.65	6.37	4.57	4.72	1.29	2.59	6.21
2.55	6.98	4.80	4.95	1.41	2.74	7.13
2.45	7.58	5.02	5.17	1.52	2.88	8.04
2.35	8.19	5.25	5.40	1.64	3.03	8.96
2.25	8.80	5.47	5.63	1.75	3.18	9.87
2.15	9.40	5.69	5.86	1.87	3.32	10.78
2.05	10.01	5.92	6.08	1.98	3.47	11.69
1.95	10.62	6.14	6.31	2.10	3.62	12.61
1.85	11.22	6.34	6.54	2.21	3.76	13.52
1.75	11.83	6.59	6.76	2.33	3.91	14.43
1.65	12.44	6.81	6.99	2.44	4.06	15.34
1.55	13.04	7.04	7.22	2.55	4.20	16.26

** Shaded sections broadly compare to published forecasts* *Source: J.P. Morgan estimates*

Oiling the Gears

Offshore helicopter operators brace for downturn due to lower oil prices

Tony Osborne London

While most of the air transport industry welcomes a reduction in the price of oil, it is more of a concern for those in the oil and gas support business.

Since helicopters are thirsty machines and gulp down significantly more fuel than their fixed-wing brethren, a decrease in their direct operating costs is extremely welcome.

But on the other hand, the falling price of oil means declining revenues for the oil company clients of the operators and their grand plans for future projects—visions of which have helped keep sales of medium and large helicopters buoyant throughout much of the world economic crisis—now face being delayed, or even canceled.

Exploration work is usually an early victim, with time frames for expensive prospecting and drilling programs pushed to the right or scrapped because of their perceived economic viability.

For larger helicopter operators such as Bristow and CHC, which have operations worldwide, a slowdown in exploration should have only a limited impact, as much of their income is derived from extraction or production that continues regardless of oil price trends. However, exploration represents up to 20-30% of operator revenues, ensuring work for some older models of helicopters that still dominate the fleets. It will also take time for exploration projects to be canceled and for that impact to be felt.

Sales of oil and gas helicopters like Airbus's EC225 could soften if fuel prices remain low.

But the reaction has been swift in some financial markets. Bristow's share price has dropped steadily, losing 25% since oil prices really began falling in mid-2014. CHC's share price has also fallen considerably in the same period.

In the company's in-house magazine, Bristow President and CEO Jonathan Baliff states that he expects more difficult conditions for the operators: "What's impacting growth now is that we've lived in a low-interest-rate environment with rising oil prices for a long time, and now oil prices are falling fast. We will see a lot of stress among the operators."

Bristow says it has about $700 million in cash and cash equivalents to protect itself and its clients, "so we can operate in a weak economic environment."

But, despite the weakening conditions, the operator is talking about a sizable order for new helicopters in the coming months.

T.R. Reid, a spokesman for CHC, tells Aviation Week: "We realized early last year that our clients were beginning to see a need to tighten their belts, and we took the opportunity to do the same, and streamlined our operations, and focused on our fleet modernization."

Both companies are not entirely dependent on oil and gas operations. They can also rely on significant incomes from search-and-rescue (SAR) contracts, the most significant being Bristow's long-term SAR deal with the British government, beginning in April.

How long oil prices remain at this low level is the biggest sticking point. The cost of a barrel of Brent Crude is now at its lowest level in more than five years, after tumbling in six months to less than $50 from its relatively stable price around $110. Several oil and gas giants have announced job cuts and are preparing for leaner times.

Some commentators suggest this period could provide an opportunity for helicopter operators to offload the older types from their fleet inventories—such as Eurocopter Super Pumas and older Sikorsky S-76s—and replace them with more up-to-date models, a scenario hoped for by the manufacturers.

Major oil companies continually demand the use of "new technology" to support their activities, particularly for production support contracts. Types such as the Airbus EC225 and EC175, Sikorsky S-92 or AgustaWestland AW189 are platforms of choice, while older aircraft are often used to support exploration.

While many signs point to low oil prices remaining for the short term, longer-term price stability could have severe impacts on the helicopter manufacturers. The high price of oil drove something of a boom for sales in medium and heavy helicopters even during the economic crisis. The OEMs have made significant investments in their rotorcraft to prepare them for long-range deepwater operators, as well as developing new products. The two-year delay for Airbus's EC175 super-medium means it has arrived during what could be a slump for orders, potentially putting it even further behind its rival, AgustaWestland's AW189.

TONY OSBORNE/AW&ST

Bell's new 525 Relentless has yet to fly but could find itself struggling for orders if low oil prices hold in what is a critical year for that program.

"We see a trend of cost reductions in this industry and this will trigger contracts being postponed," Guillaume Faury, president of Airbus Helicopters, told journalists in January.

Leasing companies may also suffer in the long term if they invested significantly in medium and large helicopters to support offshore growth. If that trend falters, it may take longer to find customers for their assets. Crispin Maunder, chairman of London-based leasing company LCI says only a fraction of its helicopters are dedicated to oil and gas services, with others used for SAR or emergency medical services.

"The majority of LCI's aircraft are used in deepwater offshore production, and we've seen little change in the operational use of our aircraft since oil prices declined," Maunder says.

Biofuel on the Scales

Cheap oil is not expected to impact biofuel developments, but it could slow commercialization efforts

Graham Warwick Washington

UNITED AIRLINES

One sector of aviation for which the dramatic drop in oil prices is not opportune is the biofuel industry, as it tries to move from research and development into commercialization and volume delivery of alternative jet fuels.

Airlines have begun the transition from demonstration flights to revenue services using biofuel blends but made clear they are not prepared to pay a significant premium for synthetic jet fuel, whatever its environmental benefits. When oil was above $100 a barrel, that looked like an achievable goal: With oil at $50 per barrel, today's biofuels cannot hope to compete on price.

But the airlines that are beginning to buy biofuels have committed to long-term offtake agreements, from three years for United Airlines' deal with Altair Fuels to 10 years for British Airways' waste-to-biofuel joint venture with Solena Fuels. This commitment—plus suspicion that oil prices will rise again and the small quantities of biofuels involved at this early stage—is giving the biofuel industry a buffer, for now.

The drop in fuel price comes as developers complete research and certification of new fuels and look for long-term offtake agreements with airlines to help with raising the financing needed to build the biorefineries. In comparison to the rapid pace of biofuel R&D, commercialization was already going slower than hoped for by the aviation industry.

"The immediate impact [of low oil prices] will be felt in terms of fuel producers having more difficulty with financing new facilities," says Steve Csonka, executive director of the Commercial Aviation Alternative Fuels Initiative (Caafi), a coalition of airlines, manufacturers, regulators and fuel producers. "Beyond that, it depends on the fundamentals of the marketplace and how long this will last. The primary precipitator of this was a policy decision, and that can be overturned instantaneously."

Lower petroleum prices do not change the rationale for developing sustainable aviation biofuels, says Boeing. "Oil prices are low today, but tend to be high and volatile over time—trends that are not expected to change." The severe fluctuations seen over the past decade make running airline operations difficult, and "an alternative fuel source can help alleviate that volatility," the manufacturer says.

Civil aviation has committed to achieving carbon-neutral growth by 2020 and by 2050 cutting carbon-dioxide emissions 50% compared with 2005. "Regardless of its price, using more petroleum will not reduce carbon emissions," says Boeing. Sustainable biofuels are a key part of achieving those goals, and so far progress has not been derailed by low oil prices.

"The 2020 goal of carbon-neutral growth will not be impacted at all, as this requires political action to develop a global MBM [market-based measure], and our efforts there continue unabated," states the Air Transport Action Group

United Airlines plans to begin uploading biofuel blend at Los Angeles International Airport in the second quarter, initially for Boeing 757s.

(ATAG). An MBM is an emissions-trading mechanism that puts a price on carbon. "We take the long-term view, as it is simply the right way to handle our part of the climate challenge," says the non-profit industry association.

For now, it is business as usual, says Caafi's Csonka. "There is a lot of development activity that has not been impacted by fuel prices, moving technologies to higher readiness levels and getting qualification through ASTM," the industry standards body responsible for approving new feedstock-to-fuel pathways for new synthetic jet fuels. U.S. government support for biofuel development and commercialization is also helping maintain momentum, he says, while the budget inertia behind its funding for drop-in biofuels and first-of-type biorefineries will provide a buffer for the industry.

"R&D activity is usually driven by cycles longer than what has occurred so far, so it is too early to see an impact. Qualification activity needs to lead demonstration and commercialization, and we are not sensing any let-off yet," Csonka says. Boeing agrees: "From our standpoint, we are seeing a lot of progress in increasing the aviation biofuel supply and bringing down its cost."

So far, three alternative jet-fuel pathways have been approved: Fischer-Tropsch synthetic paraffinic kerosene (SPK); hydroprocessed esters and fatty acids SPK; and synthetic iso-paraffins. Csonka expects the next ASTM approval, for alcohol-to-jet biofuel, by mid-year. There are another seven conversion processes with active task forces within ASTM. "My expectation is we will see those approved, one by one, every six months," he says. "Further up the pipeline are another six processes that have not yet formed task forces. The next several years look very robust."

Cheap oil is a recent phenomenon, and opinions could change if fuel prices stay low in the long term, but so far "the airlines have held their course, and we hope they will continue to," says Csonka. "The vein of inertia versus commitment on the government side is the same on the airline side. And it is very modest quantities of fuel we are talking about, so we expect the airlines to continue. From an aviation perspective, we need to move forward."

More Questions Than Answers

Cost, capacity, market and timing cloud 757 replacement options for Boeing, while Airbus faces more subtle product decisions

Guy Norris Los Angeles and Jens Flottau Frankfurt

Whatever else Boeing may be discussing with potential customers at this year's International Society of Transport Aircraft Trading (Istat) meeting regarding options for replacing the 757, we now at least know it will not be talking about bringing the original aircraft back to life with new engines.

The 757 replacement question has become an increasingly hot topic, particularly since Airbus upped the ante by launching the long-range A321neo LR variant in mid-January. Until then, Boeing had quietly conducted its ongoing studies through most of 2014, occasionally being more open about them at places such as the Singapore air show, when it acknowledged that serious market evaluations were underway.

Part of that issue has always been trying to figure out not only where and how big the market might be but whether it exists at all. Boeing has pointed out that the apparent gap on the seating chart between the 737-900/MAX 9 and the 787-8 does not necessarily create a cast-iron case for a new program, particularly when the current long-range use of the 757 is distinctly "niche" in nature.

Despite its popularity for longer-haul services, sales of the Asia-targeted Airbus A330 Regional have yet to take off.

Steven Udvar-Hazy, the highly influential CEO of Air Lease Corp., helped clarify the situation in a roundabout way on Feb. 10 after *The Wall Street Journal* reported his comments that Boeing could consider upgrading its out-of-production 757 with new engines and interiors. While Udvar-Hazy has helped drive some major design decisions, including most famously Airbus's redesign of the A350 to an all-new cross section, he could be out of luck when it comes to sparking a Phoenix-like reincarnation of the 757.

Commenting on speculation about a reengined 757, on Feb. 11 Boeing Commercial Marketing Vice President Randy Tinseth says, "The fact is, there's absolutely no business case to support that. We're very happy with our 737 and 787 product lineups. So we're studying the space in between them. Customer feedback has led us to look at an airplane that is larger than today's 737 and has greater range than the 757."

The statement reiterates Boeing's underlying message that if a market for a 757-sized aircraft does exist, it is for an all-new "middle of the market" (MOM) aircraft rather than a one-for-one successor to the current twinjet fleet. Earlier in 2014, Boeing's global sales and marketing vice president, John Wojick, told Aviation Week, "One opportunity is an airplane in the 200-300-seat category which maybe doesn't fly as far as 787 and which is more regional. People liken it to the 757 or something different." A key market for such an aircraft is likely to be Asia, and operators in this area "will play a significant role in helping us determine what those characteristics might be."

Echoing the view that Boeing is likely to take a longer-term view of this market niche rather than react to the A321neo LR with a short-to-mid-term reengining effort, Jeffries analyst Howard Rubel says, "There are over 150 757s parked in the desert today, approximately 15% of the fleet. If this plane [is] so hot, why is such a high proportion of the fleet going unused?" He adds that "we see no urgency to fill that market niche, and believe that Boeing has reasonable long-term options. The market may evolve and shift, creating a different need than what is perceived today. We are of the view that Boeing is not about to jump into a new development program."

Boeing's long-term new airplane development strategy is therefore focused on developing a New Small Airplane (NSA) 737 successor for the 2030s and beyond, and whether or not to tie this in with codevelopment of a larger MOM aircraft. "We have got things to work out, but there is no question there is the challenge of the transition between single aisle and twin aisle.

"We are working hard to understand how large that market really is because it is not that easy. What technologies do you need for an aircraft with a range of 4,000-5,000 nm, and at economics that make sense? And if it is a small market, how do you deliver at the right cost, and how do you set up a production system to do that?"

AIRBUS/H. GOUSSE

Others looking at Boeing's conundrum from the outside are also puzzled that the company is not, apparently, considering reviving the long-canceled short-to-mid range 787-3 for the MOM market. After all, the aircraft was designed to carry up to 330 passengers as far as 3,500 mi., making it close to the requirement. However, despite the fact that the broader appeal of the 787-3 was limited by being designed specifically for the Japanese market, more deeply rooted cost issues likely make the prospects of reviving the -3 a non-starter.

The 787 is the most complex, sophisticated commercial aircraft Boeing has ever produced, and it is inevitably costly to manufacture. While Boeing is making strides to drive costs down, it is extremely unlikely to produce a "simplified 787-3" at sufficiently low cost to sell to the MOM sector.

Although no one knows for sure what the exact passenger capacity and range needs are, all the Boeing planning pundits seem to agree that the 757 replacement market will be extremely cost-sensitive.

Mike Sinnett, vice president of product development for Boeing Commercial Airplanes, has already acknowledged that one option under study is to develop NSA and MOM in parallel, sharing common cockpits, systems and structures to cut costs. The result could be an "NSA1" aimed at the 737 market and a slightly larger, twin-aisle "NSA2" for the MOM sector.

The "common core" design approach was successfully used in the 1970s and 1980s to produce the 757/767 and is something "we would have in our mind going forward," he adds.

In December, Sinnett stressed to Aviation Week that the 757 replacement study "is a proxy for something that is not a 737 and is not a 757." The airlines are interested in something that "is more than a 757. They are not looking for a carbon copy," he said. Studies are therefore focused on designs with more range and capacity to "enter a niche, and to understand if it can be expanded into a third market segment. We are still testing the waters," Sinnett notes.

Far more immediate matters are therefore likely to dominate Boeing's agenda at Istat. These will include updates on the 737 MAX, the first of which will enter assembly at Renton, Washington, by year-end, as well as further measures to revive flagging sales of the 747-8, development progress on the 787-10 and new details of the planned upgrade to the current 777F and -200LR/300ER.

Airbus, in contrast, has already defined its answers for the segment of the market left open by the end of Boeing 757 and Airbus A300/A310 production. The answers are the A321LR—a minimal-change variant of the A321neo in the cabin-flex configuration with rearranged exit doors, and the A330 Regional. Airbus has already secured Udvar-Hazy's support for the A321LR, and is now promoting the aircraft to airlines following the official launch in January, but the proposed regional version of the A330 has not really taken off.

The aircraft—structurally identical to the long-haul version of the A330, but with de-rated engines and a lower maximum takeoff weight—was targeted in particular at the Chinese domestic market, where there are many high-density routes that are too large for the A321. However, Airbus has not yet identified any sales for the A330 Regional.

That is causing serious concerns in two ways. The manufacturer faces the challenge of smoothing the transition from the current version to the A330neo in the coming years. Airbus is slowing down A330 production from 10 aircraft per month to nine in the fourth quarter of this year, but it still has some open production slots in 2015, and—even more significantly—in the following years, leading many observers to conclude that more cuts are coming. Additional highly welcome short-term sales have not yet materialized.

But more long-term, the transition to the A330neo will potentially make sales of a regional version harder: The additional weight incorporated with the latest engines can be compensated for by lower fuel burn on longer-range routes, but the business case is much harder to make on the shorter-haul sectors that Airbus is targeting.

Airbus does not face comparable A330-related production issues in terms of the A320 family, which is essentially sold out through the A320neo transition unless a very large number of airlines decide to cancel late-production A320ceos because of lower fuel prices and opt instead to wait for the neo.

The next program decision Airbus may have to make is whether to reengine the A380. While that issue is likely to be broadly discussed at Istat, a decision may not be as near as the aircraft's main customer, Emirates, would like. But Airbus is coming under increasing pressure to clarify its position: The longer the speculation about an A380neo continues, the harder it becomes to sell earlier production slots of the current version to airlines that may be concerned about being stuck with late-build aircraft of an old production standard.

There is no business case for launching a revamped, reengined 757 to replace today's fleet, Boeing says.

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June 17—Commercial Aerospace Manufacturing Briefing, France.
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Nov. 3-5—Aerospace Defense Chain, Arizona.

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March 10-12—American Astronautical Society's 53rd Robert H. Goddard Memorial Symposium: "On the Cusp: What's Next?" Greenbelt (Maryland) Marriott Hotel. See www.astronautical.org
March 10-15—World ATM Congress (Canso). Madrid. See www.canso.org/worldatmcongress2015
March 15-17—Routes Asia. Kunming, Yunnan, China. See www.routesonline.com/events/173/routes-asia-2015/
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March 24-26—Spacecraft Thermal Control Workshop. The Aerospace Corp., El Segundo, California. See www.cvent.com/d/h4qy0m.
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Commonality: Where It Works And Fails

LOCKHEED MARTIN

BY MARK A. LORELL

In January, the U.S. Defense Department announced plans to fund a Darpa-Air Force-Navy technology demonstration program aimed at developing critical sixth-generation fighter capabilities. The Aerospace Innovation Initiative will develop common avionics, subsystems, engine technologies and other components that could be used on separate Air Force and Navy airframes. This announcement is an encouraging sign that the Pentagon is adopting a cost-effective strategy for joint fighter programs. However, it will need to remain vigilant to avoid the pitfalls that have caused previous joint fighter programs to fall short of hoped-for cost savings and to accept unwelcome design compromises.

The Pentagon has pursued several joint development programs—in which two or more services are significantly involved in all stages of the acquisition and operational phases—for fighters and other aircraft over the past 50 years, particularly during periods of great budgetary pressure. The reason is simple: Joint fighter programs appear to offer the prospect of life-cycle cost savings by eliminating duplicative research, development, testing and evaluation, and by achieving economies of scale in production, operations and support.

> "The fighter operating environments and missions and the doctrines of the military services vary widely."

However, Rand analysis of historical joint aircraft programs suggests such programs are highly unlikely to achieve overall life-cycle cost savings if they attempt to maximize airframe design commonality. This is because the fighter operating environments and missions and the doctrines of the military services vary widely. Moreover, Rand found that joint fighter and many other aircraft programs historically have experienced significant compromises in service-specific capability requirements and that their existence has contributed to a weakening of the industrial base.

In contrast, initial analysis suggests jointly developed engines, avionics and subsystems can lead to significant savings, even if these common elements are installed in completely different airframes optimized for different service requirements.

The case of the Joint Advanced Strike Technology (JAST) program, which became the F-35 Joint Strike Fighter (JSF) program, offers a cautionary tale for sixth-generation fighter programs. The genesis of this initiative was similar to the current Aerospace Innovation Initiative and had many of the same objectives. JAST (and later JSF) emerged in 1993 following a comprehensive examination of tactical fighter programs by the Defense Department's Bottom-Up Review. The BUR concluded that, given highly restrictive budgets following the end of the Cold War, the country could not afford independent development of all four fighter programs in development or planned: the F-22, F/A-18E/F, Air Force's Multi-Role fifth-generation Fighter (MRF) and Navy's A/F-X fifth-generation strike fighter. The BUR recommended canceling MRF and A/F-X and replacing them with an Air Force-Navy Joint Attack Fighter.

A subsequent independent Defense Science Board (DSB) Task Force review of the BUR's findings, while generally positive, strongly warned against developing a single joint airframe aimed at maximum commonality. The DSB was aware that a common airframe, while in theory capable of achieving savings, could not cost-effectively meet both Navy and Air Force requirements. Thus, the DSB specifically recommended that the Pentagon "consider two different airframes, with a common engine (or engine core), common avionics architecture, common weapons and a manufacturing process to facilitate efficient production of two different airframes." Soon afterward, the Pentagon stood up the JAST program based on these principles.

JAST began with high hopes of cost savings, based on the objectives recommended by the DSB. But by the mid-1990s, budgetary pressures and the promise of additional savings moved the program away from these objectives and toward a single airframe with 70-90% commonality among variants. It also incorporated a third set of extremely challenging requirements for a Marine short-takeoff-and-vertical-landing supersonic attack fighter. This shift in objectives virtually ensured that the JSF program would not achieve the hoped-for savings and that design compromises would have to be made to accommodate a largely common planform.

The new Aerospace Innovation Initiative for sixth-generation fighter capability appears to be on the right track, embracing principles consistent with the original vision for JAST. These principles could result in substantial cost savings while allowing services the flexibility to develop innovative airframes that meet their specific mission requirements. But if history is any lesson, the Office of the Secretary of Defense, the services, Congress and contractors should resist calls for further efficiencies through airframe commonality, a path that would likely undermine potential cost savings and compromise future mission effectiveness.

Lorell is a senior political scientist at the nonprofit, nonpartisan Rand Corp.

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